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**THE ENCYCLOPÆDIA BRITANNICA**  
**A DICTIONARY OF ARTS, SCIENCES, LITERATURE AND GENERAL INFORMATION**  
**ELEVENTH EDITION**

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**VOLUME XVI SLICE V**

**Letter to Lightfoot, John**

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Articles in This Slice

<a href="#">LETTER</a>	<a href="#">LIAS</a>
<a href="#">LETTERKENNY</a>	<a href="#">LIBANIUS</a>
<a href="#">LETTER OF CREDIT</a>	<a href="#">LIBATION</a>
<a href="#">LETTERS PATENT</a>	<a href="#">LIBAU</a>
<a href="#">LETTRES DE CACHET</a>	<a href="#">LIBEL and SLANDER</a>
<a href="#">LETTUCE</a>	<a href="#">LIBELLATICI</a>
<a href="#">LEUCADIA</a>	<a href="#">LIBER and LIBERA</a>
<a href="#">LEUCIPPUS</a>	<a href="#">LIBERAL PARTY</a>
<a href="#">LEUCITE</a>	<a href="#">LIBER DIURNUS ROMANORUM PONTIFICUM</a>
<a href="#">LEUCTRA</a>	<a href="#">LIBERIA</a>
<a href="#">LEUK</a>	<a href="#">LIBERIUS</a>
<a href="#">LEUTHEN</a>	<a href="#">LIBER PONTIFICALIS</a>
<a href="#">LEUTZE, EMANUEL</a>	<a href="#">LIBERTAD</a>
<a href="#">LEVALLOIS-PERRET</a>	<a href="#">LIBERTARIANISM</a>
<a href="#">LEVANT</a>	<a href="#">LIBERTINES</a>
<a href="#">LEVASSEUR, PIERRE EMILE</a>	<a href="#">LIBERTINES, SYNAGOGUE OF THE</a>

LEVECHE	LIBERTY
LEVÉE (river embankment)	LIBERTY PARTY
LEVEE (reception)	LIBITINA
LEVELLERS	LIBMANAN
LEVEN, ALEXANDER LESLIE	LIBO
LEVEN (Scottish burgh)	LIBON
LEVEN, LOCH	LIBOURNE
LEVEN AND MELVILLE, EARLS OF	LIBRA
LEVER, CHARLES JAMES	LIBRARIES
LEVER	LIBRATION
LEVERRIER, URBAIN JEAN JOSEPH	LIBYA
LEVERTIN, OSCAR IVAN	LICATA
LEVI, HERMANN	LICENCE
LEVI, LEONE	LICHEN
LEVIATHAN	LICHENS
LEVIRATE	LICHFIELD
LÉVIS	LICH-GATE
LEVITES	LICHTENBERG, GEORG CHRISTOPH
LEVITICUS	LICHTENBERG (German principality)
LEVY, AMY	LICINIANUS, GRANIUS
LEVY, AUGUSTE MICHEL	LICINIUS
LEVY (money raising)	LICINIUS CALVUS STOLO, GAIUS
LEWALD, FANNY	LICINIUS MACER CALVUS, GAIUS
LEWANIKA	LICODIA EUBEIA
LEWES, CHARLES LEE	LICTORS
LEWES, GEORGE HENRY	LIDDELL, HENRY GEORGE
LEWES (town of England)	LIDDESDALE
LEWES (Delaware, U.S.A.)	LIDDON, HENRY PARRY
LEWIS, SIR GEORGE CORNEWALL	LIE, JONAS LAURITZ EDEMIL
LEWIS, HENRY CARVILL	LIE, MARIUS SOPHUS
LEWIS, JOHN FREDERICK	LIEBER, FRANCIS
LEWIS, MATTHEW GREGORY	LIEBERMANN, MAX
LEWIS, MERIWETHER	LIEBIG, JUSTUS VON
LEWISBURG	LIEBKNECHT, WILHELM
LEWISHAM	LIECHTENSTEIN
LEWISTON	LIÉGE (province of Belgium)
LEWIS-WITH-HARRIS	LIÉGE (Belgian city)
LEXICON	LIEGE (feudal term)
LEXINGTON, BARON	LIEGNITZ
LEXINGTON (Kentucky, U.S.A.)	LIEN
LEXINGTON (Massachusetts, U.S.A.)	LIERRE
LEXINGTON (Missouri, U.S.A.)	LIESTAL
LEXINGTON (Virginia, U.S.A.)	LIEUTENANT
LEYDEN, JOHN	LIFE
LEYDEN JAR	LIFE-BOAT, and LIFE-SAVING SERVICE
LEYS, HENDRIK	LIFFORD
LEYTON	LIGAMENT
LHASA	LIGAO
L'HÔPITAL, MICHEL DE	LIGHT
LIAO-YANG	LIGHTFOOT, JOHN



**LETTER** (through Fr. *lettre* from Lat. *littera* or *litera*, letter of the alphabet; the origin of the Latin word is obscure; it has probably no connexion with the root of *linere*, to smear, *i.e.* with wax, for an inscription with a stilus), a character or symbol expressing any one of the elementary sounds into which a spoken word may be analysed, one of the members of an alphabet. As applied to things written, the word follows mainly the meanings of the Latin plural *litterae*, the most common meaning attaching to the word being that of a written communication from one person to another, an epistle (*q.v.*). For the means adopted to secure the transmission of letters see **POST AND POSTAL SERVICE**. The word is also, particularly in the plural, applied to many legal and formal written documents, as in letters patent, letters rogatory and dismissory, &c. The Latin use of the plural is also followed in the employment of “letters” in the sense of literature (*q.v.*) or learning.



**LETTERKENNY**, a market town of Co. Donegal, Ireland, 23 m. W. by S. of Londonderry by the Londonderry and Lough Swilly and Letterkenny railway. Pop. (1901) 2370. It has a harbour at Port Ballyrane, 1 m. distant on Lough Swilly. In the market square a considerable trade in grain, flax and provisions is prosecuted. Rope-making and shirt-making are industries. The handsome Roman Catholic cathedral for the diocese of Raphoe occupies a commanding site, and cost a large sum, as it contains carving from Rome, glass from Munich and a pulpit of Irish and Carrara marble. It was consecrated in 1901. There is a Catholic college dedicated to St Ewnan. The town, which is governed by an urban district council, is a centre for visitors to the county. Its name signifies the "hill of the O'Cannanans," a family who lorded over Tyrconnell before the rise of the O'Donnells.



**LETTER OF CREDIT**, a letter, open or sealed, from a banker or merchant, containing a request to some other person or firm to advance the bearer of the letter, or some other person named therein, upon the credit of the writer a particular or an unlimited sum of money. A letter of credit is either general or special. It is general when addressed to merchants or other persons in general, requesting an advance to a third person, and special when addressed to a particular person by name requesting him to make such an advance. A letter of credit is not a negotiable instrument. When a letter of credit is given for the purchase of goods, the letter of credit usually states the particulars of the merchandise against which bills are to be drawn, and shipping documents (bills of lading, invoices, insurance policies) are usually attached to the draft for acceptance.



**LETTERS PATENT.** It is a rule alike of common law and sound policy that grants of freehold interests, franchises, liberties, &c., by the sovereign to a subject should be made only after due consideration, and in a form readily accessible to the public. These ends are attained in England through the agency of that piece of constitutional machinery known as "letters patent." It is here proposed to consider only the characteristics of letters patent generally. The law relating to letters patent for inventions is dealt with under the heading **PATENTS**.

Letters patent (*litterae patentes*) are letters addressed by the sovereign "to all to whom these presents shall come," reciting the grant of some dignity, office, monopoly, franchise or other privilege to the patentee. They are not sealed up, but are left open (hence the term "patent"), and are recorded in the Patent Rolls in the Record Office, or in the case of very recent grants, in the Chancery Enrolment Office, so that all subjects of the realm may read and be bound by their contents. In this respect they differ from certain other letters of the sovereign directed to particular persons and for particular purposes, which, not being proper for public inspection, are closed up and sealed on the outside, and are thereupon called *writs close* (*litterae clausae*) and are recorded in the Close Rolls. Letters patent are used to put into commission various powers inherent in the crown—legislative powers, as when the sovereign entrusts to others the duty of opening parliament or assenting to bills; judicial powers, *e.g.* of gaol delivery; executive powers, as when the duties of Treasurer and Lord High Admiral are assigned to commissioners of the Treasury and Admiralty (Anson, *Const.* ii. 47). Letters patent are also used to incorporate bodies by charter—in the British colonies, this mode of legislation is frequently applied to joint stock companies (cf. Rev. Stats. Ontario, c. 191, s. 9)—to grant a *congé d'élire* to a dean and chapter to elect a bishop, or licence to convocation to amend canons; to grant pardon, and to confer certain offices and dignities. Among grants of offices, &c., made by letters patent the following may be enumerated: offices in the Herald's College; the dignities of a peer, baronet and knight bachelor; the appointments of lord-lieutenant, custos rotulorum of counties, judge of the High Court and Indian and Colonial judgeships, king's counsel, crown livings; the offices of attorney- and solicitor-general, commander-in-chief, master of the horse, keeper of the privy seal, postmaster-general, king's printer; grants of separate courts of quarter-sessions. The fees payable in respect of the grant of various forms of letters patent are fixed by orders of the lord chancellor, dated 20th of June 1871, 18th of July 1871 and 11th of Aug. 1881. (These orders are set out at length in the *Statutory Rules and Orders Revised* (ed. 1904), vol. ii. *tit.* "Clerk of the Crown in Chancery," pp. i. et seq.) Formerly each colonial governor was appointed and commissioned by letters patent under the great seal of the United Kingdom. But since 1875, the practice has been to create the office of governor in each colony by letters patent, and then to make each appointment to the office by commission under the Royal Sign Manual and to give to the governor so appointed instructions in a uniform shape under the Royal Sign Manual. The letters patent, commission and instructions, are commonly described as the Governor's Commission (see Jenkyns, *British Rule and Jurisdiction beyond the Seas*, p. 100; the forms now in use are printed in Appx. iv. Also the *Statutory Rules and Codes Revised*, ed. 1904, under the title of the colony to which they relate). The Colonial Letters Patent Act 1863 provides that letters patent shall not take effect in the colonies or possessions beyond the seas until their publication there by proclamation or otherwise (s. 2), and shall be void unless so published within nine months in the case of colonies east of Bengal or west of Cape Horn, and within six months in any other case. Colonial officers and judges holding offices by patent for life or for a term certain, are removable by a special procedure—"amotion"—by the Governor and Council, subject to a right of appeal to the king in Council (Leave of Absence Act, formerly cited as

"Burke's Act" 1782; see *Montagu v. Governor of Van Diemen's Land*, 1849, 6 Moo. P.C. 491; *Willis v. Gipps*, 1846, 6 St. Trials [N.S., 311]). The law of conquered or ceded colonies may be altered by the crown by letters patent under the Great Seal as well as by Proclamation or Order in Council (*Jephson v. Riera*, 1835, 3 Knapp, 130; 3 St. Trials [N.S.] 591).

*Procedure.*—Formerly letters patent were always granted under the Great Seal. But now, under the Crown Office Act 1877, and the Orders in Council made under it, many letters patent are sealed with the wafer great seal. Letters patent for inventions are issued under the seal of the Patent Office. The procedure by which letters patent are obtained is as follows: A warrant for the issue of letters patent is drawn up; and is signed by the lord chancellor; this is submitted to the law officers of the crown, who countersign it; finally, the warrant thus signed and countersigned is submitted to His Majesty, who affixes his signature. The warrant is then sent to the Crown Office and is filed, after it has been acted upon by the issue of letters patent under the great or under the wafer seal as the case may be. The letters patent are then delivered into the custody of those in whose favour they are granted.

*Construction.*—The construction of letters patent differs from that of other grants in certain particulars: (i.) Letters patent, contrary to the ordinary rule, are construed in a sense favourable to the grantor (viz. the crown) rather than to the grantee; although this rule is said not to apply so strictly where the grant is made for consideration, or where it purports to be made *ex certâ scientiâ et mero motu*. (ii.) When it appears from the face of the grant that the sovereign has been mistaken or deceived, either in matter of fact or in matter of law, as, *e.g.* by false suggestion on the part of the patentee, or by misrecital of former grants, or if the grant is contrary to law or uncertain, the letters patent are absolutely void, and may still, it would seem, be cancelled (except as regards letters patent for inventions, which are revoked by a special procedure, regulated by § 26 of the Patents Act 1883), by the procedure known as *scire facias*, an action brought against the patentee in the name of the crown with the fiat of the attorney-general.

As to letters patent generally, see Bacon's *Abridgment* ("Prerogative," F.); Chitty's *Prerogative*; Hindmarsh on *Patents* (1846); Anson, *Law and Custom of the Const.* ii. (3rd ed., Oxford and London, 1907-1908).

(A. W. R.)



**LETTRES DE CACHET.** Considered solely as French documents, *lettres de cachet* may be defined as letters signed by the king of France, countersigned by one of his ministers, and closed with the royal seal (*cachet*). They contained an order—in principle, any order whatsoever—emanating directly from the king, and executory by himself. In the case of organized bodies *lettres de cachet* were issued for the purpose of enjoining members to assemble or to accomplish some definite act; the provincial estates were convoked in this manner, and it was by a *lettre de cachet* (called *lettre de jussion*) that the king ordered a parlement to register a law in the teeth of its own remonstrances. The best-known *lettres de cachet*, however, were those which may be called penal, by which the king sentenced a subject without trial and without an opportunity of defence to imprisonment in a state prison or an ordinary gaol, confinement in a convent or a hospital, transportation to the colonies, or relegation to a given place within the realm.

The power which the king exercised on these various occasions was a royal privilege recognized by old French law, and can be traced to a maxim which furnished a text of the *Digest* of Justinian: "Rex solutus est a legibus." This signified particularly that when the king intervened directly in the administration proper, or in the administration of justice, by a special act of his will, he could decide without heeding the laws, and even in a sense contrary to the laws. This was an early conception, and in early times the order in question was simply verbal; thus some letters patent of Henry III. of France in 1576 (Isambert, *Anciennes lois françaises*, xiv. 278) state that François de Montmorency was "prisoner in our castle of the Bastille in Paris by verbal command" of the late king Charles IX. But in the 14th century the principle was introduced that the order should be written, and hence arose the *lettre de cachet*. The *lettre de cachet* belonged to the class of *lettres closes*, as opposed to *lettres patentes*, which contained the expression of the legal and permanent will of the king, and had to be furnished with the seal of state affixed by the chancellor. The *lettres de cachet*, on the contrary, were signed simply by a secretary of state (formerly known as *secrétaire des commandements*) for the king; they bore merely the imprint of the king's privy seal, from which circumstance they were often called, in the 14th and 15th centuries, *lettres de petit signet* or *lettres de petit cachet*, and were entirely exempt from the control of the chancellor.

While serving the government as a silent weapon against political adversaries or dangerous writers and as a means of punishing culprits of high birth without the scandal of a suit at law, the *lettres de cachet* had many other uses. They were employed by the police in dealing with prostitutes, and on their authority lunatics were shut up in hospitals and sometimes in prisons. They were also often used by heads of families as a means of correction, *e.g.* for protecting the family honour from the disorderly or criminal conduct of sons; wives, too, took advantage of them to curb the profligacy of husbands and vice versa. They were issued by the intermediary on the advice of the intendants in the provinces and of the lieutenant of police in Paris. In reality, the secretary of state issued them in a completely arbitrary fashion, and in most cases the king was unaware of their issue. In the 18th century it is certain that the letters were often issued blank, *i.e.* without containing the name of the person against whom they were directed; the recipient, or mandatary, filled in the name in order to make the letter effective.

Protests against the *lettres de cachet* were made continually by the parlement of Paris and by the provincial parlements, and often also by the States-General. In 1648 the sovereign courts of Paris procured their momentary suppression in a kind of charter of liberties which they imposed upon the crown, but which was ephemeral. It was not until the reign of Louis XVI. that a reaction against this abuse became clearly perceptible. At the beginning of that reign Malesherbes during his short ministry endeavoured to infuse some measure of justice into the system, and in March 1784 the baron de Breteuil, a minister of the king's household, addressed a

circular to the intendants and the lieutenant of police with a view to preventing the crying abuses connected with the issue of *lettres de cachet*. In Paris, in 1779, the *Cour des Aides* demanded their suppression, and in March 1788 the parlement of Paris made some exceedingly energetic remonstrances, which are important for the light they throw upon old French public law. The crown, however, did not decide to lay aside this weapon, and in a declaration to the States-General in the royal session of the 23rd of June 1789 (art. 15) it did not renounce it absolutely. *Lettres de cachet* were abolished by the Constituent Assembly, but Napoleon re-established their equivalent by a political measure in the decree of the 9th of March 1801 on the state prisons. This was one of the acts brought up against him by the *sénatus-consulte* of the 3rd of April 1814, which pronounced his fall "considering that he has violated the constitutional laws by the decrees on the state prisons."

See Honoré Mirabeau, *Les Lettres de cachet et des prisons d'état* (Hamburg, 1782), written in the dungeon at Vincennes into which his father had thrown him by a *lettre de cachet*, one of the ablest and most eloquent of his works, which had an immense circulation and was translated into English with a dedication to the duke of Norfolk in 1788; Frantz Funck-Brentano, *Les Lettres de cachet à Paris* (Paris, 1904); and André Chassaing, *Les Lettres de cachet sous l'ancien régime* (Paris, 1903).

(J. P. E.)



**LETTUCE**, known botanically as *Lactuca sativa* (nat. ord. Compositae), a hardy annual, highly esteemed as a salad plant. The London market-gardeners make preparation for the first main crop of Cos lettuces in the open ground early in August, a frame being set on a shallow hotbed, and, the stimulus of heat not being required, this is allowed to subside till the first week in October, when the soil, consisting of leaf-mould mixed with a little sand, is put on 6 or 7 in. thick, so that the surface is within 4½ in. of the sashes. The best time for sowing is found to be about the 11th of October, one of the best varieties being Lobjoits Green Cos. When the seeds begin to germinate the sashes are drawn quite off in favourable weather during the day, and put on, but tilted, at night in wet weather. Very little watering is required, and the aim should be to keep the plants gently moving till the days begin to lengthen. In January a more active growth is encouraged, and in mild winters a considerable extent of the planting out is done, but in private gardens the preferable time would be February. The ground should be light and rich, and well manured below, and the plants put out at 1 ft. apart each way with the dibble. Frequent stirring of the ground with the hoe greatly encourages the growth of the plants. A second sowing should be made about the 5th of November, and a third in frames about the end of January or beginning of February. In March a sowing may be made in some warm situation out of doors; successional sowings may be made in the open border about every third or fourth week till August, about the middle of which month a crop of Brown Cos, Hardy Hammersmith or Hardy White Cos should be sown, the latter being the most reliable in a severe winter. These plants may be put out early in October on the sides of ridges facing the south or at the front of a south wall, beyond the reach of drops from the copings, being planted 6 or 8 in. apart. Young lettuce plants should be thinned out in the seed-beds before they crowd or draw each other, and transplanted as soon as possible after two or three leaves are formed. Some cultivators prefer that the summer crops should not be transplanted, but sown where they are to stand, the plants being merely thinned out; but transplanting checks the running to seed, and makes the most of the ground.

503

For a winter supply by gentle forcing, the Hardy Hammersmith and Brown Dutch Cabbage lettuces, and the Brown Cos and Green Paris Cos lettuces, should be sown about the middle of August and in the beginning of September, in rich light soil, the plants being pricked out 3 in. apart in a prepared bed, as soon as the first two leaves are fully formed. About the middle of October the plants should be taken up carefully with balls attached to the roots, and should be placed in a mild hotbed of well-prepared dung (about 55°) covered about 1 ft. deep with a compost of sandy peat, leaf-mould and a little well-decomposed manure. The Cos and Brown Dutch varieties should be planted about 9 in. apart. Give plenty of air when the weather permits, and protect from frost. For winter work Stanstead Park Cabbage Lettuce is greatly favoured now by London market-gardeners, as it stands the winter well. Lee's Immense is another good variety, while All the Year Round may be sown for almost any season, but is better perhaps for summer crops.

There are two races of the lettuce, the Cos lettuce, with erect oblong heads, and the Cabbage lettuce, with round or spreading heads,—the former generally crisp, the latter soft and flabby in texture. Some of the best lettuces for general purposes of the two classes are the following:—

*Cos*: White Paris Cos, best for summer; Green Paris Cos, hardier than the white; Brown Cos, Lobjoits Green Cos, one of the hardiest and best for winter; Hardy White Cos.

*Cabbage*: Hammersmith Hardy Green; Stanstead Park, very hardy, good for winter; Tom Thumb; Brown Dutch; Neapolitan, best for summer; All the Year Round; Golden Ball, good for forcing in private establishments.

*Lactuca virosa*, the strong-scented lettuce, contains an alkaloid which has the power of dilating the pupil and may possibly be identical with hyoscyamine, though this point is as yet not determined. No variety of lettuce is now used for any medicinal purpose, though there is probably some slight foundation for the belief that the lettuce has faint narcotic properties.



**LEUCADIA**, the ancient name of one of the Ionian Islands, now Santa Maura (*q.v.*), and of its chief town

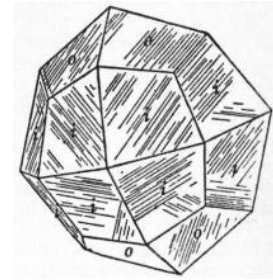


**LEUCIPPUS**, Greek philosopher, born at Miletus (or Elea), founder of the Atomistic theory, contemporary of Zeno, Empedocles and Anaxagoras. His fame was so completely overshadowed by that of Democritus, who subsequently developed the theory into a system, that his very existence was denied by Epicurus (Diog. Laërt. x. 7), followed in modern times by E. Rohde. Epicurus, however, distinguishes Leucippus from Democritus, and Aristotle and Theophrastus expressly credit him with the invention of Atomism. There seems, therefore, no reason to doubt his existence, although nothing is known of his life, and even his birthplace is uncertain. Between Leucippus and Democritus there is an interval of at least forty years; accordingly, while the beginnings of Atomism are closely connected with the doctrines of the Eleatics, the system as developed by Democritus is conditioned by the sophistical views of his time, especially those of Protagoras. While Leucippus's notion of Being agreed generally with that of the Eleatics, he postulated its plurality (atoms) and motion, and the reality of not-Being (the void) in which his atoms moved.

See **DEMOCRITUS**. On the Rohde-Diels controversy as to the existence of Leucippus, see F. Lortzing in Bursian's *Jahresbericht*, vol. cxvi. (1904); also J. Burnet, *Early Greek Philosophy* (1892).



**LEUCITE**, a rock-forming mineral composed of potassium and aluminium metasilicate  $KAl(SiO_3)_2$ . Crystals have the form of cubic icositetrahedra {211}, but, as first observed by Sir David Brewster in 1821, they are not optically isotropic, and are therefore pseudo-cubic. Goniometric measurements made by G. vom Rath in 1873 led him to refer the crystals to the tetragonal system, the faces *o* being distinct from those lettered *i* in the adjoining figure. Optical investigations have since proved the crystals to be still more complex in character, and to consist of several orthorhombic or monoclinic individuals, which are optically biaxial and repeatedly twinned, giving rise to twin-lamellae and to striations on the faces. When the crystals are raised to a temperature of about 500° C. they become optically isotropic, the twin-lamellae and striations disappearing, reappearing, however, when the crystals are again cooled. This pseudo-cubic character of leucite is exactly the same as that of the mineral boracite (*q.v.*).



The crystals are white (hence the name suggested by A. G. Werner in 1791, from λευκός) or ash-grey in colour, and are usually dull and opaque, but sometimes transparent and glassy; they are brittle and break with a conchoidal fracture. The hardness is 5.5, and the specific gravity 2.5. Enclosures of other minerals, arranged in concentric zones, are frequently present in the crystals. On account of the colour and form of the crystals the mineral was early known as "white garnet." French authors employ R. J. Haüy's name "amphigène."

(L. J. S.)

*Leucite Rocks.*—Although rocks containing leucite are numerically scarce, many countries such as England being entirely without them, yet they are of wide distribution, occurring in every quarter of the globe. Taken collectively, they exhibit a considerable variety of types and are of great interest petrographically. For the presence of this mineral it is necessary that the silica percentage of the rock should not be high, for leucite never occurs in presence of free quartz. It is most common in lavas of recent and Tertiary age, which have a fair amount of potash, or at any rate have potash equal to or greater than soda; if soda preponderates nepheline occurs rather than leucite. In pre-Tertiary rocks leucite is uncommon, since it readily decomposes and changes to zeolites, analcite and other secondary minerals. Leucite also is rare in plutonic rocks and dike rocks, but leucite-syenite and leucite-tinguaite bear witness to the possibility that it may occur in this manner. The rounded shape of its crystals, their white or grey colour, and rough cleavage, make the presence of leucite easily determinable in many of these rocks by simple inspection, especially when the crystals are large. "Pseudo-leucites" are rounded areas consisting of feldspar, nepheline, analcite, &c., which have the shape, composition and sometimes even the crystalline forms of leucite; they are probably pseudomorphs or paramorphs, which have developed from leucite because this mineral, in its isometric crystals, is not stable at ordinary temperatures and may be expected under favourable conditions to undergo spontaneous change into an aggregate of other minerals. Leucite is very often accompanied by nepheline, sodalite or nosean; other minerals which make their appearance with some frequency are melanite, garnet and melilite.

The plutonic leucite-bearing rocks are leucite-syenite and missourite. Of these the former consists of orthoclase, nepheline, sodalite, diopside and aegirine, biotite and sphene. Two occurrences are known, one in Arkansas, the other in Sutherlandshire, Scotland. The Scottish rock has been called borolanite. Both examples show large rounded spots in the hand specimens; they are pseudo-leucites and under the microscope prove to consist of orthoclase, nepheline, sodalite and decomposition products. These have a radiate arrangement externally, but are of irregular structure at their centres; it is interesting to note that in both rocks melanite is an important accessory. The missourites are more basic and consist of leucite, olivine, augite and biotite; the leucite is partly fresh, partly altered to analcite, and the rock has a spotted character recalling that of the leucite-syenites. It has been found only in the Highwood Mountains of Montana.

The leucite-bearing dike-rocks are members of the tinguaite and monchiquite groups. The leucite-tinguaite is usually pale grey or greenish in colour and consist principally of nepheline, alkali-feldspar and aegirine. The latter forms bright green moss-like patches and growths of indefinite shape, or in other cases scattered acicular

prisms, among the feldspars and nephelines of the ground mass. Where leucite occurs, it is always eumorphic in small, rounded, many-sided crystals in the ground mass, or in larger masses which have the same characters as the pseudo-leucites. Biotite occurs in some of these rocks, and melanite also is present. Nepheline appears to decrease in amount as leucite increases. Rocks of this group are known from Rio de Janeiro, Arkansas, Kola (in Finland), Montana and a few other places. In Greenland there are leucite-tingvaites with much arfvedsonite (hornblende) and eudyalite. Wherever they occur they accompany leucite- and nepheline-syenites. Leucite-monchiquites are fine-grained dark rocks consisting of olivine, titaniferous augite and iron oxides, with a glassy ground mass in which small rounded crystals of leucite are scattered. They have been described from Bohemia.

By far the greater number of the rocks which contain leucite are lavas of Tertiary or recent geological age. They are never acid rocks which contain quartz, but feldspar is usually present, though there are certain groups of leucite lavas which are non-feldspathic. Many of them also contain nepheline, sodalite, hauyne and nosean; the much rarer mineral melilite appears also in some examples. The commonest ferromagnesian mineral is augite (sometimes rich in soda), with olivine in the more basic varieties. Hornblende and biotite occur also, but are less common. Melanite is found in some of the lavas, as in the leucite-syenites.

The rocks in which orthoclase (or sanidine) is present in considerable amount are leucite-trachytes, leucite-phonolites and leucitophyres. Of these groups the two former, which are not sharply distinguished from one another by most authors, are common in the neighbourhood of Rome (L. Bracciano, L. Bolsena). They are of trachytic appearance, containing phenocrysts of sanidine, leucite, augite and biotite. Sodalite or hauyne may also be present, but nepheline is typically absent. Rocks of this class occur also in the tuffs of the Phlegraean Fields, near Naples. The leucitophyres are rare rocks which have been described from various parts of the volcanic district of the Rhine (Olbrück, Laacher See, &c.) and from Monte Vulture in Italy. They are rich in leucite, but contain also some sanidine and often much nepheline with hauyne or nosean. Their pyroxene is principally aegirine or aegirine augite; some of them are rich in melanite. Microscopic sections of some of these rocks are of great interest on account of their beauty and the variety of feldspathoid minerals which they contain. In Brazil leucitophyres have been found which belong to the Carboniferous period.

Those leucite rocks which contain abundant essential plagioclase feldspar are known as leucite-tephrites and leucite-basanites. The former consist mainly of plagioclase, leucite and augite, while the latter contain olivine in addition. The leucite is often present in two sets of crystals, both porphyritic and as an ingredient of the ground mass. It is always idiomorphic with rounded outlines. The feldspar ranges from bytownite to oligoclase, being usually a variety of labradorite; orthoclase is scarce. The augite varies a good deal in character, being green, brown or violet, but aegirine (the dark green pleochroic soda-iron-augite) is seldom present. Among the accessory minerals biotite, brown hornblende, hauyne, iron oxides and apatite are the commonest; melanite and nepheline may also occur. The ground mass of these rocks is only occasionally rich in glass. The leucite-tephrites and leucite-basanites of Vesuvius and Somma are familiar examples of this class of rocks. They are black or ash-grey in colour, often vesicular, and may contain many large grey phenocrysts of leucite. Their black augite and yellow green olivine are also easily detected in hand specimens. From Volcanello, Sardinia and Roccamonfina similar rocks are obtained; they occur also in Bohemia, in Java, Celebes, Kilimanjaro (Africa) and near Trebizond in Asia Minor.

Leucite lavas from which feldspar is absent are divided into the leucitites and leucite basalts. The latter contain olivine, the former do not. Pyroxene is the usual ferromagnesian mineral, and resembles that of the tephrites and basanites. Sanidine, melanite, hauyne and perovskite are frequent accessory minerals in these rocks, and many of them contain melilite in some quantity. The well-known leucitite of the Capo di Bove, near Rome, is rich in this mineral, which forms irregular plates, yellow in the hand specimen, enclosing many small rounded crystals of leucite. Bracciano and Roccamonfina are other Italian localities for leucitite, and in Java, Montana, Celebes and New South Wales similar rocks occur. The leucite-basalts belong to more basic types and are rich in olivine and augite. They occur in great numbers in the Rhenish volcanic district (Eifel, Laacher See) and in Bohemia, and accompany tephrites or leucitites in Java, Montana, Celebes and Sardinia. The "peperino" of the neighbourhood of Rome is a leucitite tuff.

(J. S. F.)



**LEUCTRA**, a village of Boeotia in the territory of Thespieae, chiefly noticeable for the battle fought in its neighbourhood in 371 B.C. between the Thebans and the Spartans and their allies. A Peloponnesian army, about 10,000 strong, which had invaded Boeotia from Phocis, was here confronted by a Boeotian levy of perhaps 6000 soldiers under Epaminondas (*q.v.*). In spite of inferior numbers and the doubtful loyalty of his Boeotian allies, Epaminondas offered battle on the plain before the town. Massing his cavalry and the 50-deep column of Theban infantry on his left wing, he sent forward this body in advance of his centre and right wing. After a cavalry engagement in which the Thebans drove their enemies off the field, the decisive issue was fought out between the Theban and Spartan foot. The latter, though fighting well, could not sustain in their 12-deep formation the heavy impact of their opponents' column, and were hurled back with a loss of about 2000 men, of whom 700 were Spartan citizens, including the king Cleombrotus. Seeing their right wing beaten, the rest of the Peloponnesians retired and left the enemy in possession of the field. Owing to the arrival of a Thessalian army under Jason of Pherae, whose friendship they did not trust, the Thebans were unable to exploit their victory. But the battle is none the less of great significance in Greek history. It marks a revolution in military tactics, affording the first known instance of a deliberate concentration of attack upon the vital point of the enemy's line. Its political effects were equally far-reaching, for the loss in material strength and prestige which the Spartans here sustained deprived them for ever of their supremacy in Greece.

AUTHORITIES.—Xenophon, *Hellenica*, vi. 4. 3-15; Diodorus xi. 53-56; Plutarch, *Pelopidas*, chs. 20-23; Pausanias ix. 13. 2-10; G. B. Grundy, *The Topography of the Battle of Plataea* (London, 1894), pp. 73-76; H. Delbrück, *Geschichte der Kriegskunst* (Berlin, 1900), i. 130 ff.

(M. O. B. C.)



**LEUK** (Fr. *Loèche Ville*), an ancient and very picturesque little town in the Swiss canton of the Valais. It is built above the right bank of the Rhone, and is about 1 m. from the Leuk-Susten station (15½ m. east of Sion and 17½ m. west of Brieg) on the Simplon railway. In 1900 it had 1592 inhabitants, all but wholly German-speaking and Romanists. About 10½ m. by a winding carriage road N. of Leuk, and near the head of the Dala valley, at a height of 4629 ft. above the sea-level, and overshadowed by the cliffs of the Gemmi Pass (7641 ft.; *q.v.*) leading over to the Bernese Oberland, are the Baths of Leuk (*Leukerbad*, or *Loèche les Bains*). They have only 613 permanent inhabitants, but are much frequented in summer by visitors (largely French and Swiss) attracted by the hot mineral springs. These are 22 in number, and are very abundant. The principal is that of St Laurence, the water of which has a temperature of 124° F. The season lasts from June to September. The village in winter is long deprived of sunshine, and is much exposed to avalanches, by which it was destroyed in 1518, 1719 and 1756, but it is now protected by a strong embankment from a similar catastrophe.

(W. A. B. C.)



**LEUTHEN**, a village of Prussian Silesia, 10 m. W. of Breslau, memorable as the scene of Frederick the Great's victory over the Austrians on December 5, 1757. The high road from Breslau to Lüben crosses the marshy Schweidnitz Water at Lissa, and immediately enters the rolling country about Neumarkt. Leuthen itself stands some 4000 paces south of the road, and a similar distance south again lies Sagschütz, while Nypern, on the northern edge of the hill country, is 5000 paces from the road. On Frederick's approach the Austrians took up a line of battle resting on the two last-named villages. Their whole position was strongly garrisoned and protected by obstacles, and their artillery was numerous though of light calibre. A strong outpost of Saxon cavalry was in Borne to the westward. Frederick had the previous day surprised the Austrian bakeries at Neumarkt, and his Prussians, 33,000 to the enemy's 82,000, moved towards Borne and Leuthen early on the 5th. The Saxon outpost was rushed at in the morning mist, and, covered by their advanced guard on the heights beyond, the Prussians wheeled to their right. Prince Charles of Lorraine, the Austrian commander-in-chief, on Leuthen Church tower, could make nothing of Frederick's movements, and the commander of his right wing (Lucchesi) sent him message after message from Nypem and Gocklerwitz asking for help, which was eventually despatched. But the real blow was to fall on the left under Nadasdy. While the Austrian commander was thus wasting time, the Prussians were marching against Nadasdy in two columns, which preserved their distances with an exactitude which has excited the wonder of modern generations of soldiers; at the due place they wheeled into line of battle obliquely to the Austrian front, and in one great *échelon*,—the cavalry of the right wing foremost, and that of the left "refused,"—Frederick advanced on Sagschütz. Nadasdy, surprised, put a bold face on the matter and made a good defence, but he was speedily routed, and, as the Prussians advanced, battalion after battalion was rolled up towards Leuthen until the Austrians faced almost due south. The fighting in Leuthen itself was furious; the Austrians stood, in places, 100 deep, but the disciplined valour of the Prussians carried the village. For a moment the victory was endangered when Lucchesi came down upon the Prussian left wing from the north, but Driesen's cavalry, till then refused, charged him in flank and scattered his troopers in wild rout. This stroke ended the battle. The retreat on Breslau became a rout almost comparable to that of Waterloo, and Prince Charles rallied, in Bohemia, barely 37,000 out of his 82,000. Ten thousand Austrians were left on the field, 21,000 taken prisoners (besides 17,000 in Breslau a little later), with 51 colours and 116 cannon. The Prussian loss in all was under 5500. It was not until 1854 that a memorial of this astonishing victory was erected on the battlefield.

See Carlyle, *Frederick*, bk. xviii. cap. x.; V. Ollech, *Friedrich der Grosse von Kolin bis Leuthen* (Berlin, 1858); Kutzen, *Schlacht bei Leuthen* (Breslau, 1851); and bibliography under [SEVEN YEARS' WAR](#).



**LEUTZE, EMANUEL** (1816-1868), American artist, was born at Gmünd, Württemberg, on the 24th of May 1816, and as a child was taken by his parents to Philadelphia, where he early displayed talent as an artist. At the age of twenty-five he had earned enough to take him to Düsseldorf for a course of art study at the royal academy. Almost immediately he began the painting of historical subjects, his first work, "Columbus before the Council of Salamanca," being purchased by the Düsseldorf Art Union. In 1860 he was commissioned by the United States Congress to decorate a stairway in the Capitol at Washington, for which he painted a large composition, "Westward the Star of Empire takes its Way." His best-known work, popular through engraving, is "Washington crossing the Delaware," a large canvas containing a score of life-sized figures; it is now owned by the Metropolitan Museum of Art, New York. He became a member of the National Academy of Design in 1860, and died at Washington, D.C., on the 18th of July 1868.





**LEVALLOIS-PERRET**, a north-western suburb of Paris, on the right bank of the Seine, 2½ m. from the centre of the city. Pop. (1906) 61,419. It carries on the manufacture of motor-cars and accessories, carriages, groceries, liqueurs, perfumery, soap, &c., and has a port on the Seine.



**LEVANT** (from the French use of the participle of *lever*, to rise, for the east, the orient), the name applied widely to the coastlands of the eastern Mediterranean Sea from Greece to Egypt, or, in a more restricted and commoner sense, to the Mediterranean coastlands of Asia Minor and Syria. In the 16th and 17th centuries the term "High Levant" was used of the Far East. The phrase "to levant," meaning to abscond, especially of one who runs away leaving debts unpaid, particularly of a betting man or gambler, is taken from the Span. *levantar*, to lift or break up, in such phrases as *levantar la casa*, to break up a household, or *el campo*, to break camp.



**LEVASSEUR, PIERRE EMILE** (1828- ), French economist, was born in Paris on the 8th of December 1828. Educated in Paris, he began to teach in the lycée at Alençon in 1852, and in 1857 was chosen professor of rhetoric at Besançon. He returned to Paris to become professor at the lycée Saint Louis, and in 1868 he was chosen a member of the academy of moral and political sciences. In 1872 he was appointed professor of geography, history and statistics in the Collège de France, and subsequently became also professor at the Conservatoire des arts et métiers and at the École libre des sciences politiques. Levasseur was one of the founders of the study of commercial geography, and became a member of the Council of Public Instruction, president of the French society of political economy and honorary president of the French geographical society.

His numerous writings include: *Histoire des classes ouvrières en France depuis la conquête de Jules César jusqu'à la Révolution* (1859); *Histoire des classes ouvrières en France depuis la Révolution jusqu'à nos jours* (1867); *L'Étude et l'enseignement de la géographie* (1871); *La Population française* (1889-1892); *L'Agriculture aux États-Unis* (1894); *L'Enseignement primaire dans les pays civilisés* (1897); *L'Ouvrier américain* (1898); *Questions ouvrières et industrielles sous la troisième République* (1907); and *Histoire des classes ouvrières et de l'industrie en France de 1789 à 1870* (1903-1904). He also published a *Grand Atlas de géographie physique et politique* (1890-1892).



**LEVECHE**, the name given to the dry hot sirocco wind in Spain; often incorrectly called the "solano." The direction of the Leveche is mostly from S.E., S. or S.W., and it occurs along the coast from Cabo de Gata to Cabo de Nao, and even beyond Malaga for a distance of some 10 m. inland.



**LEVÉE** (from Fr. *lever*, to raise), an embankment which keeps a river in its channel. A river such as the Mississippi (*q.v.*), draining a large area, carries a great amount of sediment from its swifter head-streams to the lower ground. As soon as a stream's velocity is checked, it drops a portion of its load of sediment and spreads an alluvial fan in the lower part of its course. This deposition of material takes place particularly at the sides of the stream where the velocity is least, and the banks are in consequence raised above the main channel, so that the river becomes lifted bodily upwards in its bed, and flows above the level of the surrounding country. In flood-time the muddy water flows over the river's banks, where its velocity is at once checked as it flows gently down the outer side, causing more material to be deposited there, and a long alluvial ridge, called a natural levée, to be built up on either side of the stream. These ridges may be wide or narrow, but they slope from the stream's outer banks to the plain below, and in consequence require careful watching, for if the levée is broken by a "crevasse," the whole body of the river may pour through and flood the country below. In 1890 the Mississippi near New Orleans broke through the Nita crevasse and flowed eastward with a current of 15 m. an hour, spreading destruction in its path. The Hwang-ho river in China is peculiarly liable to these inundations. The word levée is also sometimes used to denote a riverside quay or landing-place.



**LEVEE** (from the French substantival use of *lever*, to rise; there is no French substantival use of *levée* in the English sense), a reception or assembly held by the British sovereign or his representative, in Ireland by the lord-lieutenant, in India by the viceroy, in the forenoon or early afternoon, at which men only are present in distinction from a "drawing-room," at which ladies also are presented or received. Under the *ancien régime* in France the *lever* of the king was regulated, especially under Louis XIV., by elaborate etiquette, and the various divisions of the ceremonial followed the stages of the king's rising from bed, from which it gained its name. The *petit lever* began when the king had washed and said his daily offices; to this were admitted the princes of the blood, certain high officers of the household and those to whom a special permit had been granted; then followed the *première entrée*, to which came the secretaries and other officials and those having the *entrée*; these were received by the king in his dressing-gown. Finally, at the *grand lever*, the remainder of the household, the nobles and gentlemen of the court were received; the king by that time was shaved, had changed his linen and was in his wig. In the United States the term "levee" was formerly used of the public receptions held by the president.

506



**LEVELLERS**, the name given to an important political party in England during the period of the Civil War and the Commonwealth. The germ of the Levelling movement must be sought for among the Agitators (*q.v.*), men of strong republican views, and the name Leveller first appears in a letter of the 1st of November 1647, although it was undoubtedly in existence as a nickname before this date (Gardiner, *Great Civil War*, iii. 380). This letter refers to these extremists thus: "They have given themselves a new name, viz. Levellers, for they intend to sett all things straight, and rayse a parity and community in the kingdom."

The Levellers first became prominent in 1647 during the protracted and unsatisfactory negotiations between the king and the parliament, and while the relations between the latter and the army were very strained. Like the Agitators they were mainly found among the soldiers; they were opposed to the existence of kingship, and they feared that Cromwell and the other parliamentary leaders were too complaisant in their dealings with Charles; in fact they doubted their sincerity in this matter. Led by John Lilburne (*q.v.*) they presented a manifesto, *The Case of the Army truly stated*, to the commander-in-chief, Lord Fairfax, in October 1647. In this they demanded a dissolution of parliament within a year and substantial changes in the constitution of future parliaments, which were to be regulated by an unalterable "law paramount." In a second document, *The Agreement of the People*, they expanded these ideas, which were discussed by Cromwell, Ireton and other officers on the one side, and by John Wildman, Thomas Rainsborough and Edward Sexby for the Levellers on the other. But no settlement was made; some of the Levellers clamoured for the king's death, and in November 1647, just after his flight from Hampton Court to Carisbrooke, they were responsible for a mutiny which broke out in two regiments at Corkbush Field, near Ware. This, however, was promptly suppressed by Cromwell. During the twelve months which immediately preceded the execution of the king the Levellers conducted a lively agitation in favour of the ideas expressed in the *Agreement of the people*, and in January 1648 Lilburne was arrested for using seditious language at a meeting in London. But no success attended these and similar efforts, and their only result was that the Levellers regarded Cromwell with still greater suspicion.

Early in 1649, just after the death of the king, the Levellers renewed their activity. They were both numerous and dangerous, and they stood up, says Gardiner, "for an exaggeration of the doctrine of parliamentary supremacy." In a pamphlet, *England's New Chains*, Lilburne asked for the dissolution of the council of state and for a new and reformed parliament. He followed this up with the *Second Part of England's New Chains*; his writings were declared treasonable by parliament, and in March 1649 he and three other leading Levellers, Richard Overton, William Walwyn and Prince were arrested. The discontent which was spreading in the army was fanned when certain regiments were ordered to proceed to Ireland, and in April 1649 there was a meeting in London; but this was quickly put down by Fairfax and Cromwell, and its leader, Robert Lockyer, was shot. Risings at Burford and at Banbury were also suppressed without any serious difficulty, and the trouble with the Levellers was practically over. Gradually they became less prominent, but under the Commonwealth they made frequent advances to the exiled king Charles II., and there was some danger from them early in 1655 when Wildman was arrested and Sexby escaped from England. The distinguishing mark of the Leveller was a sea-green ribbon.

Another but more harmless form of the same movement was the assembling of about fifty men on St George's Hill near Oatlands in Surrey. In April 1649 these "True Levellers" or "Diggers," as they were called, took possession of some unoccupied ground which they began to cultivate. They were, however, soon dispersed, and their leaders were arrested and brought before Fairfax, when they took the opportunity of denouncing landowners. It is interesting to note that Lilburne and his colleagues objected to being designated Levellers, as they had no desire to take away "the proper right and title that every man has to what is his own."

Cromwell attacked the Levellers in his speech to parliament in September 1654 (Carlyle, *Cromwell's Letters and Speeches*, Speech II.). He said: "A nobleman, a gentleman, a yeoman; the distinction of these; that is a good interest of the nation, and a great one. The 'natural' magistracy of the nation, was it not almost trampled under foot, under despite and contempt, by men of Levelling principles? I beseech you, for the orders of men and ranks of men, did not that Levelling principle tend to the reducing of all to an equality? Did it 'consciously' think to do so; or did it 'only unconsciously' practise towards that for property and interest? 'At all events,' what was the

purport of it but to make the tenant as liberal a fortune as the landlord? Which, I think, if obtained, would not have lasted long.”

In 1724 there was a rising against enclosures in Galloway, and a number of men who took part therein were called Levellers or Dyke-breakers (A. Lang, *History of Scotland*, vol. iv.). The word was also used in Ireland during the 18th century to describe a secret revolutionary society similar to the Whiteboys.

(A. W. H.\*)



**LEVEN, ALEXANDER LESLIE**, 1<sup>ST</sup> EARL OF (c. 1580-1661), Scottish general, was the son of George Leslie, captain of Blair-in-Athol, and a member of the family of Leslie of Balquhain. After a scanty education he sought his fortune abroad, and became a soldier, first under Sir Horace Vere in the Low Countries, and afterwards (1605) under Charles IX. and Gustavus Adolphus of Sweden, in whose service he remained for many years and fought in many campaigns with honour. In 1626 Leslie had risen by merit to the rank of lieutenant-general, and had been knighted by Gustavus. In 1628 he distinguished himself by his constancy and energy in the defence of Stralsund against Wallenstein, and in 1630 seized the island of Rügen in the name of the king of Sweden. In the same year he returned to Scotland to assist in recruiting and organizing the corps of Scottish volunteers which James, 3rd marquis of Hamilton, brought over to Gustavus in 1631. Leslie received a severe wound in the following winter, but was able nevertheless to be present at Gustavus's last battle at Lützen. Like many others of the soldiers of fortune who served under Gustavus, Leslie cherished his old commander's memory to the day of his death, and he kept with particular care a jewel and miniature presented to him by the king. He continued as a general officer in the Swedish army for some years, was promoted in 1636 to the rank of field marshal, and continued in the field until 1638, when events recalled him to his own country. He had married long before this—in 1637 his eldest son was made a colonel in the Swedish army—and he had managed to keep in touch with Scottish affairs.

As the foremost Scottish soldier of his day he was naturally nominated to command the Scottish army in the impending war with England, a post which, resigning his Swedish command, he accepted with a glad heart, for he was an ardent Covenanter and had caused “a great number of our commanders in Germany subscribe our covenant” (Baillie's *Letters*). On leaving Sweden he brought back his arrears of pay in the form of cannon and muskets for his new army. For some months he busied himself with the organization and training of the new levies, and with inducing Scottish officers abroad to do their duty to their country by returning to lead them. Diminutive in size and somewhat deformed in person as he was, his reputation and his shrewdness and simple tact, combined with the respect for his office of lord general that he enforced on all ranks, brought even the unruly nobles to subordination. He had by now amassed a considerable fortune and was able to live in a manner befitting a commander-in-chief, even when in the field. One of his first exploits was to take the castle of Edinburgh by surprise, without the loss of a man. He commanded the Scottish army at Dunse Law in May of that year, and in 1640 he invaded England, and defeated the king's troops at Newburn on the Tyne, which gave him possession of Newcastle and of the open country as far as the Tees. At the treaty with the king at Ripon, Leslie was one of the commissioners of the Scottish parliament, and when Charles visited Edinburgh Leslie entertained him magnificently and accompanied him when he drove through the streets. His affirmations of loyalty to the crown, which later events caused to be remembered against him, were sincere enough, but the complicated politics of the time made it difficult for Leslie, the lord general of the Scottish army, to maintain a perfectly consistent attitude. However, his influence was exercised chiefly to put an end to, even to hush up, the troubles, and he is found, now giving a private warning to plotters against the king to enable them to escape, now guarding the Scottish parliament against a royalist *coup d'état*, and now securing for an old comrade of the German wars, Patrick Ruthven, Lord Ettrick, indemnity for having held Edinburgh Castle for the king against the parliament. Charles created him, by patent dated Holyrood, October 11, 1641, earl of Leven and Lord Balgonie, and made him captain of Edinburgh Castle and a privy councillor. The parliament recognized his services by a grant, and, on his resigning the lord generalship, appointed him commander of the permanent forces. A little later, Leven, who was a member of the committee of the estates which exercised executive powers during the recess of parliament, used his great influence in support of a proposal to raise a Scottish army to help the elector palatine in Germany, but the Ulster massacres gave this force, when raised, a fresh direction and Leven himself accompanied it to Ireland as lord general. He did not remain there long, for the Great Rebellion (*q.v.*) had begun in England, and negotiations were opened between the English and the Scottish parliaments for mutual armed assistance. Leven accepted the command of the new forces raised for the invasion of England, and was in consequence freely accused of having broken his personal oath to Charles, but he could hardly have acted otherwise than he did, and at that time, and so far as the Scots were concerned, to the end of the struggle, the parliaments were in arms, professedly and to some extent actually, to rescue his majesty from the influence of evil counsellors.

The military operations preceding Marston Moor are described under [GREAT REBELLION](#), and the battle itself under its own heading. Leven's great reputation, wisdom and tact made him an ideal commander for the allied army formed by the junction of Leven's, Fairfax's and Manchester's in Yorkshire. After the battle the allied forces separated, Leven bringing the siege of Newcastle to an end by storming it. In 1645 the Scots were less successful, though their operations ranged from Westmorland to Hereford, and Leven himself had many administrative and political difficulties to contend with. These difficulties became more pronounced when in 1646 Charles took refuge with the Scottish army. The king remained with Leven until he was handed over to the English parliament in 1647, and Leven constantly urged him to take the covenant and to make peace. Presbyterians and Independents had now parted, and with no more concession than the guarantee of the covenant the Scottish and English Presbyterians were ready to lay down their arms, or to turn them against the “sectaries.” Leven was now old and infirm, and though retained as nominal commander-in-chief saw no further active service. He acted with Argyll and the “godly” party in the discussions preceding the second invasion of England, and remained at his post as long as possible in the hope of preventing the Scots becoming merely a royalist instrument for the conquest of the English Independents. But he was induced in the end to resign,

though he was appointed lord general of all new forces that might be raised for the defence of Scotland. The occasion soon came, for Cromwell annihilated the Scottish invaders at Preston and Uttoxeter, and thereupon Argyll assumed political and Leven military control at Edinburgh. But he was now over seventy years of age, and willingly resigned the effective command to his subordinate David Leslie (see [NEWARK, LORD](#)), in whom he had entire confidence. After the execution of Charles I. the war broke out afresh, and this time the "godly" party acted with the royalists. In the new war, and in the disastrous campaign of Dunbar, Leven took but a nominal part, though attempts were afterwards made to hold him responsible. But once more the parliament refused to accept his resignation. Leven at last fell into the hands of a party of English dragoons in August 1651, and with some others was sent to London. He remained incarcerated in the Tower for some time, till released on finding securities for £20,000, upon which he retired to his residence in Northumberland. While on a visit to London he was again arrested, for a technical breach of his engagement, but by the intercession of the queen of Sweden he obtained his liberty. He was freed from his engagements in 1654, and retired to his seat at Balgonie in Fifeshire, where he died at an advanced age in 1661. He acquired considerable landed property, particularly Inchmartin in the Carse of Gowrie, which he called Inchleslie.

See [LEVEN AND MELVILLE, EARLS OF](#), below.



**LEVEN**, a police burgh of Fifeshire, Scotland. Pop. (1901) 5577. It is situated on the Firth of Forth, at the mouth of the Leven, 5¾ m. E. by N. of Thornton Junction by the North British railway. The public buildings include the town hall, public hall and people's institute, in the grounds of which the old town cross has been erected. The industries are numerous, comprising flax-spinning, brewing, linen-weaving, paper-making, seed-crushing and rope-making, besides salt-works, a foundry, saw-mill and brick-works. The wet dock is not much used, owing to the constant accumulation of sand. The golf-links extending for 2 m. to Lundin are among the best in Scotland. Two miles N.E. is Lundin Mill and Drumochie, usually called **LUNDIN** (pop. 570), at the mouth of Kiel Burn, with a station on the Links. The three famous standing stones are supposed to be either of "Druidical" origin or to mark the site of a battle with the Danes. In the vicinity are the remains of an old house of the Lundins, dating from the reign of David II. To the N.W. of Leven lies the parish of **KENNOWAY** (pop. 870). In Captain Seton's house, which still stands in the village of Kennoway, Archbishop Sharp spent the night before his assassination (1679). One mile east of Lundin lies **LARGO** (pop. of parish 2046), consisting of Upper Largo, or Kirkton of Largo, and Lower Largo. The public buildings include Simpson institute, with a public hall, library, reading-room, bowling-green and lawn-tennis court, and John Wood's hospital, founded in 1659 for poor persons bearing his name. A statue of Alexander Selkirk, or Selcraig (1676-1721), the prototype of "Robinson Crusoe," who was born here, was erected in 1886. Sir John Leslie (1766-1832), the natural philosopher, was also a native. Largo claims two famous sailors, Admiral Sir Philip Durham (1763-1845), commander-in-chief at Portsmouth from 1836 to 1839, and Sir Andrew Wood (d. 1515), the trusted servant of James III. and James IV., who sailed the "Great Michael," the largest ship of its time. When he was past active service he had a canal cut from his house to the parish church, to which he was rowed every Sunday in an eight-oared barge. Largo House was granted to him by James III., and the tower of the original structure still exists. About 1½ m. from the coast rises the height of Largo Law (948 ft.). Kellie Law lies some 5½ m. to the east.



**LEVEN, LOCH**, a lake of Kinross-shire, Scotland. It has an oval shape, the longer axis running from N.W. to S.E., has a length of 3¾ m., and a breadth of 2¾ m. and is situated near the south and east boundaries of the shire. It lies at a height of 350 ft. above the sea. The mean depth is less than 15 ft., with a maximum of 83 ft., the lake being thus one of the shallowest in Scotland. Reclamation works carried on from 1826 to 1836 reduced its area by one quarter, but it still possesses a surface area of 5½ sq. m. It drains the county and is itself drained by the Leven. It is famous for the Loch Leven trout (*Salmo levenensis*, considered by some a variety of *S. trutta*), which are remarkable for size and quality. The fishings are controlled by the Loch Leven Angling Association, which organizes competitions attracting anglers from far and near. The loch contains seven islands. Upon St Serf's, the largest, which commemorates the patron saint of Fifeshire, are the ruins of the Priory of Portmoak—so named from St Moak, the first abbot—the oldest Culdee establishment in Scotland. Some time before 961 it was made over to the bishop of St Andrews, and shortly after 1144 a body of canons regular was established on it in connexion with the priory of canons regular founded in that year at St Andrews. The second largest island, Castle Island, possesses remains of even greater interest. The first stronghold is supposed to have been erected by Congal, son of Dongart, king of the Picts. The present castle dates from the 13th century and was occasionally used as a royal residence. It is said to have been in the hands of the English for a time, from whom it was delivered by Wallace. It successfully withstood Edward Baliol's siege in 1335, and was granted by Robert II. to Sir William Douglas of Lugton. It became the prison at various periods of Robert II.; of Alexander Stuart, earl of Buchan, "the Wolf of Badenoch"; Archibald, earl of Douglas (1429); Patrick Graham, archbishop of St Andrews (who died, still in bondage, on St Serf's Island in 1478), and of Mary, queen of Scots. The queen had visited it more than once before her detention, and had had a presence chamber built in it. Conveyed hither in June 1567 after her surrender at Carberry, she signed her abdication within its walls on the 4th of July and effected her escape on the 2nd of May 1568. The keys of the castle, which were thrown into the loch during her flight, were found and are preserved at Dalmahoy in Midlothian. Support of Mary's cause had involved Thomas Percy, 7th earl of Northumberland (b. 1528). He too was lodged in the castle in 1569, and after three years' imprisonment was handed over to the English, by whom he was beheaded at York in 1572. The proverb that

“Those never got luck who came to Loch Leven” sums up the history of the castle. The causeway connecting the isle with the mainland was long submerged too deeply for use, but the reclamation operations already referred to almost brought it into view again.



**LEVEN AND MELVILLE, EARLS OF.** The family of Melville which now holds these two earldoms is descended from Sir John Melville of Raith in Fifeshire. Sir John, who was a member of the reforming party in Scotland, was put to death for high treason on the 13th of December 1548; he left with other children a son Robert (1527-1621), who in 1616 was created a lord of parliament as Lord Melville of Monymaill. Before his elevation to the Scottish peerage Melville had been a stout partisan of Mary, queen of Scots, whom he represented at the English court, and he had filled several important offices in Scotland under her son James VI. The fourth holder of the lordship of Melville was George (c. 1634-1707), a son of John, the 3rd lord (d. 1643), and a descendant of Sir John Melville. Implicated in the Rye House plot against Charles II., George took refuge in the Netherlands in 1683, but he returned to England after the revolution of 1688 and was appointed secretary for Scotland by William III. in 1689, being created earl of Melville in the following year. He was made president of the Scottish privy council in 1696, but he was deprived of his office when Anne became queen in 1702, and he died on the 20th of May 1707. His son David, 2nd earl of Melville (1660-1728), fled to Holland with his father in 1683; after serving in the army of the elector of Brandenburg he accompanied William of Orange to England in 1688. At the head of a regiment raised by himself he fought for William at Killiecrankie and elsewhere, and as commander-in-chief of the troops in Scotland he dealt promptly and effectively with the attempted Jacobite rising of 1708. In 1712, however, his office was taken from him and he died on the 6th of June 1728.

Alexander Leslie, 1st earl of Leven (*q.v.*), was succeeded in his earldom by his grandson Alexander, who died without sons in July 1664. The younger Alexander's two daughters were then in turn countesses of Leven in their own right; and after the death of the second of these two ladies in 1676 a dispute arose over the succession to the earldom between John Leslie, earl (afterwards duke) of Rothes, and David Melville, 2nd earl of Melville, mentioned above. In 1681, however, Rothes died, and Melville, who was a great-grandson of the 1st earl of Leven, assumed the title, calling himself earl of Leven and Melville after he succeeded his father as earl of Melville in May 1707. Since 1805 the family has borne the name of Leslie-Melville. In 1906 John David Leslie-Melville (b. 1886) became 12th earl of Leven and 11th earl of Melville.

See Sir W. Fraser, *The Melvilles, Earls of Melville, and the Leslies, Earls of Leven* (1890); and the *Leven and Melville Papers*, edited by the Hon. W. H. Leslie-Melville for the Bannatyne Club (1843).



**LEVER, CHARLES JAMES** (1806-1872), Irish novelist, second son of James Lever, a Dublin architect and builder, was born in the Irish capital on the 31st of August 1806. His descent was purely English. He was educated in private schools, where he wore a ring, smoked, read novels, was a ringleader in every breach of discipline, and behaved generally like a boy destined for the navy in one of Captain Marryat's novels. His escapades at Trinity College, Dublin (1823-1828), whence he took the degree of M.B. in 1831, form the basis of that vast cellarage of anecdote from which all the best vintages in his novels are derived. The inimitable Frank Webber in *Charles O'Malley* (spiritual ancestor of Foker and Mr Bouncer) was a college friend, Robert Boyle, later on an Irish parson. Lever and Boyle sang ballads of their own composing in the streets of Dublin, after the manner of Fergusson or Goldsmith, filled their caps with coppers and played many other pranks embellished in the pages of *O'Malley*, *Con Cregan* and *Lord Kilgobbin*. Before seriously embarking upon the medical studies for which he was designed, Lever visited Canada as an unqualified surgeon on an emigrant ship, and has drawn upon some of his experiences in *Con Cregan*, *Arthur O'Leary* and *Roland Cashel*. Arrived in Canada he plunged into the backwoods, was affiliated to a tribe of Indians and had to escape at the risk of his life, like his own Bagenal Daly.

Back in Europe, he travelled in the guise of a student from Göttingen to Weimar (where he saw Goethe), thence to Vienna; he loved the German student life with its beer, its fighting and its fun, and several of his merry songs, such as “The Pope he loved a merry life” (greatly envied by Titmarsh), are on *Student-liked* models. His medical degree admitted him to an appointment from the Board of Health in Co. Clare and then as dispensary doctor at Port Stewart, but the liveliness of his diversions as a country doctor seems to have prejudiced the authorities against him. In 1833 he married his first love, Catherine Baker, and in February 1837, after varied experiences, he began running *The Confessions of Harry Lorrequer* through the pages of the recently established *Dublin University Magazine*. During the previous seven years the popular taste had declared strongly in favour of the service novel as exemplified by *Frank Mildmay*, *Tom Cringle*, *The Subaltern*, *Cyril Thornton*, *Stories of Waterloo*, *Ben Brace* and *The Bivouac*; and Lever himself had met William Hamilton Maxwell, the titular founder of the genre. Before *Harry Lorrequer* appeared in volume form (1839), Lever had settled on the strength of a slight diplomatic connexion as a fashionable physician in Brussels (16, Rue Ducale). *Lorrequer* was merely a string of Irish and other stories good, bad and indifferent, but mostly rollicking, and Lever, who strung together his anecdotes late at night after the serious business of the day was done, was astonished at its success. “If this sort of thing amuses them, I can go on for ever.” Brussels was indeed a superb place for the observation of half-pay officers, such as Major Monsoon (Commissioner Meade), Captain Bubbleton and the like, who terrorized the *tavernes* of the place with their endless peninsular stories, and of English society a little damaged, which it became the specialty of Lever to depict. He sketched with a free hand, wrote,

as he lived, from hand to mouth, and the chief difficulty he experienced was that of getting rid of his characters who “hung about him like those tiresome people who never can make up their minds to bid you good night.” Lever had never taken part in a battle himself, but his next three books, *Charles O'Malley* (1841), *Jack Hinton* and *Tom Burke of Ours* (1843), written under the spur of the writer's chronic extravagance, contain some splendid military writing and some of the most animated battle-pieces on record. In pages of *O'Malley* and *Tom Burke* Lever anticipates not a few of the best effects of Marbot, Thiébaud, Lejeune, Griois, Seruzier, Burgoyne and the like. His account of the Douro need hardly fear comparison, it has been said, with Napier's. Condemned by the critics, Lever had completely won the general reader from the Iron Duke himself downwards.

In 1842 he returned to Dublin to edit the *Dublin University Magazine*, and gathered round him a typical coterie of Irish wits (including one or two hornets) such as the O'Sullivans, Archer Butler, W. Carleton, Sir William Wilde, Canon Hayman, D. F. McCarthy, McGlashan, Dr Kenealy and many others. In June 1842 he welcomed at Templeogue, 4 m. south-west of Dublin, the author of the *Snob Papers* on his Irish tour (the *Sketch Book* was, later, dedicated to Lever). Thackeray recognized the fund of Irish sadness beneath the surface merriment. “The author's character is not humour but sentiment. The spirits are mostly artificial, the *fond* is sadness, as appears to me to be that of most Irish writing and people.” The Waterloo episode in *Vanity Fair* was in part an outcome of the talk between the two novelists. But the “Galway pace,” the display he found it necessary to maintain at Templeogue, the stable full of horses, the cards, the friends to entertain, the quarrels to compose and the enormous rapidity with which he had to complete *Tom Burke*, *The O'Donoghue* and *Arthur O'Leary* (1845), made his native land an impossible place for Lever to continue in. Templeogue would soon have proved another Abbotsford. Thackeray suggested London. But Lever required a new field of literary observation and anecdote. His *sève originel* was exhausted and he decided to renew it on the continent. In 1845 he resigned his editorship and went back to Brussels, whence he started upon an unlimited tour of central Europe in a family coach. Now and again he halted for a few months, and entertained to the limit of his resources in some ducal castle or other which he hired for an off season. Thus at Riedenburg, near Bregenz, in August 1846, he entertained Charles Dickens and his wife and other well-known people. Like his own *Daltons* or *Dodd Family Abroad* he travelled continentally, from Carlsruhe to Como, from Como to Florence, from Florence to the Baths of Lucca and so on, and his letters home are the litany of the literary remittance man, his ambition now limited to driving a pair of novels abreast without a diminution of his standard price for serial work (“twenty pounds a sheet”). In the *Knight of Gwynne*, a story of the Union (1847), *Con Cregan* (1849), *Roland Cashel* (1850) and *Maurice Tiernay* (1852) we still have traces of his old manner; but he was beginning to lose his original joy in composition. His *fond* of sadness began to cloud the animal joyousness of his temperament. Formerly he had written for the happy world which is young and curly and merry; now he grew fat and bald and grave. “After 38 or so what has life to offer but one universal declension. Let the crew pump as hard as they like, the leak gains every hour.” But, depressed in spirit as he was, his wit was unextinguished; he was still the delight of the *salons* with his stories, and in 1867, after a few years' experience of a similar kind at Spezia, he was cheered by a letter from Lord Derby offering him the more lucrative consulship of Trieste. “Here is six hundred a year for doing nothing, and you are just the man to do it.” The six hundred could not atone to Lever for the lassitude of prolonged exile. Trieste, at first “all that I could desire,” became with characteristic abruptness “detestable and damnable.” “Nothing to eat, nothing to drink, no one to speak to.” “Of all the dreary places it has been my lot to sojourn in this is the worst” (some references to Trieste will be found in *That Boy of Norcott's*, 1869). He could never be alone and was almost morbidly dependent upon literary encouragement. Fortunately, like Scott, he had unscrupulous friends who assured him that his last efforts were his best. They include *The Fortunes of Glencore* (1857), *Tony Butler* (1865), *Luttrell of Arran* (1865), *Sir Brooke Fosbrooke* (1866), *Lord Kilgobbin* (1872) and the table-talk of *Cornelius O'Dowd*, originally contributed to Blackwood. His depression, partly due to incipient heart disease, partly to the growing conviction that he was the victim of literary and critical conspiracy, was confirmed by the death of his wife (23rd April 1870), to whom he was tenderly attached. He visited Ireland in the following year and seemed alternately in very high and very low spirits. Death had already given him one or two runaway knocks, and, after his return to Trieste, he failed gradually, dying suddenly, however, and almost painlessly, from failure of the heart's action on the 1st of June 1872. His daughters, one of whom, Sydney, is believed to have been the real author of *The Rent in a Cloud* (1869), were well provided for.

Trollope praised Lever's novels highly when he said that they were just like his conversation. He was a born raconteur, and had in perfection that easy flow of light description which without tedium or hurry leads up to the point of the good stories of which in earlier days his supply seemed inexhaustible. With little respect for unity of action or conventional novel structure, his brightest books, such as *Lorrequer*, *O'Malley* and *Tom Burke*, are in fact little more than recitals of scenes in the life of a particular “hero,” unconnected by any continuous intrigue. The type of character he depicted is for the most part elementary. His women are mostly *rouées*, romps or Xanthippes; his heroes have too much of the Pickle temper about them and fall an easy prey to the serious attacks of Poe or to the more playful gibes of Thackeray in *Phil Fogarty* or Bret Harte in *Terence Deuville*. This last is a perfect bit of burlesque. Terence exchanges nineteen shots with the Hon. Captain Henry Somerset in the glen. “At each fire I shot away a button from his uniform. As my last bullet shot off the last button from his sleeve, I remarked quietly, ‘You seem now, my lord, to be almost as ragged as the gentry you sneered at,’ and rode haughtily away.” And yet these careless sketches contain such haunting creations as Frank Webber, Major Monsoon and Micky Free, “the Sam Weller of Ireland.” Falstaff is alone in the literature of the world; but if ever there came a later Falstaff, Monsoon was the man. As for Baby Blake, is she not an Irish Di Vernon? The critics may praise Lever's thoughtful and careful later novels as they will, but *Charles O'Malley* will always be the pattern of a military romance.

Superior, it is sometimes claimed, in construction and style, the later books approximate it may be thought to the good *ordinary* novel of commerce, but they lack the *extraordinary* qualities, the incommunicable “go” of the early books—the élan of Lever's untamed youth. Artless and almost formless these productions may be, but they represent to us, as very few other books can, that pathetic ejaculation of Lever's own—“Give us back the wild freshness of the morning!” We know the novelist's teachers, Maxwell, Napier, the old-fashioned compilation known as *Victoires, conquêtes et désastres des Français* (1835), and the old buffers at Brussels who emptied the room by uttering the word “Badajos.” But where else shall we find the equals of the military scenes in *O'Malley* and *Tom Burke*, or the military episodes in *Jack Hinton*, *Arthur O'Leary* (the story of Aubusson) or *Maurice Tiernay* (nothing he ever did is finer than the chapter introducing “A remnant of Fontenoy”)? It is here that his true genius lies, even more than in his talent for conviviality and fun, which makes an early copy of an early Lever (with Phiz's illustrations) seem literally to exhale an atmosphere of past and present entertainment. It is

here that he is a true romancist, not for boys only, but also for men.

Lever's lack of artistry and of sympathy with the deeper traits of the Irish character have been stumbling-blocks to his reputation among the critics. Except to some extent in *The Martins of Cro' Martin* (1856) it may be admitted that his portraits of Irish are drawn too exclusively from the type depicted in Sir Jonah Barrington's *Memoirs* and already well known on the English stage. He certainly had no deliberate intention of "lowering the national character." Quite the reverse. Yet his posthumous reputation seems to have suffered in consequence, in spite of all his Gallic sympathies and not unsuccessful endeavours to apotheosize the "Irish Brigade."

510

The chief authorities are the *Life*, by W. J. Fitzpatrick (1879), and the *Letters*, ed. in 2 vols. by Edmund Downey (1906), neither of which, however, enables the reader to penetrate below the surface. See also Dr Garnett in *Dict. Nat. Biog.*; *Dublin Univ. Mag.* (1880), 465 and 570; Anthony Trollope's *Autobiography*; *Blackwood* (August 1862); *Fortnightly Review*, vol. xxxii.; Andrew Lang's *Essays in Little* (1892); Henley's *Views and Reviews*; Hugh Walker's *Literature of the Victorian Era* (1910); *The Bookman Hist. of English Literature* (1906), p. 467; *Bookman* (June 1906; portraits). A library edition of the novels in 37 vols. appeared 1897-1899 under the superintendence of Lever's daughter, Julie Kate Neville.

(T. SE.)



**LEVER** (through O. Fr. *leveour*, *levere*, mod. *levier*, from Lat. *levare*, to lift, raise), a mechanical device for raising bodies; the "simple" lever consists of a rigid bar free to move about a fixed point, termed the *fulcrum*; one point of the rod is connected to the piece to be moved, and power is applied at another point (see [MECHANICS](#)).



**LEVERRIER, URBAIN JEAN JOSEPH** (1811-1877), French astronomer, was born at St Lô in Normandy on the 11th of March 1811. His father, who held a small post under government, made great efforts to send him to Paris, where a brilliant examination gained him, in 1831, admittance to the École Polytechnique. The distinction of his career there was rewarded with a free choice amongst the departments of the public service open to pupils of the school. He selected the administration of tobaccos, addressing himself especially to chemical researches under the guidance of Gay-Lussac, and gave striking proof of ability in two papers on the combinations of phosphorus with hydrogen and oxygen, published in *Annales de Chimie et de Physique* (1835 and 1837). His astronomical vocation, like that of Kepler, came from without. The place of teacher of that science at the École Polytechnique falling vacant in 1837, it was offered to and accepted by Leverrier, who, "docile to circumstance," instantly abandoned chemistry, and directed the whole of his powers to celestial mechanics. The first fruits of his labours were contained in two memoirs presented to the Academy, September 16 and October 14, 1839. Pursuing the investigations of Laplace, he demonstrated with greater rigour the stability of the solar system, and calculated the limits within which the eccentricities and inclinations of the planetary orbits vary. This remarkable début excited much attention, and, on the recommendation of François Arago, he took in hand the theory of Mercury, producing, in 1843, vastly improved tables of that planet. The perturbations of the comets discovered, the one by H. A. E. A. Faye in November 1843, the other by Francesco de Vico a year later, were minutely investigated by Leverrier, with the result of disproving the supposed identity of the first with Lexell's lost comet of 1770, and of the other with Tycho's of 1585. On the other hand, he made it appear all but certain that Vico's comet was the same with one seen by Philippe de Lahire in 1678. Recalled once more, by the summons of Arago, to planetary studies, he was this time invited to turn his attention to Uranus. Step by step, with sagacious and patient accuracy, he advanced to the great discovery which has immortalized his name. Carefully sifting all the known causes of disturbance, he showed that one previously unknown had to be reckoned with, and on the 23rd of September 1846 the planet Neptune was discerned by J. G. Galle (d. 1910) at Berlin, within one degree of the spot Leverrier had indicated (see [NEPTUNE](#)).

This memorable achievement was greeted with an outburst of public enthusiasm. Academies vied with each other in enrolling Leverrier among their members; the Royal Society awarded him the Copley medal; the king of Denmark sent him the order of the Dannebrog; he was named officer in the Legion of Honour, and preceptor to the comte de Paris; a chair of astronomy was created for his benefit at the Faculty of Sciences; he was appointed adjunct astronomer to the Bureau of Longitudes. Returned to the Legislative Assembly in 1849 by his native department of Manche, he voted with the anti-republican party, but devoted his principal attention to subjects connected with science and education. After the *coup d'état* of 1851 he became a senator and inspector-general of superior instruction, sat upon the commission for the reform of the École Polytechnique (1854), and, on the 30th of January 1854, succeeded Arago as director of the Paris observatory. His official work in the latter capacity would alone have strained the energies of an ordinary man. The institution had fallen into a state of lamentable inefficiency. Leverrier placed it on a totally new footing, freed it from the control of the Bureau of Longitudes, and raised it to its due rank among the observatories of Europe. He did not escape the common lot of reformers. His uncompromising measures and unconciliatory manner of enforcing them raised a storm only appeased by his removal on the 5th of February 1870. On the death of his successor Charles Eugène Delaunay (1816-1872), he was reinstated by Thiers, but with authority restricted by the supervision of a council. In the midst of these disquietudes, he executed a task of gigantic proportions. This was nothing less than the complete revision of the planetary theories, followed by a laborious comparison of results with the most authentic observations, and the construction of tables representing the movements thus corrected. It required all his indomitable perseverance to carry through a purpose which failing health continually menaced with frustration.

He had, however, the happiness of living long enough to perfect his work. Three weeks after he had affixed his signature to the printed sheets of the theory of Neptune he died at Paris on the 23rd of September 1877. By his marriage with Mademoiselle Choquet, who survived him little more than a month, he left a son and daughter.

The discovery with which Leverrier's name is popularly identified was only an incident in his career. The elaboration of the scheme of the heavens traced out by P. S. Laplace in the *Mécanique céleste* was its larger aim, for the accomplishment of which forty years of unremitting industry barely sufficed. He nevertheless found time to organize the meteorological service in France and to promote the present system of international weather-warnings. He founded the Association Scientifique, and was active in introducing a practical scientific element into public education. His inference of the existence, between Mercury and the sun, of an appreciable quantity of circulating matter (*Comptes rendus*, 1859, ii. 379), has not yet been verified. He was twice, in 1868 and 1876, the recipient of the gold medal of the Royal Astronomical Society, London, and the university of Cambridge conferred upon him, in 1875, the honorary degree of LL.D. His planetary and solar tables were adopted by the *Nautical Almanac*, as well as by the *Connaissance des temps*.

The *Annales de l'Observatoire de Paris*, the publication of which was set on foot by Leverrier, contain, in vols. i.-vi. (*Mémoires*) (1855-1861) and x.-xiv. (1874-1877), his theories and tables of the several planets. In vol. i. will be found, besides his masterly report on the observatory, a general theory of secular inequalities, in which the development of the disturbing function was carried further than had previously been attempted.

The memoirs and papers communicated by him to the Academy were summarized in *Comptes rendus* (1839-1876), and the more important published in full either separately or in the *Conn. des temps* and the *Journal des mathématiques*. That entitled *Développemens sur différens points de la théorie des perturbations* (1841), was translated in part xviii. of Taylor's *Scientific Memoirs*. For his scientific work see Professor Adams's address, *Monthly Notices*, xxxvi. 232, and F. Tisserand's review in *Ann. de l'Obs.* tom. xv. (1880); for a notice of his life, J. Bertrand's "Éloge historique," *Mém. de l'Ac. des Sciences*, tom. xli., 2<sup>me</sup> série.

(A. M. C.)



**LEVERTIN, OSCAR IVAN** (1862-1906), Swedish poet and man of letters, was born of Jewish parents at Norrköping on the 17th of July 1862. He received his doctorate in letters at Upsala in 1887, and was subsequently *docent* at Upsala, and later professor of literature at Stockholm. Enforced sojourns in southern Europe on account of health familiarized him with foreign languages. He began by being an extreme follower of the naturalist school, but on his return in 1890 from a two years' residence in Davos he wrote, in collaboration with the poet C. G. Verner von Heidenstam (b. 1859), a novel, *Pepitas bröllop* (1890), which was a direct attack on naturalism. His later volumes of short stories, *Rococonoveller* and *Sista noveller*, are fine examples of modern Swedish fiction. The lyrical beauty of his poems, *Legender och visor* (1891), placed him at the head of the romantic reaction in Sweden. In his poems entitled *Nya Dikter* (1894) he drew his material partly from medieval sources, and a third volume of poetry in 1902 sustained his reputation. His last poetical work (1905) was *Kung Salomo och Morolf*, poems founded on an eastern legend. As a critic he first attracted attention by his books on the Gustavian age of Swedish letters: *Teater och drama under Gustaf III.* (1889), &c. He was an active collaborator in the review *Ord och Bild*. He died in 1906, at a time when he was engaged on his *Linné*, posthumously published, a fragment of a great work on Linnaeus.

511



**LEVI, HERMANN** (1839-1900), German orchestral conductor, was born at Giessen on the 7th of November 1839, and was the son of a Jewish rabbi. He was educated at Giessen and Mannheim, and came under Vincenz Lachner's notice. From 1855 to 1858 Levi studied at the Leipzig conservatorium, and after a series of travels which took him to Paris, he obtained his first post as music director at Saarbrücken, which post he exchanged for that at Mannheim in 1861. From 1862 to 1864 he was chief conductor of the German opera in Rotterdam, then till 1872 at Carlsruhe, when he went to Munich, a post he held until 1896, when ill-health compelled him to resign. Levi's name is indissolubly connected with the increased public appreciation of Wagner's music. He conducted the first performance of *Parsifal* at Bayreuth in 1882, and was connected with the musical life of that place during the remainder of his career. He visited London in 1895.



**LEVI, LEONE** (1821-1888), English jurist and statistician, was born of Jewish parents on the 6th of June 1821, at Ancona, Italy. After receiving an early training in a business house in his native town, he went to Liverpool in 1844, became naturalized, and changing his faith, joined the Presbyterian church. Perceiving the necessity, in view of the unsystematic condition of the English law on the subject, for the establishment of chambers and tribunals of commerce in England, he warmly advocated their institution in numerous pamphlets; and as a result of his labours the Liverpool Chamber of Commerce, of which Levi was made secretary, was founded in 1849. In 1850 Levi published his *Commercial Law of the World*, being an exhaustive and comparative treatise upon the laws and codes of mercantile countries. Appointed in 1852 to the chair of commercial law in



King's College, London, he proved himself a highly competent and popular instructor, and his evening classes were a most successful innovation. He was called to the bar at Lincoln's Inn in 1859, and received from the university of Tübingen the degree of doctor of political science. His chief work—*History of British Commerce and of the Economic Progress of the British Nation, 1763-1870*, is perhaps a rather too partisan account of British economic development, being a eulogy upon the blessings of Free Trade, but its value as a work of reference cannot be gainsaid. Among his other works are: *Work and Pay; Wages and Earnings of the Working Classes; International Law, with Materials for a Code*. He died on the 7th of May 1888.



**LEVIATHAN**, the Hebrew name (*livyāthān*), occurring in the poetical books of the Bible, of a gigantic animal, apparently the sea or water equivalent of behemoth (*q.v.*), the king of the animals of the dry land. In Job xli. 15 it would seem to represent the crocodile, in Isaiah xxvii. 1 it is a crooked and piercing serpent, the dragon of the sea; cf. Psalms civ. 26. The etymology of the word is uncertain, but it has been taken to be connected with a root meaning "to twist." Apart from its scriptural usage, the word is applied to any gigantic marine animal such as the whale, and hence, figuratively, of very large ships, and also of persons of outstanding strength, power, wealth or influence. Hobbes adopted the name as the title of his principal work, applying it to "the multitude so united in one person ... called a commonwealth.... This is the generation of that Leviathan, or rather ... of that mortal God, to which we owe under the immortal God, our peace and defence."



**LEVIRATE** (Lat. *levir*, a husband's brother), a custom, sometimes even a law, compelling a dead man's brother to marry his widow. It seems to have been widespread in primitive times, and is common to-day. Of the origin and primitive purpose of the levirate marriage various explanations have been put forward:—

1. It has been urged that the custom was primarily based on the law of inheritance; a wife, regarded as a chattel, being inherited like other possessions. The social advantage of providing one who should maintain the widow doubtless aided the spread of the custom. The abandonment of a woman and her children in the nomadic stage of civilization would be equivalent to death for them; hence with some peoples the levirate became a duty rather than a right. Among the Thlinkets, for example, when a man dies, his brother or his sister's son must marry the widow, a failure in this duty occasioning feuds. The obligation on a man to provide for his sister-in-law is analogous to other duties devolving on kinsfolk, such as the vendetta.

2. J. F. McLennan, however, would assume the levirate to be a relic of polyandry, and in his argument lays much stress on the fact that it is the dead man's *brother* who inherits the widow. But among many races who follow the custom, such as the Fijians, Samoans, Papuans of New Guinea, the Caroline Islanders, and some tribes in the interior of Western Equatorial Africa, the rule of inheritance is to the brother first. Thus among the Santals, "when the elder brother dies, the next younger inherits the widow, children and all the property." Further, there is no known race where it is permitted to a son to marry his own mother. Inheriting a woman in primitive societies would be always tantamount to marrying her, and, apart from any special laws of inheritance, it would be natural for the brother to take over the widow. In polygamous countries where a man leaves many widows the son would have a right of ownership over these, and could dispose of them or keep them as he pleased, his own mother alone excepted. Thus among the Bakalai, an African tribe, widows may marry the son of their dead husband, or in default of a son, can live with the brother. The Negroes of Benin and the Gabun and the Kaffirs of Natal have similar customs. In New Caledonia every man, married or single, must immediately marry his brother's widow. In Polynesia the levirate has the force of law, and it is common throughout America and Asia.

3. Another explanation of the custom has been sought in a semi-religious motive which has had extraordinary influence in countries where to die without issue is regarded as a terrible calamity. The fear of this catastrophe would readily arise among people who did not believe in personal immortality, and to whom the extinction of their line would be tantamount to annihilation. Or it is easily conceivable as a natural result of ancestor-worship, under which failure of offspring entailed deprivation of cherished rites and service.<sup>1</sup> Thus it is only when the dead man has no offspring that the Jewish, Hindu and Malagasy laws prescribe that the brother shall "raise up seed" to him. In this sense the levirate forms part of the Deuteronomic Code, under which, however, the obligation is restricted to the brother who "dwelleth together" (*i.e.* on the family estate) with the dead man, and the first child only of the levirate marriage is regarded as that of the dead man. That the custom was obsolescent seems proved by the enjoining of ceremony on any brother who wished to evade the duty, though he had to submit to an insult from his sister-in-law, who draws off his sandal and spits in his face. The biblical story of Ruth exemplifies the custom, though with further modifications (see **RUTH, BOOK OF**). Finally the custom is forbidden in Leviticus, though in New Testament times the levirate law was still observed by some Jews. The ceremony ordained by Deuteronomy is still observed among the orthodox. Among the Hindus the *levir* did not take his brother's widow as wife, but he had intercourse with her. This practice was called *niyoga*.

4. Yet another suggested origin of the levirate is agrarian, the motive being to keep together under the levirate husband the property which would otherwise have been divided among all the brothers or next of kin.

See J. F. McLennan, *Studies in Ancient History* (London, 1886) and "The Levirate and Polyandry," in *The Fortnightly Review*, n.s. vol. xxi. (1877); C. N. Starcke, *The Primitive Family in its Origin and Development* (London, 1889); Edward Westermarck, *History of Human Marriage* (London, 1894), pp. 510-514, where are

- 1 An expression of this idea is quoted from the *Mahābhārata* (Muir's trans.), by Max Müller (Gifford Lectures), *Anthropological Religion*, p. 31—

“That stage completed, seek a wife  
And gain the fruit of wedded life,  
A race of sons, by rites to seal,  
When thou art gone, thy spirit's weal.”



**LÉVIS** (formerly Pointe Levi), the chief town of Lévis county, Quebec, Canada, situated on the precipitous south bank of the St Lawrence, opposite Quebec city. Pop. (1901) 7783. It is on the Intercolonial railway, and is the eastern terminus of the Grand Trunk and Quebec Central railways. It contains the Lorne dock, a Dominion government graving dock, 445 ft. long, 100 ft. wide, with a depth on the sill of 26½ and 20½ ft. at high water, spring and neap tides respectively. It is an important centre of the river trade, and is connected by steam ferries with the city of Quebec. It is named after the maréchal duc de Lévis, the last commander of the French troops in Canada.



**LEVITES**, or sons of Levi (son of Jacob by Leah), a sacred caste in ancient Israel, the guardians of the temple service at Jerusalem.<sup>1</sup>

1. *Place in Ritual.*—In the developed hierarchical system the ministers of the sanctuary are divided into distinct grades. All are “Levites” by descent, and are thus correlated in the genealogical and other lists, but the true priesthood is confined to the sons of Aaron, while the mass of the Levites are subordinate servants who are not entitled to approach the altar or to perform any strictly priestly function. All access to the Deity is restricted to the one priesthood and to the one sanctuary at Jerusalem; the worshipping subject is the nation of Israel as a unity, and the function of worship is discharged on its behalf by divinely chosen priests. The ordinary individual may not intrude under penalty of death; only those of Levitical origin may perform service, and they are essentially the servants and hereditary serfs of the Aaronite priests (see Num. xviii.). But such a scheme finds no place in the monarchy; it presupposes a hierocracy under which the priesthood increased its rights by claiming the privileges which past kings had enjoyed; it is the outcome of a complicated development in Old Testament religion in the light of which it is to be followed (see [HEBREW RELIGION](#)).

First (*a*), in the earlier biblical writings which describe the state of affairs under the Hebrew monarchy there is not this fundamental distinction among the Levites, and, although a list of Aaronite high-priests is preserved in a late source, internal details and the evidence of the historical books render its value extremely doubtful (1 Chron. vi. 3-15, 49-53). In Jerusalem itself the subordinate officers of the temple were not members of a holy gild, but of the royal body-guard, or bond-slaves who had access to the sacred courts, and might even be uncircumcised foreigners (Josh. ix. 27; 1 Kings xiv. 28; 2 Kings xi.; cf. Zeph. i. 8 seq.; Zech. xiv. 21). Moreover, ordinary individuals might serve as priests (1 Sam. ii II, 18, vii. 1; see 2 Sam. viii. 18, deliberately altered in 1 Chron. xviii. 17); however, every Levite was a priest, or at least qualified to become one (Deut. x. 8, xviii. 7; Judges xvii. 5-13), and when the author of 1 Kings xii. 31, wishes to represent Jeroboam's priests as illegitimate, he does not say that they were not Aaronites, but that they were not of the sons of Levi.

The next stage (*b*) is connected with the suppression of the local high-places or minor shrines in favour of a central sanctuary. This involved the suppression of the Levitical priests in the country (cf. perhaps the allusion in Deut. xxi. 5); and the present book of Deuteronomy, in promulgating the reform, represents the Levites as poor scattered “sojourners” and recommends them to the charity of the people (Deut. xii. 12, 18 seq., xiv. 27, 29, xvi. 11, 14, xxvi. 11 sqq.). However, they are permitted to congregate at “the place which Yahweh shall choose,” where they may perform the usual priestly duties together with their brethren who “stand there before Yahweh,” and they are allowed their share of the offerings (Deut. xviii. 6-8).<sup>2</sup> The Deuteronomic history of the monarchy actually ascribes to the Judæan king Josiah (621 B.C.) the suppression of the high-places, and states that the local priests were brought to Jerusalem and received support, but did not minister at the altar (2 Kings xxiii. 9). Finally, a scheme of ritual for the second temple raises this exclusion to the rank of a principle. The Levites who had been idolatrous are punished by exclusion from the proper priestly work, and take the subordinate offices which the uncircumcised and polluted foreigners had formerly filled, while the sons of Zadok, who had remained faithful, are henceforth the legitimate priests, the only descendants of Levi who are allowed to minister unto Yahweh (Ezek. xliv. 6-15, cf. xl. 46, xliii. 19, xlvi. 11). “A threefold cord is not quickly broken,” and these three independent witnesses agree in describing a significant innovation which ends with the supremacy of the Zadokites of Jerusalem over their brethren.

In the last stage (*c*) the exclusion of the ordinary Levites from all share in the priesthood of the sons of Aaron is looked upon as a matter of course, dating from the institution of priestly worship by Moses. The two classes are supposed to have been founded separately (Exod. xxviii., cf. xxix. 9; Num. iii. 6-10), and so far from any degradation being attached to the rank and file of the Levites, their position is naturally an honourable one

compared with that of the mass of non-Levitical worshippers (see Num. i. 50-53), and they are taken by Yahweh as a surrogate for the male first-born of Israel (iii. 11-13). They are inferior only to the Aaronites to whom they are "joined" (xviii. 2, a play on the name Levi) as assistants. Various adjustments and modifications still continue, and a number of scattered details may indicate that internal rivalries made themselves felt. But the different steps can hardly be recovered clearly, although the fact that the priesthood was extended beyond the Zadokites to families of the dispossessed priests points to some compromise (1 Chron. xxiv.). Further, it is subsequently found that certain classes of temple servants, the singers and porters, who had once been outside the Levitical guilds, became absorbed as the term "Levite" was widened, and this change is formally expressed by the genealogies which ascribe to Levi, the common "ancestor" of them all, the singers and even certain families whose heathenish and foreign names show that they were once merely servants of the temple.<sup>3</sup>

2. *Significance of the Development.*—Although the legal basis for the final stage is found in the legislation of the time of Moses (latter part of the second millennium B.C.), it is in reality scarcely earlier than the 5th century B.C., and the Jewish theory finds analogies when developments of the Levitical service are referred to David (1 Chron. xv. seq., xxiii. sqq.), Hezekiah (2 Chron. xxix.) and Josiah (xxxv.)—contrast the history in the earlier books of Samuel and Kings—or when the still later book of Jubilees (xxxii.) places the rise of the Levitical priesthood in the patriarchal period. The traditional theory of the Mosaic origin of the elaborate Levitical legislation cannot be maintained save by the most arbitrary and inconsequential treatment of the evidence and by an entire indifference to the historical spirit; and, although numerous points of detail still remain very obscure, the three leading stages in the Levitical institutions are now recognized by nearly all independent scholars. These stages with a number of concomitant features confirm the literary hypothesis that biblical history is in the main due to two leading recensions, the Deuteronomic and the Priestly (cf. [b] and [c] above), which have incorporated older sources.<sup>4</sup> If the hierarchical system as it existed in the post-exilic age was really the work of Moses, it is inexplicable that all trace of it was so completely lost that the degradation of the non-Zadokites in Ezekiel was a new feature and a punishment, whereas in the Mosaic law the ordinary Levites, on the traditional view, was already forbidden priestly rights under penalty of death. There is in fact no clear evidence of the existence of a distinction between priests and Levites in any Hebrew writing demonstrably earlier than the Deuteronomic stage, although, even as the Pentateuch contains ordinances which have been carried back by means of a "legal convention" to the days of Moses, writers have occasionally altered earlier records of the history to agree with later standpoints.<sup>5</sup>

No argument in support of the traditional theory can be drawn from the account of Korah's revolt (Num. xvi. sqq., see § 3) or from the Levitical cities (Num. xxxv.; Josh. xxi.). Some of the latter were either not conquered by the Israelites until long after the invasion, or, if conquered, were not held by Levites; and names are wanting of places in which priests are actually known to have lived. Certainly the names are largely identical with ancient holy cities, which, however, are holy because they possessed noted shrines, not because the inhabitants were members of a holy tribe. Gezer and Taanach, for example, are said to have remained in the hands of Canaanites (Judges i. 27, 29; cf. 1 Kings ix. 16), and recent excavation has shown how far the cultus of these cities was removed from Mosaic religion and ritual and how long the grosser elements persisted.<sup>6</sup> On the other hand, the sanctuaries obviously had always their local ministers, all of whom in time could be called Levitical, and it is only in this sense, not in that of the late priestly legislation, that a place like Shechem could ever have been included. Further, instead of holding cities and pasture-grounds, the Levites are sometimes described as scattered and divided (Gen. xlix. 7; Deut. xviii. 6), and though they may naturally possess property as private individuals, they alone of all the tribes of Israel possess no tribal inheritance (Num. xviii. 23, xxvi. 62; Deut. x. 9; Josh. xiv. 3). This fluctuation finds a parallel in the age at which the Levites were to serve; for neither has any reasonable explanation been found on the traditional view. Num. iv. 3 fixes the age at thirty, although in i. 3 it has been reduced to twenty; but in 1 Chron. xxiii. 3, David is said to have numbered them from the higher limit, whereas in vv. 24, 27 the lower figure is given on the authority of "the last words (or acts) of David." In Num. viii. 23-26, the age is given as twenty-five, but twenty became usual and recurs in Ezra iii. 8 and 2 Chron. xxxi. 17. There are, however, independent grounds for believing that 1 Chron. xxiii. 24, 27, 2 Chron. xxxi. 17 belong to later insertions and that Ezr. iii. 8 is relatively late.

When, in accordance with the usual methods of Hebrew genealogical history, the Levites are defined as the descendants of Levi, the third son of Jacob by Leah (Gen. xxix. 34), a literal interpretation is unnecessary, and the only narrative wherein Levi appears as a person evidently delineates under the form of personification events in the history of the Levites (Gen. xxxiv.).<sup>7</sup> They take their place in Israel as the tribe set apart for sacred duties, and without entering into the large question how far the tribal schemes can be used for the earlier history of Israel, it may be observed that no adequate interpretation has yet been found of the ethnological traditions of Levi and other sons of Leah in their historical relation to one another or to the other tribes. However intelligible may be the notion of a tribe *reserved* for priestly service, the fact that it does not apply to early biblical history is apparent from the heterogeneous details of the Levitical divisions. The incorporation of singers and porters is indeed a late process, but it is typical of the tendency to co-ordinate all the religious classes (see [GENEALOGY: Biblical](#)). The genealogies in their complete form pay little heed to Moses, although Aaron and Moses could typify the priesthood and other Levites generally (1 Chron. xxiii. 14). Certain priesthoods in the first stage (§ 1 [a]) claimed descent from these prototypes, and it is interesting to observe (1) the growing importance of Aaron in the later sources of "the Exodus," and (2) the relation between Mosheh (Moses) and his two sons Gershom and Eliezer, on the one side, and the Levitical names Mushi (*i.e.* the Mosaicite), Gershon and the Aaronite priest Eleazar, on the other. There are links, also, which unite Moses with Kenite, Rechabite, Calebite and Edomite families, and the Levitical names themselves are equally connected with the southern tribes of Judah and Simeon and with the Edomites.<sup>8</sup> It is to be inferred, therefore, that some relationship subsisted, or was thought to subsist, among (1) the Levites, (2) clans actually located in the south of Palestine, and (3) families whose names and traditions point to a southern origin. The exact meaning of these features is not clear, but if it be remembered (a) that the Levites of post-exilic literature represent only the result of a long and intricate development, (b) that the name "Levite," in the later stages at least, was extended to include all priestly servants, and (c) that the priesthoods, in tending to become hereditary, included priests who were Levites by adoption and not by descent, it will be recognized that the examination of the evidence for the earlier stages cannot confine itself to those narratives where the specific term alone occurs.

3. *The Traditions of the Levites.*—In the "Blessing of Moses" (Deut. xxxiii. 8-11), Levi is a collective name for the priesthood, probably that of (north) Israel. He is the guardian of the sacred oracles, knowing no kin, and enjoying his privileges for proofs of fidelity at Massah and Meribah. That these places (in the district of Kadesh)

were traditionally associated with the origin of the Levites is suggested by various Levitical stories, although it is in a narrative now in a context pointing to Horeb or Sinai that the Levites are Israelites who for some cause (now lost) severed themselves from their people and took up a stand on behalf of Yahweh (Exod. xxxii.). Other evidence allows us to link together the Kenites, Calebites and Danites in a tradition of some movement into Palestine, evidently quite distinct from the great invasion of Israelite tribes which predominates in the existing records. The priesthood of Dan certainly traced its origin to Moses (Judges xvii. 9, xviii. 30); that of Shiloh claimed an equally high ancestry (1 Sam. ii. 27 seq.).<sup>9</sup> Some tradition of a widespread movement appears to be ascribed to the age of Jehu, whose accession, promoted by the prophet Elisha, marks the end of the conflict between Yahweh and Baal. To a Rechabite (the clan is allied to the Kenites) is definitely ascribed a hand in Jehu's sanguinary measures, and, though little is told of the obviously momentous events, one writer clearly alludes to a bloody period when reforms were to be effected by the sword (1 Kings xix. 17). Similarly the story of the original selection of the Levites in the wilderness mentions an uncompromising massacre of idolaters. Consequently, it is very noteworthy that popular tradition preserves the recollection of some attack by the "brothers" Levi and Simeon upon the famous holy city of Shechem to avenge their "sister" Dinah (Gen. xxxiv.), and that a detailed narrative tells of the bloodthirsty though pious Danites who sacked an Ephraimite shrine on their journey to a new home (Judges xvii. sq.).

The older records utilized by the Deuteronomic and later compilers indicate some common tradition which has found expression in these varying forms. Different religious standpoints are represented in the biblical writings, and it is now important to observe that the prophecies of Hosea unmistakably show another attitude to the Israelite priesthood. The condemnation of Jehu's bloodshed (Hos. i. 4) gives another view of events in which both Elijah and Elisha were concerned, and the change is more vividly realized when it is found that even to Moses and Aaron, the traditional founders of Israelite religion and ritual, is ascribed an offence whereby they incurred Yahweh's wrath (Num. xx. 12, 24, xxvii. 14; Deut. ix. 20, xxxii. 51). The sanctuaries of Shiloh and Dan lasted until the deportation of Israel (Judges xviii. 30 seq.), and some of their history is still preserved in the account of the late pre-monarchical age (12th-11th centuries B.C.). Shiloh's priestly gild is condemned for its iniquity (1 Sam. iii. 11-14), the sanctuary mysteriously disappears, and the priests are subsequently found at Nob outside Jerusalem (1 Sam. xxi. seq.). All idea of historical perspective has been lost, since the fall of Shiloh was apparently a recent event at the close of the 7th century (Jer. vii. 12-15, xxvi. 6-9). But the tendency to ascribe the disasters of northern Israel to the priesthood (see esp. Hosea) takes another form when an inserted prophecy revokes the privileges of the ancient and honourable family, foretells its overthrow, and announces the rise of a new faithful and everlasting priesthood, at whose hands the dispossessed survivors, reduced to poverty, would beg some priestly office to secure a livelihood (1 Sam. ii. 27-36). The sequel to this phase is placed in the reign of Solomon, when David's old priest Abiathar, sole survivor of the priests of Shiloh, is expelled to Anathoth (near Jerusalem), and Zadok becomes the first chief priest contemporary with the foundation of the *first* temple (1 Kings ii. 27, 35). These situations cannot be severed from what is known elsewhere of the Deuteronomic teaching, of the reform ascribed to Josiah, or of the principle inculcated by Ezekiel (see § 1 [b]). The late specific tendency in favour of Jerusalem agrees with the Deuteronomic editor of Kings who condemns the sanctuaries of Dan and Bethel for calf-worship (1 Kings xii. 28-31), and does not acknowledge the northern priesthood to be Levitical (1 Kings xii. 31, note the interpretation in 2 Chron. xi. 14, xiii. 9). It is from a similar standpoint that Aaron is condemned for the manufacture of the golden calf, and a compiler (not the original writer) finds its sequel in the election of the faithful Levites.<sup>10</sup>

In the third great stage there is another change in the tone. The present (priestly) recension of Gen. xxxiv. has practically justified Levi and Simeon from its standpoint of opposition to intermarriage, and in spite of Jacob's curse (Gen. xlix. 5-7) later traditions continue to extol the slaughter of the Shechemites as a pious duty. Post-exilic revision has also hopelessly obscured the offence of Moses and Aaron, although there was already a tendency to place the blame upon the people (Deut. i. 37, iii. 26, iv. 21). When two-thirds of the priestly families are said to be Zadokites and one-third are of the families of Abiathar, some reconciliation, some adjustment of rivalries, is to be recognized (1 Chron. xxiv.). Again, in the composite story of Korah's revolt, one version reflects a contest between Aaronites and the other Levites who claimed the priesthood (Num. xvi. 8-11, 36-40), while another shows the supremacy of the Levites as a caste either over the rest of the people (? cf. the prayer, Deut. xxxiii. 11), or, since the latter are under the leadership of Korah, later the eponym of a gild of singers, perhaps over the more subordinate ministers who once formed a separate class.<sup>11</sup> In the composite work Chronicles-Ezra-Nehemiah (dating after the post-exilic Levitical legislation) a peculiar interest is taken in the Levites, more particularly in the singers, and certain passages even reveal some animus against the Aaronites (2 Chron. xxix. 34, xxx. 3). A Levite probably had a hand in the work, and this, with the evidence for the Levitical Psalms (see [PSALMS](#)), gives the caste an interesting place in the study of the transmission of the biblical records.<sup>12</sup> But the history of the Levites in the early post-exilic stage and onwards is a separate problem, and the work of criticism has not advanced sufficiently for a proper estimate of the various vicissitudes. However, the feeling which was aroused among the priests when some centuries later the singers obtained from Agrippa the privilege of wearing the priestly linen dress (Josephus, *Ant.* xx. 9. 6), at least enables one to appreciate more vividly the scantier hints of internal jealousies during the preceding years.<sup>13</sup>

4. *Summary.*—From the inevitable conclusion that there are three stages in the written sources for the Levitical institutions, the next step is the correlation of allied traditions on the basis of the genealogical evidence. But the problem of fitting these into the history of Israel still remains. The assumption that the earlier sources for the pre-monarchical history, as incorporated by late compilers, are necessarily trustworthy confuses the inquiry (on Gen. xxxiv., see [SIMEON](#)), and even the probability of a reforming spirit in Jehu's age depends upon the internal criticism of the related records (see [JEWS](#), §§ 11-14). The view that the Levites came from the south may be combined with the conviction that there Yahweh had his seat (cf. Deut. xxxiii. 2; Judges v. 4; Hab. iii. 3), but the latter is only one view, and the traditions of the patriarchs point to another belief (cf. also Gen. iv. 26). The two are reconciled when the God of the patriarchs reveals His name for the first time unto Moses (Exod. iii. 15, vi. 3). With these variations is involved the problem of the early history of the Israelites.<sup>14</sup> Moreover, the real Judaeen tendency which associates the fall of Eli's priesthood at Shiloh with the rise of the Zadokites involves the literary problems of Deuteronomy, a composite work whose age is not certainly known, and of the twofold Deuteronomic redaction elsewhere, one phase of which is more distinctly Judaeen and anti-Samaritan. There are vicissitudes and varying standpoints which point to a complicated literary history and require some historical background, and, apart from actual changes in the history of the Levites, some allowance must be made for the real character of the circles where the diverse records originated or through which they passed. The key must be sought in the exilic and post-exilic age where, unfortunately, direct and decisive evidence is lacking. It is

clear that the Zadokite priests were rendered legitimate by finding a place for their ancestor in the Levitical genealogies—through Phinehas (cf. Num. xxv. 12 seq.), and Aaron—there was a feeling that a legitimate priest must be an Aaronite, but the historical reason for this is uncertain (see R. H. Kennett, *Journ. Theolog. Stud.*, 1905, pp. 161 sqq.). Hence, it is impossible at present to trace the earlier steps which led to the grand hierarchy of post-exilic Judaism. Even the name Levite itself is of uncertain origin. Though popularly connected with *lāvāh*, “be joined, attached,” an ethnic from Leah has found some favour; the Assyrian *lī’u* “powerful, wise,” has also been suggested. The term has been more plausibly identified with *l-v’* (fem. *l-v’-t*), the name given in old Arabian inscriptions (e.g. at al-’Olā, south-east of Elath) to the priests and priestesses of the Arabian god Vadd (so especially Hommel, *Anc. Heb. Trad.*, pp. 278 seq.). The date of the evidence, however, has not been fixed with unanimity, and this very attractive and suggestive view requires confirmation and independent support.

AUTHORITIES.—For the argument in § 1, see Wellhausen, *Prolegomena*, pp. 121-151; W. R. Smith, *Old Test. in Jew. Church* (2nd ed., Index, s.v. “Levites”); A. Kuenen, *Hexateuch*, §§ 3 n. 16; 11, pp. 203 sqq.; 15 n. 15 (more technical); also the larger commentaries on Exodus-Joshua and the ordinary critical works on Old Testament literature. In § 1 and part of § 2 use has been freely made of W. R. Smith’s article “Levites” in the 9th edition of the *Ency. Brit.* (see the revision by A. Bertholet, *Ency. Bib.* col. 2770 sqq.). For the history of the Levites in the post-exilic and later ages, see the commentaries on Numbers (by G. B. Gray) and Chronicles (E. L. Curtis), and especially H. Vogelstein, *Der Kampf zwischen Priestern u. Leviten seit den Tagen Ezechiels*, with Kuenen’s review in his *Gesammelte Abhandlungen* (ed. K. Budde, 1894). See further [PRIEST](#).

(S. A. C.)

- 1 For the derivation of “Levi” see below § 4 end.
- 2 The words “beside that which cometh of the sale of his patrimony” (lit. “his sellings according to the fathers”) are obscure; they seem to imply some additional source of income which the Levite enjoys at the central sanctuary.
- 3 For the *nēthīnīm* (“given”) and “children of the slaves of Solomon” (whose hereditary service would give them a pre-eminence over the temple slaves), see art. [NETHINIM](#), and Benzinger, *Ency. Bib.* cols. 3397 sqq.
- 4 In defence of the traditional view, see S. I. Curtiss, *The Levitical Priests* (1877), with which his later attitude should be contrasted (see *Primitive Semitic Religion To-day*, pp. 14, 50, 133 seq., 171, 238 sqq., 241 sqq.); W. L. Baxter, *Sanctuary and Sacrifice* (1895); A. van Hoonacker, *Le Sacerdoce lévitique* (1899); and J. Orr, *Problem of the O.T.* (1905). These and other apologetic writings have so far failed to produce any adequate alternative hypothesis, and while they argue for the traditional theory, later revision not being excluded, the modern critical view accepts late dates for the literary sources in their present form, and explicitly recognizes the presence of much that is ancient. Note the curious old tradition that Ezra wrote out the law which had been burnt (2 Esdr. xiv. 21 sqq.).
- 5 For example, in 1 Kings viii. 4, there are many indications that the context has undergone considerable editing at a fairly late date. The Septuagint translators did not read the clause which speaks of “priests and Levites,” and 2 Chron. v. 5 reads “the Levite priests,” the phrase characteristic of the Deuteronomic identification of priestly and Levitical ministry. 1 Sam. vi. 15, too, brings in the Levites, but the verse breaks the connexion between 14 and 16. For the present disorder in the text of 2 Sam. xv. 24, see the commentaries.
- 6 See Father H. Vincent, O.P., *Canaan d’après l’exploration récente* (1907), pp. 151, 200 sqq., 463 sq.
- 7 So Gen. xxxiv. 7, Hamor has wrought folly “in Israel” (cf. Judges xx. 6 and often), and in v. 30 “Jacob” is not a personal but a collective idea, for he says, “I am a few men,” and the capture and destruction of a considerable city is in the nature of things the work of more than two individuals. In the allusion to Levi and Simeon in Gen. xlix. the two are spoken of as “brothers” with a communal assembly. See, for other examples of personification, [GENEALOGY: Biblical](#).
- 8 See E. Meyer, *Israeliten u. ihre Nachbarstämme*, pp. 299 sqq. (passim); S. A. Cook, *Ency. Bib.* col. 1665 seq.; *Crit. Notes on O.T. History*, pp. 84 sqq., 122-125.
- 9 The second element of the name Abiathar is connected with Jether or Jethro, the father-in-law of Moses, and even Ichabod (1 Sam. iv. 21) seems to be an intentional reshaping of Jochebed, which is elsewhere the name of the mother of Moses. Phinehas, Eli’s son, becomes in later writings the name of a prominent Aaronite priest in the days of the exodus from Egypt.
- 10 With this development in Israelite religion, observe that Judaeen cult included the worship of a brazen serpent, the institution of which was ascribed to Moses, and that, according to the compiler of Kings, Hezekiah was the first to destroy it when he suppressed idolatrous worship in Judah (2 Kings xviii. 4). It may be added that the faithful Kenites (found in N. Palestine, Judges iv. 11) appear in another light when threatened with captivity by Asshur (Num. xxiv. 22; cf. fall of Dan and Shiloh), and if their eponym is Cain (*q.v.*), the story of Cain and Abel serves, amid a variety of purposes, to condemn the murder of the settled agriculturist by the nomad, but curiously allows that any retaliation upon Cain shall be avenged (see below, note 5).
- 11 The name Korah itself is elsewhere Edomite (Gen. xxxvi. 5, 14, 18) and Calebite (1 Chron. ii. 43). See *Ency. Bib.*, s.v.
- 12 : The musical service of the temple has no place in the Pentateuch, but was considerably developed under the second temple and attracted the special attention of Greek observers (Theophrastus, *apud* Porphyry, *de Abstin.* ii. 26); see on this subject, R. Kittel’s *Handkommentar* on Chronicles, pp. 90 sqq.
- 13 Even the tithes enjoyed by the Levites (Num. xviii. 21 seq.) were finally transferred to the priests (so in the Talmud: see *Yebamoth*, fol. 86a, Carpzov, *App. ad Godw.* p. 624; Hottinger, *De Dec.* vi. 8, ix. 17).
- 14 For some suggestive remarks on the relation between nomadism and the Levites, and their influence upon Israelite religion and literary tradition, see E. Meyer, *Die Israeliten u. ihre Nachbarstämme* (1906), pp. 82-89, 138; on the problems of early Israelite history, see [SIMEON](#) (end), [JEWS](#), §§ 5, 8, and [PALESTINE, History](#).



**LEVITICUS**, in the Bible, the third book of the Pentateuch. The name is derived from that of the Septuagint version (τὸ λευ[ε]ιτικόν (sc. βιβλίον), though the English form is due to the Latin rendering, *Leviticus* (sc. *liber*). By the Jews the book is called *Wayyikrā* (ויקרא) from the first word of the Hebrew text, but it is also referred to (in the Talmud and Massorah) as *Tōrath kōhānīm* (תורת כהנים, law of the priests), *Sēpher*

*kōhānīm* (ספר כהן, book of the priests), and *Sēpher qorbanīm* (ספר קרבנות, book of offerings). As a descriptive title *Leviticus*, "the Levitical book," is not inappropriate to the contents of the book, which exhibits an elaborate system of sacrificial worship. In this connexion, however, the term "Levitical" is used in a perfectly general sense, since there is no reference in the book itself to the Levites themselves.

The book of Leviticus presents a marked contrast to the two preceding books of the Hexateuch in that it is derived from one document only, viz. the Priestly Code (P), and contains no trace of the other documents from which the Hexateuch has been compiled. Hence the dominant interest is a priestly one, while the contents are almost entirely legislative as opposed to historical. But though the book as a whole is assigned to a single document, its contents are by no means homogeneous: in fact the critical problem presented by the legislative portions of Leviticus, though more limited in scope, is very similar to that of the other books of the Hexateuch. Here, too, the occurrence of repetitions and divergencies, the variations of standpoint and practice, and, at times, the linguistic peculiarities point no less clearly to diversity of origin.

The historical narrative with which P connects his account of the sacred institutions of Israel is reduced in Leviticus to a minimum, and presents no special features. The consecration of Aaron and his sons (viii. ix.) resumes the narrative of Exod. xl., and this is followed by a brief notice of the death of Nadab and Abihu (x. 1-5), and later by an account of the death of the blasphemer (xxiv. 10 f.). Apart from these incidents, which, in accordance with the practice of P, are utilized for the purpose of introducing fresh legislation, the book consists of three main groups or collections of ritual laws: (1) chaps. i.-vii., laws of sacrifice; (2) chaps. xi.-xv., laws of purification, with an appendix (xvi.) on the Day of Atonement; (3) chaps. xvii.-xxvi., the Law of Holiness, with an appendix (xxvii.) on vows and tithes. In part these laws appear to be older than P, but when examined in detail the various collections show unmistakably that they have undergone more than one process of redaction before they assumed the form in which they are now presented. The scope of the present article does not permit of an elaborate analysis of the different sections, but the evidence adduced will, it is hoped, afford sufficient proof of the truth of this statement.

I. *The Laws of Sacrifice.*—Chaps. i.-vii. This group of laws clearly formed no part of the original narrative of P since it interrupts the connexion of chap. viii. with Exod. xl. For chap. viii. describes how Moses carried out the command of Exod. xl. 12-15 in accordance with the instructions given in Exod. xxix. 1-35, and bears the same relation to the latter passage that Exod. xxxv. ff. bears to Exod. xxv. ff. Hence we can only conclude that Lev. i.-vii. were added by a later editor. This conclusion does not necessarily involve a late date for the laws themselves, many of which have the appearance of great antiquity, though their original form has been considerably modified. But though these chapters form an independent collection of laws, and were incorporated as such in P, a critical analysis of their contents shows that they were not all derived from the same source.

The collection falls into two divisions, (*a*) i.-vi. 7 (Heb. v. 26), and (*b*) vi. 8 (Heb. vi. 1)-vii., the former being addressed to the people and the latter to the priests. The laws contained in (*a*) refer to (1) burnt-offerings, i.; (2) meal-offerings, ii.; (3) peace-offerings, iii.; (4) sin-offerings, iv. (on v. 1-13 see below); (5) trespass-offerings, v. 14-vi. 7 (Heb. v. 14-26). The laws in (*b*) cover practically the same ground—(1) burnt-offerings, vi. 8-13 (Heb. vv. 1-6); (2) meal-offerings, vi. 14-18 (Heb. vv. 7-11); (3) the meal-offering of the priest, vi. 19-23 (Heb. vv. 12-16); (4) sin-offerings, vi. 24-30 (Heb. vv. 17-23); (5) trespass-offerings, vii. 1-7, together with certain regulations for the priest's share of the burnt- and meal-offerings (vv. 8-10); (6) peace-offerings, vii. 11-21. Then follow the prohibition of eating the fat or blood (vv. 22-28), the priest's share of the peace-offerings (vv. 29-34), the priest's anointing-portion (vv. 35, 36), and the subscription (vv. 37, 38). The second group of laws is thus to a certain extent supplementary to the first, and was, doubtless, intended as such by the editor of chaps. i.-vii. Originally it can hardly have formed part of the same collection; for (*a*) the order is different, that of the second group being supported by its subscription, and (*b*) the laws in vi. 8-vii. are regularly introduced by the formula "This is the law (*tōrah*) of..." Most probably the second group was excerpted by the editor of chaps. i.-vii. from another collection for the purpose of supplementing the laws of i.-v., more especially on points connected with the functions and dues of the officiating priests.

Closer investigation, however, shows that both groups of laws contain heterogeneous elements and that their present form is the result of a long process of development. Thus i. and iii. seem to contain genuinely old enactments, though i. 14-17 is probably a later addition, since there is no reference to birds in the general heading v. 2. Chap. ii. 1-3, on the other hand, though it corresponds in form to i. and iii., interrupts the close connexion between those chapters, and should in any case stand after iii.: the use of the second for the third person in the remaining verses points to a different source. As might be expected from the nature of the sacrifice with which it deals, iv. (sin-offerings) seems to belong to a relatively later period of the sacrificial system. Several features confirm this view: (1) the blood of the sin-offering of the "anointed priest" and of the whole congregation is brought within the veil and sprinkled on the altar of incense, (2) the sin-offering of the congregation is a bullock, and not, as elsewhere, a goat (ix. 15; Num. xv. 24), (3) the altar of incense is distinguished from the altar of burnt-offering (as opposed to Exod. xxix.; Lev. viii. ix.). Chap. v. 1-13 have usually been regarded as an appendix to iv., setting forth (*a*) a number of typical cases for which a sin-offering is required (vv. 1-6), and (*b*) certain concessions for those who could not afford the ordinary sin-offering (vv. 7-13). But vv. 1-6, which are not homogeneous (vv. 2 and 3 treating of another question and interrupting vv. 1, 4, 5 f.), cannot be ascribed to the same author as iv.: for (1) it presents a different theory of the sin-offering (contrast v. 1 f. with iv. 2), (2) it ignores the fourfold division of offerings corresponding to the rank of the offender, (3) it fails to observe the distinction between sin- and trespass-offering (in vv. 6, 7, "his guilt-offering" (אשמו) appears to have the sense of a "penalty" or "forfeit," unless with Baentsch we read קרבנו "his oblation" in each case; cf. v. 11, iv. 23 ff. Verses 7-13, on the other hand, form a suitable continuation of iv., though probably they are secondary in character. Chap. v. 14 (Heb. v. 26)-vi. 7 contain regulations for the trespass-offering, in which the distinctive character of that offering is clearly brought out. The cases cited in vi. 1-7 (Heb. v. 20-26) are clearly analogous to those in v. 14-16, from which they are at present separated by vv. 17-19. These latter prescribe a trespass-offering for the same case for which in iv. 22 f. a sin-offering is required: it is noticeable also that no restitution, the characteristic feature of the *āshām*, is prescribed. It is hardly doubtful that the verses are derived from a different source to that of their immediate context, possibly the same as v. 1-6.

The subscription (vii. 37, 38) is our chief guide to determining the original extent of the second group of laws (vi. 8 [Heb. vi. 1]-vii. 36). From it we infer that originally the collection only dealt with the five chief sacrifices (vi. 8-13; 14-18; 24, 25, 27-30; vii. 1-6; 11-21) already discussed in i.-v., since only these are referred to in the colophon where they are given in the same order (the consecration-offering [v. 37] is probably due to the same redactor who introduced the gloss "in the day when he is anointed" in vi. 20). Of the remaining sections vi. 19-23

(Heb. 12-16), the daily meal-offering of the (high-) priest, betrays its secondary origin by its absence from the subscription, cf. also the different introduction. Chaps. vi. 26 (Heb. 19) and vii. 7 assign the offering to the officiating priest in contrast to vi. 18 (Heb. 11), 29 (Heb. 22), vii. 6 ("every male among the priests"), and possibly belong, together with vii. 8-10, to a separate collection which dealt especially with priestly dues. Chap. vii. 22-27, which prohibit the eating of fat and blood, are addressed to the community at large, and were, doubtless, inserted here in connexion with the sacrificial meal which formed the usual accompaniment of the peace-offering. Chap. vii. 28-34 are also addressed to the people, and cannot therefore have formed part of the original priestly manual; v. 33 betrays the same hand as vi. 26 (Heb. 19) and vii. 7, and with 35a may be assigned to the same collection as those verses; to the redactor must be assigned vv. 32 (a doublet of v. 33), 34, 35b and 36.

Chaps. viii.-x. As stated, these chapters form the original sequel to Exod. xl. They describe (a) the consecration of Aaron and his sons, a ceremony which lasted seven days (viii.), and (b) the public worship on the eighth day, at which Aaron and his sons officiated for the first time as priests (ix.); then follow (c) an account of the death of Nadab and Abihu for offering strange fire (x. 1-5); (d) various regulations affecting the priests (vv. 12-15), and (e) an explanation, in narrative form, of the departure in ix. 15 from the rules for the sin-offering given in vi. 30 (vv. 16-20).

According to Exod. xl. 1-15 Moses was commanded to set up the Tabernacle and to consecrate the priests, and the succeeding verses (16-38) describe how the former command was carried out. The execution of the second command, however, is first described in Lev. viii., and since the intervening chapters exhibit obvious traces of belonging to another source, we may conclude with some certainty that Lev. viii. formed the immediate continuation of Exod. xl. in the original narrative of P. But it has already been pointed out (see Exodus) that Exod. xxxv.-xl. belong to a later stratum of P than Exod. xxv.-xxix, hence it is by no means improbable that Exod. xxxv.-xl. have superseded an earlier and shorter account of the fulfilment of the commands in Exod. xxv.-xxix. If this be the case, we should naturally expect to find that Lev. viii., which bears the same relation to Exod. xxix. 1-35 as Exod. xxxv. ff. to Exod. xxv. ff. also belonged to a later stratum. But Lev. viii., unlike Exod. xxxv. ff., only mentions one altar, and though in its present form the chapter exhibits marks of later authorship, these marks form no part of the original account, but are clearly the work of a later editor. These additions, the secondary character of which is obvious both from the way in which they interrupt the context and also from their contents, are (1), v. 10, the anointing of the Tabernacle in accordance with Exod. xxx. 26 ff.: it is not enjoined in Exod. xxix.; (2) v. 11, the anointing of the altar and the laver (cf. Exod. xxx. 17 ff.) as in Exod. xxix. 36b, xxx. 26 ff.; (3) v. 30, the sprinkling of blood and oil on Aaron and his sons. Apart from these secondary elements, which readily admit of excision, the chapter is in complete accord with P as regards point of view and language, and is therefore to be assigned to that source.

The consecration of Aaron and his sons was, according to P, a necessary preliminary to the offering of sacrifice, and chap. ix. accordingly describes the first solemn act of worship. The ceremony consists of (a) the offerings for Aaron, and (b) those for the congregation; then follows the priestly blessing (v. 22), after which Moses and Aaron enter the sanctuary, and on reappearing once more bless the people. The ceremony terminates with the appearance of the glory of Yahweh, accompanied by a fire which consumes the sacrifices on the altar. Apart from a few redactional glosses the chapter as a whole belongs to P. The punishment of Nadab and Abihu by death for offering "strange fire" (x. 1-5) forms a natural sequel to chap. ix. To this incident a number of disconnected regulations affecting the priests have been attached, of which the first, viz. the prohibition of mourning to Aaron and his sons (vv. 6, 7), alone has any connexion with the immediate context; as it stands, the passage is late in form (cf. xxi. 10 ff.). The second passage, vv. 8, 9, which prohibits the use of wine and strong drink to the priest when on duty, is clearly a later addition. The connexion between these verses and the following is extremely harsh, and since vv. 10, 11 relate to an entirely different subject (cf. xi. 47), the latter verses must be regarded as a misplaced fragment. Verses 12-15 relate to the portions of the meal- and peace-offerings which fell to the lot of the priests, and connect, therefore, with chap. ix.; possibly they have been wrongly transferred from that chapter. In the remaining paragraph, x. 16-20, we have an interesting example of the latest type of additions to the Hexateuch. According to ix. 15 (cf. v. 11) the priests had burnt the flesh of the sin-offering which had been offered on behalf of the congregation, although its blood had not been taken into the inner sanctuary (cf. iv. 1-21, vi. 26). Such treatment, though perfectly legitimate according to the older legislation (Exod. xxix. 14; cf. Lev. viii. 17), was in direct contradiction to the ritual of vi. 24 ff., which prescribed that the flesh of ordinary sin-offerings should be eaten by the priests. Such a breach of ritual on the part of Aaron and his sons seemed to a later redactor to demand an explanation, and this is furnished in the present section.

II. *The Laws of Purification.*—Chaps. xi.-xv. This collection of laws comprises four main sections relating to (1) clean and unclean beasts (xi.), (2) childbirth (xii.), (3) leprosy (xiii. xiv.), and (4) certain natural secretions (xv.). These laws, or *tōrōth*, are so closely allied to each other by the nature of their contents and their literary form (cf. especially the recurring formula "This is the law of ..." xi. 46, xii. 7, xiii. 59, xiv. 32, 54, 57, xv. 32) that they must originally have formed a single collection. The collection, however, has clearly undergone more than one redaction before reaching its final form. This is made evident not only by the present position of chap. xii. which in v. 2 presupposes chap. xv. (cf. xv. 19), and must originally have followed after that chapter, but also by the contents of the different sections, which exhibit clear traces of repeated revision. At the same time it seems, like chaps. i.-vii., xvii.-xxvi., to have been formed independently of P and to have been added to that document by a later editor; for in its present position it interrupts the main thread of P's narrative, chap. xvi. forming the natural continuation of chap. xv.; and, further, the inclusion of Aaron as well as Moses in the formula of address (xi. 1, xiii. 1, xiv. 33, xv. 1) is contrary to the usage of P.

1. Chap. xi. consists of two main sections, of which the first (vv. 1-23, 41-47) contains directions as to the clean and unclean animals which may or may not be used for food, while the second (vv. 24-40) treats of the defilement caused by contact with the carcasses of unclean animals (in v. 39 f. contact with clean animals after death is also forbidden), and prescribes certain rites of purification. The main interest of the chapter, from the point of view of literary criticism, centres in the relation of the first section to the Law of Holiness (xvii.-xxvi.) and to the similar laws in Deut. xiv. 3-20. From xx. 25 it has been inferred with considerable probability that H, or the Law of Holiness, originally contained legislation of a similar character with reference to clean and unclean animals; and many scholars have held that the first section (vv. 1 [or 2]-23 and 41-47) really belongs to that code. But while vv. 43-45 may unhesitatingly be assigned to H, the remaining verses fail to exhibit any of the characteristic features of that code. We must assign them, therefore, to another source, though, in view of xx. 25 and xi. 43-45, it is highly probable that they have superseded similar legislation belonging to H.

The relation of Lev. xi. 2-23 to Deut. xiv. 4-20 is less easy to determine, since the phenomena presented by the two texts are somewhat inconsistent. The two passages are to a large extent verbally identical, but while Deut. xiv. 4*b*, 5 both defines and exemplifies the clean animals (as opposed to Lev. xi. 3; which only defines them), the rest of the Deuteronomic version is much shorter than that of Leviticus. Thus, except for vv. 4*b*, 5, the Deuteronomic version, which in its general style, and to a certain extent in its phraseology (cf. *יָרַח* *kind*, vv. 13, 15, 18, and *שָׂרָץ* *swarm*, v. 19), shows traces of a priestly origin, might be regarded as an abridgment of Lev. xi. But the Deuteronomic version uses *טָמֵא* *unclean* throughout (vv. 7, 10, 19), while Lev. xi. from v. 11 onwards employs the technical term *טָמֵא* *detestable thing*, and it is at least equally possible to treat the longer version of Leviticus as an expansion of Deut. xiv. 4-20. The fact that Deut. xiv. 21 permits the stranger (*גֵּר*) to eat the flesh of any animal that dies a natural death, while Lev. xvii. 25 places him on an equal footing with the Israelite, cannot be cited in favour of the priority of Deuteronomy since v. 21 is clearly supplementary; cf. also Lev. xi. 39. On the whole it seems best to accept the view that both passages are derived separately from an earlier source.

2. Chap. xii. prescribes regulations for the purification of a woman after the birth of (*a*) a male and (*b*) a female child. It has been already pointed out that this chapter would follow more suitably after chap. xv., with which it is closely allied in regard to subject-matter. The closing formula (v. 7) shows clearly that, as in the case of v. 7-13 (cf. i. 14-17), the concessions in favour of the poorer worshipper are a later addition.

3. Chaps. xiii., xiv. The regulations concerning leprosy fall readily into four main divisions: (*a*) xiii. 1-46*a*, an elaborate description of the symptoms common to the earlier stages of leprosy and other skin diseases to guide the priest in deciding as to the cleanness or uncleanness of the patient; (*b*) xiii. 47-59, a further description of different kinds of mould or fungus growth affecting stuffs and leather; (*c*) xiv. 1-32, the rites of purification to be employed after the healing of leprosy; and (*d*) xiv. 33-53, regulations dealing with the appearance of patches of mould or mildew on the walls of a house. Like other collections the group of laws on leprosy easily betrays its composite character and exhibits unmistakable evidence of its gradual growth. There is, however, no reason to doubt that a large portion of the laws is genuinely old since the subject is one that would naturally call for early legislation; moreover, Deut. xxiv. 8 presupposes the existence of regulations concerning leprosy, presumably oral, which were in the possession of the priests. The earliest sections are admittedly xiii. 1-46*a* and xiv. 2-8*a*, the ritual of the latter being obviously of a very archaic type. The secondary character of xiii. 47-59 is evident: it interrupts the close connexion between xiii. 1-46*a* and xiv. 2-8*a*, and further it is provided with its own colophon in v. 59. A similar character must be assigned to the remaining verses of chap. xiv., with the exception of the colophon in v. 57*b*; the latter has been successively expanded in vv. 54-57*a* so as to include the later additions. Thus xiv. 9-20 prescribes a second and more elaborate ritual of purification after the healing of leprosy, though the leper, according to v. 8*a*, is already clean; its secondary character is further shown by the heightening of the ceremonial which seems to be modelled on that of the consecration of the priest (viii. 23 ff.), the multiplication of sacrifices and the minute regulations with regard to the blood and oil. The succeeding section (vv. 21-32) enjoins special modifications for those who cannot afford the more costly offerings of vv. 9-20, and like v. 7-13, xii. 8 is clearly a later addition; cf. the separate colophon, v. 32. The closing section xiv. 33-53 is closely allied to xiii. 47-59, though probably later in date: probably the concluding verses (48-53), in which the same rites are prescribed for the purification of a house as are ordained for a person in vv. 3-8*a*, were added at a still later period.

4. Chap. xv. deals with the rites of purification rendered necessary by various natural secretions, and is therefore closely related to chap. xii. On the analogy of the other laws it is probable that the old *tōrāh*, which forms the basis of the chapter, has been subsequently expanded, but except in the colophon (vv. 32-34), which displays marks of later redaction, there is nothing to guide us in separating the additional matter.

Chap. xvi. It may be regarded as certain that this chapter consists of three main elements, only one of which was originally connected with the ceremonial of the Day of Atonement, and that it has passed through more than one stage of revision. Since the appearance of Benzinger's analysis *ZATW* (1889), critics in the main have accepted the division of the chapter into three independent sections: (1) vv. 1-4, 6, 12, 13, 34*b* (probably vv. 23, 24 also form part of this section), regulations to be observed by Aaron whenever he might enter "the holy place within the veil." These regulations are the natural outcome of the death of Nadab and Abihu (x. 1-5), and their object is to guard Aaron from a similar fate; the section thus forms the direct continuation of chap. x.; (2) vv. 29-34*a*, rules for the observance of a yearly fast day, having for their object the purification of the sanctuary and of the people; (3) vv. 5, 7-10, 14-22, 26-28, a later expansion of the blood-ritual to be performed by the high-priest when he enters the Holy of Holies, with which is combined the strange ceremony of the goat which is sent away into the wilderness to Azazel. The matter common to the first two sections, viz. the entrance of the high priest into the Holy of Holies, was doubtless the cause of their subsequent fusion; beyond this, however, the sections have no connexion with one another, and must originally have been quite independent. Doubtless, as Benzinger suggests, the rites to be performed by the officiating high priest on the annual Day of Atonement, which are not prescribed in vv. 29-34*a*, were identical with those laid down in chap. ix. That the third section belongs to a later stage of development and was added at a later date is shown by (*a*) the incongruity of vv. 14 ff. with v. 6—according to the latter the purification of Aaron is a preliminary condition of his entrance within the veil—and (*b*) the elaborate ceremonial in connexion with the sprinkling of the blood. The first section, doubtless, belongs to the main narrative of P; it connects directly with chap. x. and presupposes only one altar (cf. v. 12, Exod. xxviii. 35). The second and third sections, however, must be assigned to a later stratum of P, if only because they appear to have been unknown to Ezra (Neh. ix. 1); the fact that Ezra's fast day took place on the twenty-fourth day of the seventh month (as opposed to Lev. xvi. 29, xxiii. 26 f.) acquires an additional importance in view of the agreement between Neh. viii. 23 f. and Lev. xxiii. 33 f. as to the date of the Feast of Tabernacles. No mention is made of the Day of Atonement in the pre-exilic period, and it is a plausible conjecture that the present law arose from the desire to turn the spontaneous fasting of Neh. ix. 1 into an annual ceremony; in any case directions as to the annual performance of the rite must originally have preceded vv. 29 ff. Possibly the omission of this introduction is due to the redactor who combined (1) and (2) by transferring the regulations of (1) to the ritual of the annual Day of Atonement. At a later period the ritual was further developed by the inclusion of the additional ceremonial contained in (3).

III. *The Law of Holiness*.—Chaps. xvii.-xxvi. The group of laws contained in these chapters has long been recognized as standing apart from the rest of the legislation set forth in Leviticus. For, though they display undeniable affinity with P, they also exhibit certain features which closely distinguish them from that document. The most noticeable of these is the prominence assigned to certain leading ideas and motives, especially to that of *holiness*. The idea of holiness, indeed, is so characteristic of the entire group that the title "Law of Holiness," first given to it by Klostermann (1877), has been generally adopted. The term "holiness" in this connexion consists positively in the fulfilment of ceremonial obligations and negatively in abstaining from the defilement caused by heathen customs and superstitions, but it also includes obedience to the moral requirements of the



On the literary side also the chapters are distinguished by the paraenetic setting in which the laws are embedded and by the use of a special terminology, many of the words and phrases occurring rarely, if ever, in P (for a list of characteristic phrases cf. Driver, *L.O.T.*<sup>6</sup>, p. 49). Further, the structure of these chapters, which closely resembles that of the other two Hexateuchal codes (Exod. xx. 22-xxiii. and Deut. xii.-xxviii.), may reasonably be adduced in support of their independent origin. All three codes contain a somewhat miscellaneous collection of laws; all alike commence with regulations as to the place of sacrifice and close with an exhortation. Lastly, some of the laws treat of subjects which have been already dealt with in P (cf. xvii. 10-14 and vii. 26 f., xix. 6-8 and vii. 15-18). It is hardly doubtful also that the group of laws, which form the basis of chaps. xvii.-xxvi., besides being independent of P, represent an older stage of legislation than that code. For the sacrificial system of H (= Law of Holiness) is less developed than that of P, and in particular shows no knowledge of the sin- and trespass-offerings; the high priest is only *primus inter pares* among his brethren, xxi. 10 (cf. Lev. x. 6, 7, where the same prohibition is extended to all the priests); the distinction between "holy" and "most holy" things (Num. xviii. 8) is unknown to Lev. xxii. (Lev. xxi. 22 is a later addition). It cannot be denied, however, that chaps. xvii.-xxvi. present many points of resemblance with P, both in language and subject-matter, but on closer examination these points of contact are seen to be easily separable from the main body of the legislation. It is highly probable, therefore, that these marks of P are to be assigned to the compiler who combined H with P. But though it may be regarded as certain that H existed as an independent code, it cannot be maintained that the laws which it contains are all of the same origin or belong to the same age. The evidence rather shows that they were first collected by an editor before they were incorporated in P. Thus there is a marked difference in style between the laws themselves and the paraenetic setting in which they are embedded; and it is not unnatural to conjecture that this setting is the work of the first editor.

Two other points in connexion with H are of considerable importance: (a) the possibility of other remains of H, and (b) its relation to Deuteronomy and Ezekiel.

(a) It is generally recognized that H, in its present form, is incomplete. The original code must, it is felt, have included many other subjects now passed over in silence. These, possibly, were omitted by the compiler of P, because they had already been dealt with elsewhere, or they may have been transferred to other connexions. This latter possibility is one that has appealed to many scholars, who have accordingly claimed many other passages of P as parts of H. We have already accepted xi. 43 ff. as an undoubted excerpt from H, but, with the exception of Num. xv. 37-41 (on fringes), the other passages of the Hexateuch which have been attributed to H do not furnish sufficient evidence to justify us in assigning them to that collection. Moore (*Ency. Bibl.* col. 2787) rightly points out that "resemblance in the subject or formulation of laws to *tôrôth* incorporated in H may point to a relation to the *sources* of H, but is not evidence that these laws were ever included in that collection."

(b) The exact relation of H to Deuteronomy and Ezekiel is hard to determine. That chaps. xvii.-xxvi. display a marked affinity to Deuteronomy cannot be denied. Like D, they lay great stress on the duties of humanity and charity both to the Israelite and to the stranger (Deut. xxiv.; Lev. xix.; compare also laws affecting the poor in Deut. xv.; Lev. xxv.), but in some respects the legislation of H appears to reflect a more advanced stage than that of D, e.g. the rules for the priesthood (chap. xxi.), the feasts (xxiii. 9-20, 39-43), the Sabbatical year (xxv. 1-7, 18-22), weights and measures (xix. 35 f.). It must be remembered, however, that these laws have passed through more than one stage of revision and that the original regulations have been much obscured by later glosses and additions; it is therefore somewhat hazardous to base any argument on their present form. "The mutual independence of the two (codes) is rather to be argued from the absence of laws identically formulated, the lack of agreement in order either in the whole or in smaller portions, and the fact that of the peculiar motives and phrases of R<sub>D</sub> there is no trace in H (Lev. xxiii. 40 is almost solitary). It is an unwarranted assumption that all the fragments of Israelite legislation which have been preserved lie in one serial development" (Moore, *Ency. Bibl.* col. 2790).

The relation of H to Ezekiel is remarkably close, the resemblances between the two being so striking that many writers have regarded Ezekiel as the author of H. Such a theory, however, is excluded by the existence of even greater differences of style and matter, so that the main problem to be decided is whether Ezekiel is prior to H or vice versa. The main arguments brought forward by those who maintain the priority of Ezekiel are (1) the fact that H makes mention of a high priest, whereas Ezekiel betrays no knowledge of such an official, and (2) that the author of Lev. xxvi. presupposes a condition of exile and looks forward to a restoration from it. Too much weight, however, must not be attached to these points; for (1) the phrase used in Lev. xxi. 10 (*literally*, "he who is greater than his brethren") cannot be regarded as the equivalent of the definitive "chief priest" of P, and is rather comparable with the usage of 2 Kings xxii. 4 ff., xxv. 18 ("the chief priest"), cf. "the priest" in xi. 9 ff., xvi. 10 ff.; and (2) the passages in Lev. xxvi. (vv. 34 f., 39-45), which are especially cited in support of the exilic standpoint of the writer, are just those which, on other grounds, show signs of later interpolation. The following considerations undoubtedly suggest the priority of H: (1) there is no trace in H of the distinction between priests and Levites first introduced by Ezekiel; (2) Ezekiel xviii., xx., xxii., xxiii. appear to presuppose the laws of Lev. xviii.-xx.; (3) the calendar of Lev. xxiii. represents an earlier stage of development than the fixed days and months of Ezek. xl.; (4) the sin- and trespass-offerings are not mentioned in H (cf. Ezek. xl. 39, xlii. 13, xlv. 29, xlvi. 20); (5) the parallels to H, which are found especially in Ezek. xviii., xx., xxii. f., include both the paraenetic setting and the laws; and lastly, (6) a comparison of Lev. xxvi. with Ezekiel points to the greater originality of the former. Baentsch, however, who is followed by Bertholet, adopts the view that Lev. xxvi. is rather an independent hortatory discourse modelled on Ezekiel. The same writer further maintains that H consists of three separate elements, viz. chaps. xvii.; xviii.-xx., with various ordinances in chaps. xxiii.-xxv.; and xxii., xxiii., of which the last is certainly later than Ezekiel, while the second is in the main prior to that author. But the arguments which he adduces in favour of the threefold origin of H are not sufficient to outweigh the general impression of unity which the code presents.

Chap. xvii. comprises four main sections which are clearly marked off by similar introductory and closing formulae: (1) vv. 3-7, prohibition of the slaughter of domestic animals, unless they are presented to Yahweh; (2) vv. 8, 9, sacrifices to be offered to Yahweh alone; (3) vv. 10-12, prohibition of the eating of blood; (4) vv. 13, 14, the blood of animals not used in sacrifice to be poured on the ground. The chapter as a whole is to be assigned to H. At the same time it exhibits many marks of affinity with P, a phenomenon most easily explained by the supposition that older laws of H have been expanded and modified by later hands in the spirit of P. Clear instances of such revision may be seen in the references to "the door of the tent of meeting" (vv. 4, 5, 6, 9) and "the camp" (v. 3), as well as in vv. 6, 11, 12-14; vv. 15, 16 (prohibiting the eating of animals that die a natural death or are torn by beasts) differ formally from the preceding paragraphs, and are to be assigned to P. What remains after the excision of later additions, however, is not entirely uniform, and points to earlier editorial work

on the part of the compiler of H. Thus vv. 3-7 reflect two points of view, vv. 3, 4 drawing a contrast between profane slaughter and sacrifice, while vv. 5-7 distinguish between sacrifices offered to Yahweh and those offered to demons.

Chap. xviii. contains laws on prohibited marriages (vv. 6-18) and various acts of unchastity (vv. 19-23) embedded in a paraenetic setting (vv. 1-5 and 24-30), the laws being given in the 2nd pers. sing., while the framework employs the 2nd pers. plural. With the exception of v. 21 (on Molech worship), which is here out of place, and has possibly been introduced from xx. 2-5, the chapter displays all the characteristics of H.

Chap. xix. is a collection of miscellaneous laws, partly moral, partly religious, of which the fundamental principle is stated in v. 2 ("Ye shall be holy"). The various laws are clearly defined by the formula "I am Yahweh," or "I am Yahweh your God," phrases which are especially characteristic of chaps. xviii.-xx. The first group of laws (vv. 3 f.) corresponds to the first table of the decalogue, while vv. 11-18 are analogous to the second table; vv. 5-8 (on peace-offerings) are obviously out of place here, and are possibly to be restored to the cognate passage xxii. 29 f., while the humanitarian provisions of vv. 9 and 10 (cf. xxiii. 22) have no connexion with the immediate context; similarly v. 20 (to which a later redactor has added vv. 21, 22, in accordance with vi. 6 f.) appears to be a fragment from a penal code; the passage resembles Exod. xxi. 7 ff., and the offence is clearly one against property, the omission of the punishment being possibly due to the redactor who added vv. 21, 22.

Chap. xx. Prohibitions against Molech worship, vv. 2-5, witchcraft, vv. 6 and 27, unlawful marriages and acts of unchastity, vv. 10-21. Like chap. xviii., the main body of laws is provided with a paraenetic setting, vv. 7, 8 and 22-24; it differs from that chapter, however, in prescribing the death penalty in each case for disobedience. Owing to the close resemblance between the two chapters, many critics have assumed that they are derived from the same source and that the latter chapter was added for the purpose of supplying the penalties. This view, however, is not borne out by a comparison of the two chapters, for four of the cases mentioned in chap. xviii. (vv. 7, 10, 17b, 18) are ignored in chap. xx., while the order and in part the terminology are also different; further, it is difficult on this view to explain why the two chapters are separated by chap. xix. A more probable explanation is that the compiler of H has drawn from two parallel, but independent, sources. Signs of revision are not lacking, especially in vv. 2-5, where vv. 4 f. are a later addition intended to reconcile the inconsistency of v. 2 with v. 3 (R<sub>H</sub>); v. 6, which is closely connected with xix. 31, appears to be less original than v. 27, and may be ascribed to the same hand as v. 3; v. 9 can hardly be in its original context—it would be more suitable after xxiv. 15. The paraenetic setting (vv. 7, 8 and 22-24) is to be assigned to the compiler of H, who doubtless prefaced the parallel version with the additional laws of vv. 2-6. Verses 25, 26 apparently formed the conclusion of a law on clean and unclean animals similar to that of chap. xi., and very probably mark the place where H's regulations on that subject originally stood.

Chaps. xxi., xxii. A series of laws affecting the priests and offerings, viz. (1) regulations ensuring the holiness of (a) ordinary priests, xxi. 1-9, and (b) the chief priest, vv. 10-15; (2) a list of physical defects which exclude a priest from exercising his office, vv. 16-24; (3) the enjoyment of sacred offerings limited to (a) priests, if they are ceremonially clean, xxi. 1-9, and (b) members of a priestly family, vv. 10-16; (4) animals offered in sacrifice must be without blemish, vv. 17-25; (5) further regulations with regard to sacrifices, vv. 26-30, with a paraenetic conclusion, vv. 31-33.

These chapters present considerable difficulty to the literary critic; for while they clearly illustrate the application of the principle of "holiness," and in the main exhibit the characteristic phraseology of H, they also display many striking points of contact with P and the later strata of P, which have been closely interwoven into the original laws. These phenomena can be best explained by the supposition that we have here a body of old laws which have been subjected to more than one revision. The nature of the subjects with which they deal is one that naturally appealed to the priestly schools, and owing to this fact the laws were especially liable to modification and expansion at the hands of later legislators who wished to bring them into conformity with later usage. Signs of such revision may be traced back to the compiler of H, but the evidence shows that the process must have been continued down to the latest period of editorial activity in connexion with P. To redactors of the school of P belong such phrases as "the sons of Aaron" (xxi. 1, 24, xxii. 2, 18), "the seed of Aaron" (xxi. 21, xxii. 4 and "thy seed," v. 17; cf. xxii. 3), "the offerings of the Lord made by fire" (xxi. 6, 21, xxii. 22, 27), "the most holy things" (xxi. 22; cf. xxii. 3 ff. "holy things" only), "throughout their (or your) generations" (xxi. 7, xxii. 3), the references to the anointing of Aaron (xxi. 10, 12) and the Veil (xxi. 23), the introductory formulae (xxi. 1, 16 f., xxii. 1 f., 17 f., 26) and the subscription (xxi. 24). Apart from these redactional additions, chap. xxi. is to be ascribed to H, vv. 6 and 8 being possibly the work of R<sub>H</sub>. Most critics detect a stronger influence of P in chap. xxii., more especially in vv. 3-7 and 17-25, 29, 30; most probably these verses have been largely recast and expanded by later editors, but it is noticeable that they contain no mention of either sin- or trespass-offerings.

Chap. xxiii. A calendar of sacred seasons. The chapter consists of two main elements which can easily be distinguished from one another, the one being derived from P and the other from H. To the former belongs the fuller and more elaborate description of vv. 4-8, 21, 23-38; to the latter, vv. 9-20, 22, 39-44. Characteristic of the priestly calendar are (1) the enumeration of "holy convocations," (2) the prohibition of all work, (3) the careful determination of the date by the day and month, (4) the mention of "the offerings made by fire to Yahweh," and (5) the stereotyped form of the regulations. The older calendar, on the other hand, knows nothing of "holy convocations," nor of abstinence from work; the time of the feasts, which are clearly connected with agriculture, is only roughly defined with reference to the harvest (cf. Exod. xxiii. 14 ff., xxxiv. 22; Deut. xvi. 9 ff.).

The calendar of P comprises (a) the Feast of Passover and the Unleavened Cakes, vv. 4-8; (b) a fragment of Pentecost, v. 21; (c) the Feast of Trumpets, vv. 23-25; (d) the Day of Atonement, vv. 26-32; and (e) the Feast of Tabernacles, vv. 33-36, with a subscription in vv. 37, 38. With these have been incorporated the older regulations of H on the Feast of Weeks, or Pentecost, vv. 9-20, which have been retained in place of P's account (cf. v. 21), and on the Feast of Tabernacles, vv. 39-44, the latter being clearly intended to supplement vv. 33-36. The hand of the redactor who combined the two elements may be seen partly in additions designed to accommodate the regulations of H to P (e.g. v. 39a, "on the fifteenth day of the seventh month," and 39b, "and on the eighth day shall be a solemn rest"), partly in the later expansions corresponding to later usage, vv. 12 f., 18, 19a, 21b, 41. Further, vv. 26-32 (on the Day of Atonement, cf. xvi.) are a later addition to the P sections.

Chap. xxiv. affords an interesting illustration of the manner in which the redactor of P has added later elements to the original code of H. For the first part of the chapter, with its regulations as to (a) the lamps in the Tabernacle, vv. 1-4, and (b) the Shewbread, vv. 5-9, is admittedly derived from P, vv. 1-4, forming a supplement to Exod. xxv. 31-40 (cf. xxvii. 20 f.) and Num. viii. 1-4, and vv. 5-9 to Exod. xxv. 30. The rest of the chapter contains old laws (vv. 15b-22) derived from H on blasphemy, manslaughter and injuries to the person, to which the redactor has added an historical setting (vv. 10-14, 23) as well as a few glosses.

Chap. xxv. lays down regulations for the observance of (a) the Sabbatical year, vv. 1-7, 19-22, and (b) the year of Jubilees, vv. 8-18, 23, and then applies the principle of redemption to (1) land and house property, vv. 24-34, and (2) persons, vv. 35-55. The rules for the Sabbatical year (vv. 1-7) are admittedly derived from H, and vv. 19-22 are also from the same source. Their present position after vv. 8-18 is due to the redactor who wished to apply the same rules to the year of Jubilee. But though the former of the two sections on the year of Jubilee (vv. 8-18, 23) exhibits undoubted signs of P, the traces of H are also sufficiently marked to warrant the conclusion that the latter code included laws relating to the year of Jubilee, and that these have been modified by R<sub>p</sub> and then connected with the regulations for the Sabbatical year. Signs of the redactor's handiwork may be seen in vv. 9, 11-13 (the year of Jubilee treated as a fallow year) and 15, 16 (cf. the repetition of "ye shall not wrong one another," vv. 14 and 17). Both on historical and on critical grounds, however, it is improbable that the principle of restitution underlying the regulations for the year of Jubilee was originally extended to *persons* in the earlier code. For it is difficult to harmonize the laws as to the release of Hebrew slaves with the other legislation on the same subject (Exod. xxi. 2-6; Deut. xv.), while both the secondary position which they occupy in this chapter and their more elaborate and formal character point to a later origin for vv. 35-55. Hence these verses in the main must be assigned to R<sub>p</sub>. In this connexion it is noticeable that vv. 35-38, 39-40a, 43, 47, 53, 55, which show the characteristic marks of H, bear no special relation to the year of Jubilee, but merely inculcate a more humane treatment of those Israelites who are compelled by circumstances to sell themselves either to their brethren or to strangers. It is probable, therefore, that they form no part of the original legislation of the year of Jubilee, but were incorporated at a later period. The present form of vv. 24-34 is largely due to R<sub>p</sub>, who has certainly added vv. 32-34 (cities of the Levites) and probably vv. 29-31.

Chap. xxvi. The concluding exhortation. After reiterating commands to abstain from idolatry and to observe the Sabbath, vv. 1, 2, the chapter sets forth (a) the rewards of obedience, vv. 3-13, and (b) the penalties incurred by disobedience to the preceding laws, vv. 14-46. The discourse, which is spoken throughout in the name of Yahweh, is similar in character to Exod. xxiii. 20-33 and Deut. xxviii., more especially to the latter. That it forms an integral part of H is shown both by the recurrence of the same distinctive phraseology and by the emphasis laid on the same motives. At the same time it is hardly doubtful that the original discourse has been modified and expanded by later hands, especially in the concluding paragraphs. Thus vv. 34, 35, which refer back to xxv. 2 ff., interrupt the connexion and must be assigned to the priestly redactor, while vv. 40-45 display obvious signs of interpolation. With regard to the literary relation of this chapter with Ezekiel, it must be admitted that Ezekiel presents many striking parallels, and in particular makes use, in common with chap. xxvi., of several expressions which do not occur elsewhere in the Old Testament. But there are also points of difference both as regards phraseology and subject-matter, and in view of these latter it is impossible to hold that Ezekiel was either the author or compiler of this chapter.

Chap. xxvii. On the commutation of vows and tithes. The chapter as a whole must be assigned to a later stratum of P, for while vv. 2-25 (on vows) presuppose the year of Jubilee, the section on tithes, vv. 30-33, marks a later stage of development than Num. xviii. 21 ff. (P); vv. 26-29 (on firstlings and devoted things) are supplementary restrictions to vv. 2-25.

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(J. F. ST.)



**LEVY, AMY** (1861-1889), English poetess and novelist, second daughter of Lewis Levy, was born at Clapham on the 10th of November 1861, and was educated at Newnham College, Cambridge. She showed a precocious aptitude for writing verse of exceptional merit, and in 1884 she published a volume of poems, *A Minor Poet and Other Verse*, some of the pieces in which had already been printed at Cambridge with the title *Xantippe and Other Poems*. The high level of this first publication was maintained in *A London Plane Tree and Other Poems*, a collection of lyrics published in 1889, in which the prevailing pessimism of the writer's temperament was conspicuous. She had already in 1888 tried her hand at prose fiction in *The Romance of a Shop*, which was followed by *Reuben Sachs*, a powerful novel. She committed suicide on the 10th of September 1889.



**LEVY, AUGUSTE MICHEL** (1844- ), French geologist, was born in Paris on the 7th of August 1844. He became inspector-general of mines, and director of the Geological Survey of France. He was distinguished for his researches on eruptive rocks, their microscopic structure and origin; and he early employed the polarizing microscope for the determination of minerals. In his many contributions to scientific journals he described the granulite group, and dealt with pegmatites, variolites, eurites, the ophites of the Pyrenees, the extinct volcanoes of Central France, gneisses, and the origin of crystalline schists. He wrote *Structures et classification des roches éruptives* (1889), but his more elaborate studies were carried on with F. Fouqué. Together they wrote on the artificial production of felspar, nepheline and other minerals, and also of

meteorites, and produced *Minéralogie micrographique* (1879) and *Synthèse des minéraux et des roches* (1882). Levy also collaborated with A. Lacroix in *Les Minéraux des roches* (1888) and *Tableau des minéraux des roches* (1889).



**LEVY** (Fr. *levée*, from *lever*; Lat. *levare*, to lift, raise), the raising of money by the collection of an assessment, &c., a tax or compulsory contribution; also the collection of a body of men for military or other purposes. When all the able-bodied men of a nation are enrolled for service, the French term *levée en masse*, levy in mass, is frequently used.



**LEWALD, FANNY** (1811-1889), German author, was born at Königsberg in East Prussia on the 24th of March 1811, of Jewish parentage. When seventeen years of age she embraced Christianity, and after travelling in Germany, France and Italy, settled in 1845 at Berlin. Here, in 1854, she married the author, Adolf Wilhelm Theodor Stahr (1805-1876), and removed after his death in 1876 to Dresden, where she resided, engaged in literary work, until her death on the 5th of August 1889. Fanny Lewald is less remarkable for her writings, which are mostly sober, matter-of-fact works, though displaying considerable talent and culture, than for her championship of "women's rights," a question which she was practically the first German woman to take up, and for her scathing satire on the sentimentalism of the Gräfin Hahn Hahn. This authoress she ruthlessly attacked in the exquisite parody (*Diogena, Roman von Iduna Gräfin H.... H....* (2nd ed., 1847). Among the best known of her novels are *Klementine* (1842); *Prinz Louis Ferdinand* (1849; 2nd ed., 1859); *Das Mädchen von Hela* (1860); *Von Geschlecht zu Geschlecht* (8 vols., 1863-1865); *Benvenuto* (1875), and *Stella* (1883; English by B. Marshall, 1884). Of her writings in defence of the emancipation of women *Osterbriefe für die Frauen* (1863) and *Für und wider die Frauen* (1870) are conspicuous. Her autobiography, *Meine Lebensgeschichte* (6 vols., 1861-1862), is brightly written and affords interesting glimpses of the literary life of her time.

A selection of her works was published under the title *Gesammelte Schriften* in 12 vols. (1870-1874). Cf. K. Frenzel, *Erinnerungen und Strömungen* (1890).



**LEWANIKA** (c. 1860- ), paramount chief of the Barotse and subject tribes occupying the greater part of the upper Zambezi basin, was the twenty-second of a long line of rulers, whose founder invaded the Barotse valley about the beginning of the 17th century, and according to tradition was the son of a woman named Buya Mamboa by a god. The graves of successive ruling chiefs are to this day respected and objects of pilgrimage for purposes of ancestor worship. Lewanika was born on the upper Kabompo in troublous times, where his father—Letia, a son of a former ruler—lived in exile during the interregnum of a foreign dynasty (Makololo), which remained in possession from about 1830 to 1865, when the Makololo were practically exterminated in a night by a well-organized revolt. Once more masters of their own country, the Barotse invited Sepopa, an uncle of Lewanika, to rule over them. Eleven years of brutality and licence resulted in the tyrant's expulsion and subsequent assassination, his place being taken by Ngwana-Wina, a nephew. Within a year abuse of power brought about this chief's downfall (1877), and he was succeeded by Lobosi, who assumed the name of Lewanika in 1885. The early years of his reign were also stained by many acts of blood, until in 1884 the torture and murder of his own brother led to open rebellion, and it was only through extreme presence of mind that the chief escaped with his life into exile. His cousin, Akufuna or Tatela, was then proclaimed chief. It was during his brief reign that François Coillard, the eminent missionary, arrived at Lialui, the capital. The following year Lewanika, having collected his partisans, deposed the usurper and re-established his power. Ruthless revenge not unmixed with treachery characterized his return to power, but gradually the strong personality of the high-minded François Coillard so far influenced him for good that from about 1887 onward he ruled tolerantly and showed a consistent desire to better the condition of his people. In 1890 Lewanika, who two years previously had proposed to place himself under the protection of Great Britain, concluded a treaty with the British South Africa Company, acknowledging its supremacy and conceding to it certain mineral rights. In 1897 Mr R. T. Coryndon took up his position at Lialui as British agent, and the country to the east of 25° E. was thrown open to settlers, that to the west being reserved to the Barotse chief. In 1905 the king of Italy's award in the Barotse boundary dispute with Portugal deprived Lewanika of half of his dominions, much of which had been ruled by his ancestors for many generations. In 1902 Lewanika attended the coronation of Edward VII. as a guest of the nation. His recognized heir was his eldest son Letia.

See **BAROTSE**, and the works there cited, especially *On the Threshold of Central Africa* (London, 1897), by François Coillard.

(A. ST. H. G.)



**LEWES, CHARLES LEE** (1740-1803), English actor, was the son of a hosier in London. After attending a school at Ambleside he returned to London, where he found employment as a postman; but about 1760 he went on the stage in the provinces, and some three years later began to appear in minor parts at Covent Garden Theatre. His first rôle of importance was that of "Young Marlow" in *She Stoops to Conquer*, at its production of that comedy in 1773, when he delivered an epilogue specially written for him by Goldsmith. He remained a member of the Covent Garden company till 1783, appearing in many parts, among which were "Fag" in *The Rivals*, which he "created," and "Sir Anthony Absolute" in the same comedy. In 1783 he removed to Drury Lane, where he assumed the Shakespearian rôles of "Touchstone," "Lucio" and "Falstaff." In 1787 he left London for Edinburgh, where he gave recitations, including Cowper's "John Gilpin." For a short time in 1792 Lewes assisted Stephen Kemble in the management of the Dundee Theatre; in the following year he went to Dublin, but he was financially unsuccessful and suffered imprisonment for debt. He employed his time in compiling his *Memoirs*, a worthless production published after his death by his son. He was also the author of some poor dramatic sketches. Lewes died on the 23rd of July 1803. He was three times married; the philosopher, George Henry Lewes, was his grandson.

See John Genest, *Some Account of the English Stage* (Bath, 1832).



**LEWES, GEORGE HENRY** (1817-1878), British philosopher and literary critic, was born in London in 1817. He was a grandson of Charles Lee Lewes, the actor. He was educated in London, Jersey, Brittany, and finally at Dr Burney's school in Greenwich. Having abandoned successively a commercial and a medical career, he seriously thought of becoming an actor, and between 1841 and 1850 appeared several times on the stage. Finally he devoted himself to literature, science and philosophy. As early as 1836 he belonged to a club formed for the study of philosophy, and had sketched out a physiological treatment of the philosophy of the Scottish school. Two years later he went to Germany, probably with the intention of studying philosophy. In 1840 he married a daughter of Swynfen Stevens Jervis (1798-1867), and during the next ten years supported himself by contributing to the quarterly and other reviews. These articles discuss a wide variety of subject, and, though often characterized by hasty impulse and imperfect study, betray a singularly acute critical judgment, enlightened by philosophic study. The most valuable are those on the drama, afterwards republished under the title *Actors and Acting* (1875). With this may be taken the volume on *The Spanish Drama* (1846). The combination of wide scholarship, philosophic culture and practical acquaintance with the theatre gives these essays a high place among the best efforts in English dramatic criticism. In 1845-1846 he published *The Biographical History of Philosophy*, an attempt to depict the life of philosophers as an ever-renewed fruitless labour to attain the unattainable. In 1847-1848 he made two attempts in the field of fiction—*Ranthrope*, and *Rose, Blanche and Violet*—which, though displaying considerable skill both in plot, construction and in characterization, have taken no permanent place in literature. The same is to be said of an ingenious attempt to rehabilitate Robespierre (1849). In 1850 he collaborated with Thornton Leigh Hunt in the foundation of the *Leader*, of which he was the literary editor. In 1853 he republished under the title of *Comte's Philosophy of the Sciences* a series of papers which had appeared in that journal. In 1851 he became acquainted with Miss Evans (George Eliot) and in 1854 left his wife. Subsequently he lived with Miss Evans as her husband (see [ELIOT, GEORGE](#)).

The culmination of Lewes's work in prose literature is the *Life of Goethe* (1855), probably the best known of his writings. Lewes's many-sidedness of mind, and his combination of scientific with literary tastes, eminently fitted him to appreciate the large nature and the wide-ranging activity of the German poet. The high position this work has taken in Germany itself, notwithstanding the boldness of its criticism and the unpopularity of some of its views (*e.g.* on the relation of the second to the first part of *Faust*), is a sufficient testimony to its general excellence. From about 1853 Lewes's writings show that he was occupying himself with scientific and more particularly biological work. He may be said to have always manifested a distinctly scientific bent in his writings, and his closer devotion to science was but the following out of early impulses. Considering that he had not had the usual course of technical training, these studies are a remarkable testimony to the penetration of his intellect. The most important of these essays are collected in the volumes *Seaside Studies* (1858), *Physiology of Common Life* (1859), *Studies in Animal Life* (1862), and *Aristotle, a Chapter from the History of Science* (1864). They are much more than popular expositions of accepted scientific truths. They contain able criticisms of authorized ideas, and embody the results of individual research and individual reflection. He made a number of impressive suggestions, some of which have since been accepted by physiologists. Of these the most valuable is that now known as the doctrine of the functional indifference of the nerves—that what are known as the specific energies of the optic, auditory and other nerves are simply differences in their mode of action due to the differences of the peripheral structures or sense-organs with which they are connected. This idea was subsequently arrived at independently by Wundt (*Physiologische Psychologie*, 2nd ed., p. 321). In 1865, on the starting of the *Fortnightly Review*, Lewes became its editor, but he retained the post for less than two years, when he was succeeded by John Morley. This date marks the transition from more strictly scientific to philosophic work. He had from early youth cherished a strong liking for philosophic studies; one of his earliest essays was an appreciative account of Hegel's *Aesthetics*. Coming under the influence of positivism as unfolded both in Comte's own works and in J. S. Mill's *System of Logic*, he abandoned all faith in the possibility of metaphysics, and recorded this abandonment in the above-mentioned *History of Philosophy*. Yet he did not at any

time give an unqualified adhesion to Comte's teachings, and with wider reading and reflection his mind moved away further from the positivist standpoint. In the preface to the third edition of his *History of Philosophy* he avowed a change in this direction, and this movement is still more plainly discernible in subsequent editions of the work. The final outcome of this intellectual progress is given to us in *The Problems of Life and Mind*, which may be regarded as the crowning work of his life. His sudden death on the 28th of November 1878 cut short the work, yet it is complete enough to allow us to judge of the author's matured conceptions on biological, psychological and metaphysical problems. Of his three sons only one, Charles (1843-1891), survived him; in the first London County Council Election (1888) he was elected for St Pancras; he was also much interested in the Hampstead Heath extension.

*Philosophy.*—The first two volumes on *The Foundations of a Creed* lay down what Lewes regarded as the true principles of philosophizing. He here seeks to effect a *rapprochement* between metaphysic and science. He is still so far a positivist as to pronounce all inquiry into the ultimate nature of things fruitless. What matter, form, spirit are in themselves is a futile question that belongs to the sterile region of "metemprirics." But philosophical questions may be so stated as to be susceptible of a precise solution by scientific method. Thus, since the relation of subject to object falls within our experience, it is a proper matter for philosophic investigation. It may be questioned whether Lewes is right in thus identifying the methods of science and philosophy. Philosophy is not a mere extension of scientific knowledge; it is an investigation of the nature and validity of the knowing process itself. In any case Lewes cannot be said to have done much to aid in the settlement of properly philosophical questions. His whole treatment of the question of the relation of subject to object is vitiated by a confusion between the scientific truth that mind and body coexist in the living organism and the philosophic truth that all knowledge of objects implies a knowing subject. In other words, to use Shadworth Hodgson's phrase, he mixes up the question of the *genesis* of mental forms with the question of their *nature* (see *Philosophy of Reflexion*, ii. 40-58). Thus he reaches the "monistic" doctrine that mind and matter are two aspects of the same existence by attending simply to the parallelism between psychical and physical processes given as a fact (or a probable fact) of our experience, and by leaving out of account their relation as subject and object in the cognitive act. His identification of the two as phases of one existence is open to criticism, not only from the point of view of philosophy, but from that of science. In his treatment of such ideas as "sensibility," "sentience" and the like, he does not always show whether he is speaking of physical or of psychical phenomena. Among the other properly philosophic questions discussed in these two volumes the nature of the casual relation is perhaps the one which is handled with most freshness and suggestiveness. The third volume, *The Physical Basis of Mind*, further develops the writer's views on organic activities as a whole. He insists strongly on the radical distinction between organic and inorganic processes, and on the impossibility of ever explaining the former by purely mechanical principles. With respect to the nervous system, he holds that all its parts have one and the same elementary property, namely, sensibility. Thus sensibility belongs as much to the lower centres of the spinal cord as to the brain, contributing in this more elementary form elements to the "subconscious" region of mental life. The higher functions of the nervous system, which make up our conscious mental life, are merely more complex modifications of this fundamental property of nerve substance. Closely related to this doctrine is the view that the nervous organism acts as a whole, that particular mental operations cannot be referred to definitely circumscribed regions of the brain, and that the hypothesis of nervous activity passing in the centre by an isolated pathway from one nerve-cell to another is altogether illusory. By insisting on the complete coincidence between the regions of nerve-action and sentience, and by holding that these are but different aspects of one thing, he is able to attack the doctrine of animal and human automatism, which affirms that feeling or consciousness is merely an incidental concomitant of nerve-action and in no way essential to the chain of physical events. Lewes's views in psychology, partly opened up in the earlier volumes of the *Problems*, are more fully worked out in the last two volumes (3rd series). He discusses the method of psychology with much insight. He claims against Comte and his followers a place for introspection in psychological research. In addition to this subjective method there must be an objective, which consists partly in a reference to nervous conditions and partly in the employment of sociological and historical data. Biological knowledge, or a consideration of the organic conditions, would only help us to explain mental *functions*, as feeling and thinking; it would not assist us to understand differences of mental *faculty* as manifested in different races and stages of human development. The organic conditions of these differences will probably for ever escape detection. Hence they can be explained only as the products of the social environment. This idea of dealing with mental phenomena in their relation to social and historical conditions is probably Lewes's most important contribution to psychology. Among other points which he emphasizes is the complexity of mental phenomena. Every mental state is regarded as compounded of three factors in different proportions—namely, a process of sensible affection, of logical grouping and of motor impulse. But Lewes's work in psychology consists less in any definite discoveries than in the inculcation of a sound and just method. His biological training prepared him to view mind as a complex unity, in which the various functions interact one on the other, and of which the highest processes are identical with and evolved out of the lower. Thus the operations of thought, "or the logic of signs," are merely a more complicated form of the elementary operations of sensation and instinct or "the logic of feeling." The whole of the last volume of the *Problems* may be said to be an illustration of this position. It is a valuable repository of psychological facts, many of them drawn from the more obscure regions of mental life and from abnormal experience, and is throughout suggestive and stimulating. To suggest and to stimulate the mind, rather than to supply it with any complete system of knowledge, may be said to be Lewes's service in philosophy. The exceptional rapidity and versatility of his intelligence seems to account at once for the freshness in his way of envisaging the subject-matter of philosophy and psychology, and for the want of satisfactory elaboration and of systematic co-ordination.

(J. S.; X.)



**LEWES**, a market-town and municipal borough and the county town of Sussex, England, in the Lewes parliamentary division, 50 m. S. from London by the London, Brighton & South Coast railway. Pop. (1901) 11,249. It is picturesquely situated on the slope of a chalk down falling to the river Ouse. Ruins of the old castle, supposed to have been founded by King Alfred and rebuilt by William de Warenne shortly after the Conquest, rise from the height. There are two mounds which bore keeps, an uncommon feature. The castle guarded the

pass through the downs formed by the valley of the Ouse. In one of the towers is the collection of the Sussex Archaeological Society. St Michael's church is without architectural merit, but contains old brasses and monuments; St Anne's church is a transitional Norman structure; St Thomas-at-Cliffe is Perpendicular; St John's, Southover, of mixed architecture, preserves some early Norman portions, and has some relics of the Warenne family. In the grounds of the Cluniac priory of St Pancras, founded in 1078, the leaden coffins of William de Warenne and Gundrada his wife were dug up during an excavation for the railway in 1845. There is a free grammar school dating from 1512, and among the other public buildings are the town hall and corn exchange, county hall, prison, and the Fitzroy memorial library. The industries include the manufacture of agricultural implements, brewing, tanning, and iron and brass founding. The municipal borough is under a mayor, 6 aldermen and 18 councillors. Area, 1042 acres.

The many neolithic and bronze implements that have been discovered, and the numerous tumuli and earthworks which surround Lewes, indicate its remote origin. The town Lewes (Loewas, Loewen, Leswa, Laquis, Latisaquesensis) was in the royal demesne of the Saxon kings, from whom it received the privilege of a market. Æthelstan established two royal mints there, and by the reign of Edward the Confessor, and probably before, Lewes was certainly a borough. William I. granted the whole barony of Lewes, including the revenue arising from the town, to William de Warenne, who converted an already existing fortification into a place of residence. His descendants continued to hold the barony until the beginning of the 14th century. In default of male issue, it then passed to the earl of Arundel, with whose descendants it remained until 1439, when it was divided between the Norfolks, Dorsets and Abergavennys. By 1086 the borough had increased 30% in value since the beginning of the reign, and its importance as a port and market-town is evident from Domesday. A gild merchant seems to have existed at an early date. The first mention of it is in a charter of Reginald de Warenne, about 1148, by which he restored to the burgesses the privileges they had enjoyed in the time of his grandfather and father, but of which they had been deprived. In 1595 a "Fellowship" took the place of the old gild and in conjunction with two constables governed the town until the beginning of the 18th century. The borough seal probably dates from the 14th century. Lewes was incorporated by royal charter in 1881. The town returned two representatives to parliament from 1295 until deprived of one member in 1867. It was disfranchised in 1885. Earl Warenne and his descendants held the fairs and markets from 1066. In 1792 the fair-days were the 6th of May, Whit-Tuesday, the 26th of July (for wool), and the 2nd of October. The market-day was Saturday. Fairs are now held on the 6th of May for horses and cattle, the 20th of July for wool, and the 21st and 28th of September for Southdown sheep. A corn-market is held every Tuesday, and a stock-market every alternate Monday. The trade in wool has been important since the 14th century.

Lewes was the scene of the battle fought on the 14th of May 1264 between Henry III. and Simon de Montfort, earl of Leicester. Led by the king and by his son, the future king Edward I., the royalists left Oxford, took Northampton and drove Montfort from Rochester into London. Then, harassed on the route by their foes, they marched through Kent into Sussex and took up their quarters at Lewes, a stronghold of the royalist Earl Warenne. Meanwhile, reinforced by a number of Londoners, Earl Simon left London and reached Fletching, about 9 m. north of Lewes, on the 13th of May. Efforts at reconciliation having failed he led his army against the town, which he hoped to surprise, early on the following day. His plan was to direct his main attack against the priory of St Pancras, which sheltered the king and his brother Richard, earl of Cornwall, king of the Romans, while causing the enemy to believe that his principal objective was the castle, where Prince Edward was. But the surprise was not complete and the royalists rushed from the town to meet the enemy in the open field. Edward led his followers against the Londoners, who were gathered around the standard of Montfort, put them to flight, pursued them for several miles, and killed a great number of them. Montfort's ruse, however, had been successful. He was not with his standard as his foes thought, but with the pick of his men he attacked Henry's followers and took prisoner both the king and his brother. Before Edward returned from his chase the earl was in possession of the town. In its streets the prince strove to retrieve his fortunes, but in vain. Many of his men perished in the river, but others escaped, one band, consisting of Earl Warenne and others, taking refuge in Pevensey Castle. Edward himself took sanctuary and on the following day peace was made between the king and the earl.



**LEWES**, a town in Sussex county, Delaware, U.S.A., in the S.E. part of the state, on Delaware Bay. Pop. (1910), 2158. Lewes is served by the Philadelphia, Baltimore & Washington (Pennsylvania System), and the Maryland, Delaware & Virginia railways. Its harbour is formed by the Delaware Breakwater, built by the national government and completed in 1869, and 2¼ m. above it another breakwater was completed in December 1901 by the government. The cove between them forms a harbour of refuge of about 550 acres. At the mouth of Delaware Bay, about 2 m. below Lewes, is the Henlopen Light, one of the oldest lighthouses in America. The Delaware Bay pilots make their headquarters at Lewes. Lewes has a large trade with northern cities in fruits and vegetables, and is a subport of entry of the Wilmington Customs District. The first settlement on Delaware soil by Europeans was made near here in 1631 by Dutch colonists, sent by a company organized in Holland in the previous year by Samuel Blommaert, Killian van Rensselaer, David Pieterszen de Vries and others. The settlers called the place Zwaanendael, valley of swans. The settlement was soon entirely destroyed by the Indians, and a second body of settlers whom de Vries, who had been made director of the colony, brought in 1632 remained for only two years. The fact of the settlement is important; because of it the English did not unite the Delaware country with Maryland, for the Maryland Charter of 1632 restricted colonization to land within the prescribed boundaries, uncultivated and either uninhabited or inhabited only by Indians. In 1658 the Dutch established an Indian trading post, and in 1659 erected a fort at Zwaanendael. After the annexation of the Delaware counties to Pennsylvania in 1682, its name was changed to Lewes, after the town of that name in Sussex, England. It was pillaged by French pirates in 1698. One of the last naval battles of the War of Independence was fought in the bay near Lewes on the 8th of April 1782, when the American privateer "Hyder Ally" (16), commanded by Captain Joshua Barnes (1759-1818), defeated and captured the British sloop "General Monk" (20), which had been an

American privateer, the "General Washington," had been captured by Admiral Arbuthnot's squadron in 1780, and was now purchased by the United States government and, as the "General Washington," was commanded by Captain Barnes in 1782-1784. In March 1813 the town was bombarded by a British frigate.

See the "History of Lewes" in the *Papers* of the Historical Society of Delaware, No. xxxviii. (Wilmington, 1903); and J. T. Scharf, *History of Delaware* (2 vols., Philadelphia, 1888).



**LEWIS, SIR GEORGE CORNEWALL**, BART. (1806-1863), English statesman and man of letters, was born in London on the 21st of April 1806. His father, Thomas F. Lewis, of Harpton Court, Radnorshire, after holding subordinate office in various administrations, became a poor-law commissioner, and was made a baronet in 1846. Young Lewis was educated at Eton and at Christ Church, Oxford, where in 1828 he took a first-class in classics and a second-class in mathematics. He then entered the Middle Temple, and was called to the bar in 1831. In 1833 he undertook his first public work as one of the commissioners to inquire into the condition of the poor Irish residents in the United Kingdom.<sup>1</sup> In 1834 Lord Althorp included him in the commission to inquire into the state of church property and church affairs generally in Ireland. To this fact we owe his work on *Local Disturbances in Ireland, and the Irish Church Question* (London, 1836), in which he condemned the existing connexion between church and state, proposed a state provision for the Catholic clergy, and maintained the necessity of an efficient workhouse organization. During this period Lewis's mind was much occupied with the study of language. Before leaving college he had published some observations on Whately's doctrine of the predicables, and soon afterwards he assisted Thirlwall and Hare in starting the *Philological Museum*. Its successor, the *Classical Museum*, he also supported by occasional contributions. In 1835 he published an *Essay on the Origin and Formation of the Romance Languages* (re-edited in 1862), the first effective criticism in England of Raynouard's theory of a uniform romance tongue, represented by the poetry of the troubadours. He also compiled a glossary of provincial words used in Herefordshire and the adjoining counties. But the most important work of this earlier period was one to which his logical and philological tastes contributed. *The Remarks on the Use and Abuse of some Political Terms* (London, 1832) may have been suggested by Bentham's *Book of Parliamentary Fallacies*, but it shows all that power of clear sober original thinking which marks his larger and later political works. Moreover, he translated Boeckh's *Public Economy of Athens* and Müller's *History of Greek Literature*, and he assisted Tufnell in the translation of Müller's *Dorians*. Some time afterwards he edited a text of the *Fables of Babrius*. While his friend Hayward conducted the *Law Magazine*, he wrote in it frequently on such subjects as secondary punishments and the penitentiary system. In 1836, at the request of Lord Glenelg, he accompanied John Austin to Malta, where they spent nearly two years reporting on the condition of the island and framing a new code of laws. One leading object of both commissioners was to associate the Maltese in the responsible government of the island. On his return to England Lewis succeeded his father as one of the principal poor-law commissioners. In 1841 appeared the *Essay on the Government of Dependencies*, a systematic statement and discussion of the various relations in which colonies may stand towards the mother country. In 1844 Lewis married Lady Maria Theresa Lister, sister of Lord Clarendon, and a lady of literary tastes. Much of their married life was spent in Kent House, Knightsbridge. They had no children. In 1847 Lewis resigned his office. He was then returned for the county of Hereford, and Lord John Russell appointed him secretary to the Board of Control, but a few months afterwards he became under-secretary to the Home Office. In this capacity he introduced two important bills, one for the abolition of turnpike trusts and the management of highways by a mixed county board, the other for the purpose of defining and regulating the law of parochial assessment. In 1850 he succeeded Hayter as financial secretary to the treasury. About this time, also, appeared his *Essay on the Influence of Authority in Matters of Opinion*. On the dissolution of parliament which followed the resignation of Lord John Russell's ministry in 1852, Lewis was defeated for Herefordshire and then for Peterborough. Excluded from parliament he accepted the editorship of the *Edinburgh Review*, and remained editor until 1855. During this period he served on the Oxford commission, and on the commission to inquire into the government of London. But its chief fruits were the *Treatise on the Methods of Observation and Reasoning in Politics*, and the *Enquiry into the Credibility of the Early Roman History*,<sup>2</sup> in which he vigorously attacked the theory of epic lays and other theories on which Niebuhr's reconstruction of that history had proceeded. In 1855 Lewis succeeded his father in the baronetcy. He was at once elected member for the Radnor boroughs, and Lord Palmerston made him chancellor of the exchequer. He had a war loan to contract and heavy additional taxation to impose, but his industry, method and clear vision carried him safely through. After the change of ministry in 1859 Sir George became home secretary under Lord Palmerston, and in 1861, much against his wish, he succeeded Sidney Herbert (Lord Herbert of Lea) at the War Office. The closing years of his life were marked by increasing intellectual vigour. In 1859 he published an able *Essay on Foreign Jurisdiction and the Extradition of Criminals*, a subject to which the attempt on Napoleon's life, the discussions on the Conspiracy Bill, and the trial of Bernard, had drawn general attention. He advocated the extension of extradition treaties, and condemned the principal idea of *Weltrechtsordnung* which Mohl of Heidelberg had proposed. His two latest works were the *Survey of the Astronomy of the Ancients*, in which, without professing any knowledge of Oriental languages, he applied a sceptical analysis to the ambitious Egyptology of Bunsen; and the *Dialogue on the Best Form of Government*, in which, under the name of Crito, the author points out to the supporters of the various systems that there is no one abstract government which is the best possible for all times and places. An essay on the *Characteristics of Federal, National, Provincial and Municipal Government* does not seem to have been published. Sir George died in April 1863. A marble bust by Weekes stands in Westminster Abbey.

Lewis was a man of mild and affectionate disposition, much beloved by a large circle of friends, among whom were Sir E. Head, the Grotes, the Austins, Lord Stanhope, J. S. Mill, Dean Milman, the Duff Gordons. In public life he was distinguished, as Lord Aberdeen said, "for candour, moderation, love of truth." He had a passion for the systematic acquirement of knowledge, and a keen and sound critical faculty. His name has gone down to history as that of a many-sided man, sound in judgment, unselfish in political life, and abounding in practical good sense.



A reprint from the *Edinburgh Review* of his long series of papers on the *Administration of Great Britain* appeared in 1864, and his *Letters to various Friends* (1870) were edited by his brother Gilbert, who succeeded him in the baronetcy.

- 1 See the *Abstract of Final Report of Commissioners of Irish Poor Enquiry, &c.*, by G. C. Lewis and N. Senior (1837).
- 2 Translated into German by Liebrecht (Hanover, 1858).



**LEWIS, HENRY CARVILL** (1853-1888), American geologist, was born in Philadelphia on the 16th of November 1853. Educated in the university of Pennsylvania he took the degree of M.A. in 1876. He became attached to the Geological Survey of Pennsylvania in 1879, serving for three years as a volunteer member, and during this term he became greatly interested in the study of glacial phenomena. In 1880 he was chosen professor of mineralogy in the Philadelphia academy of natural sciences, and in 1883 he was appointed to the chair of geology in Haverford College, Pennsylvania. During the winters of 1885 to 1887 he studied petrology under H. F. Rosenbusch at Heidelberg, and during the summers he investigated the glacial geology of northern Europe and the British Islands. His observations in North America, where he had studied under Professor G. F. Wright, Professor T. C. Chamberlin and Warren Upham, had demonstrated the former extension of land-ice, and the existence of great terminal moraines. In 1884 his *Report on the Terminal Moraine in Pennsylvania and New York* was published: a work containing much information on the limits of the North American ice-sheet. In Britain he sought to trace in like manner the southern extent of the terminal moraines formed by British ice-sheets, but before his conclusions were matured he died at Manchester on the 21st of July 1888. The results of his observations were published in 1894 entitled *Papers and Notes on the Glacial Geology of Great Britain and Ireland*, edited by Dr H. W. Crosskey.

See "Prof. Henry Carvill Lewis and his Work in Glacial Geology," by Warren Upham, *Amer. Geol.* vol. ii. (Dec. 1888) p. 371, with portrait.



**LEWIS, JOHN FREDERICK** (1805-1876), British painter, son of F. C. Lewis, engraver, was born in London. He was elected in 1827 associate of the Society of Painters in Water Colours, of which he became full member in 1829 and president in 1855; he resigned in 1858, and was made associate of the Royal Academy in 1859 and academician in 1865. Much of his earlier life was spent in Spain, Italy and the East, but he returned to England in 1851 and for the remainder of his career devoted himself almost exclusively to Eastern subjects, which he treated with extraordinary care and minuteness of finish, and with much beauty of technical method. He is represented by a picture, "Edfou: Upper Egypt," in the National Gallery of British Art. He achieved equal eminence in both oil and water-colour painting.



**LEWIS, MATTHEW GREGORY** (1775-1818), English romance-writer and dramatist, often referred to as "Monk" Lewis, was born in London on the 9th of July 1775. He was educated for a diplomatic career at Westminster school and at Christ Church, Oxford, spending most of his vacations abroad in the study of modern languages; and in 1794 he proceeded to the Hague as attaché to the British embassy. His stay there lasted only a few months, but was marked by the composition, in ten weeks, of his romance *Ambrosio, or the Monk*, which was published in the summer of the following year. It immediately achieved celebrity; but some passages it contained were of such a nature that about a year after its appearance an injunction to restrain its sale was moved for and a rule *nisi* obtained. Lewis published a second edition from which he had expunged, as he thought, all the objectionable passages, but the work still remains of such a character as almost to justify the severe language in which Byron in *English Bards and Scotch Reviewers* addresses—

"Wonder-working Lewis, Monk or Bard,  
Who fain would'st make Parnassus a churchyard;  
Even Satan's self with thee might dread to dwell,  
And in thy skull discern a deeper hell."

Whatever its demerits, ethical or aesthetic, may have been, *The Monk* did not interfere with the reception of Lewis into the best English society; he was favourably noticed at court, and almost as soon as he came of age he obtained a seat in the House of Commons as member for Hindon, Wilts. After some years, however, during which he never addressed the House, he finally withdrew from a parliamentary career. His tastes lay wholly in the direction of literature, and *The Castle Spectre* (1796, a musical drama of no great literary merit, but which enjoyed a long popularity on the stage), *The Minister* (a translation from Schiller's *Kabale u. Liebe*), *Rolla* (1797, a translation from Kotzebue), with numerous other operatic and tragic pieces, appeared in rapid succession. *The*

*Bravo of Venice*, a romance translated from the German, was published in 1804; next to *The Monk* it is the best known work of Lewis. By the death of his father he succeeded to a large fortune, and in 1815 embarked for the West Indies to visit his estates; in the course of this tour, which lasted four months, the *Journal of a West Indian Proprietor*, published posthumously in 1833, was written. A second visit to Jamaica was undertaken in 1817, in order that he might become further acquainted with, and able to ameliorate, the condition of the slave population; the fatigues to which he exposed himself in the tropical climate brought on a fever which terminated fatally on the homeward voyage on the 14th of May 1818.

*The Life and Correspondence of M. G. Lewis*, in two volumes, was published in 1839.



**LEWIS, MERIWETHER** (1774-1809), American explorer, was born near Charlottesville, Virginia, on the 18th of August 1774. In 1794 he volunteered with the Virginia troops called out to suppress the "Whisky Insurrection," was commissioned as ensign in the regular United States army in 1795, served with distinction under General Anthony Wayne in the campaigns against the Indians, and attained the rank of captain in 1797. From 1801 to 1803 he was the private secretary of President Jefferson. On the 18th of January 1803 Jefferson sent a confidential message to Congress urging the development of trade with the Indians of the Missouri Valley and recommending that an exploring party be sent into this region, notwithstanding the fact that it was then held by Spain and owned by France. Congress appropriated funds for the expedition, and the president instructed Lewis to proceed to the head-waters of the Missouri river and thence across the mountains to the Pacific Ocean. With Jefferson's consent Lewis chose as a companion Lieut. William Clark, an old friend and army comrade. The preparations were made under the orders of the War Department, and, until the news arrived that France had sold Louisiana to the United States, they were conducted in secrecy. Lewis spent some time in Philadelphia, gaining additional knowledge of the natural sciences and learning the use of instruments for determining positions; and late in 1803 he and Clark, with twenty-nine men from the army, went into winter quarters near St Louis, where the men were subjected to rigid training. On the 14th of May 1804 the party, with sixteen additional members, who, however, were to go only a part of the way, started up the Missouri river in three boats, and by the 2nd of November had made the difficult ascent of the stream as far as 47° 21' N. lat., near the site of the present Bismarck, North Dakota, where, among the Mandan Indians, they passed the second winter. Early in April 1805 the ascent of the Missouri was continued as far as the three forks of the river, which were named the Jefferson, the Gallatin and the Madison. The Jefferson was then followed to its source in the south-western part of what is now the state of Montana. Procuring a guide and horses from the Shoshone Indians, the party pushed westward through the Rocky Mountains in September, and on the 7th of October embarked in canoes on a tributary of the Columbia river, the mouth of which they reached on the 15th of November. They had travelled upwards of 4000 m. from their starting-point, had encountered various Indian tribes never before seen by whites, had made valuable scientific collections and observations, and were the first explorers to reach the Pacific by crossing the continent north of Mexico. After spending the winter on the Pacific coast they started on the 23rd of March 1806 on their return journey, and, after crossing the divide, Lewis with one party explored Maria's river, and Clark with another the Yellowstone. On the 12th of August the two explorers reunited near the junction of the Yellowstone and the Missouri, and on the 23rd of September reached St Louis. In spite of exposure, hardship and peril only one member of the party died, and only one deserted. No later feat of exploration, perhaps, in any quarter of the globe has exceeded this in romantic interest. The expedition was commemorated by the Lewis and Clark Centennial Exposition at Portland, Oregon, in 1905. The leaders and men of the exploring party were rewarded with liberal grants of land from the public domain, Lewis receiving 1500 acres; and in March 1807 Lewis was made governor of the northern part of the territory obtained from France in 1803, which had been organized as the Louisiana Territory. He performed the duties of this office with great efficiency, but it is said that in the unwonted quiet of his new duties, his mind, always subject to melancholy, became unbalanced, and that while on his way to Washington he committed suicide about 60 m. south-west of Nashville, Tennessee, on the 11th of October 1809. It is not definitely known, however, whether he actually committed suicide or was murdered.

BIBLIOGRAPHY.—Jefferson's *Message from the President of the United States, Communicating Discoveries made in Exploring the Missouri, Red River and Washita by Captains Lewis and Clark, Dr Sibley and Mr Dunbar* (Washington, 1806, and subsequent editions) is the earliest account, containing the reports sent back by the explorers in the winter of 1804-1805. Patrick Gass's *Journal of the Voyages and Travels of a Corps of Discovery under the Command of Capt. Lewis and Capt. Clark* (Pittsburg, 1807) is the account of a sergeant in the party. Biddle and Allen's *History of the Expedition under the Command of Captains Lewis and Clark* (2 vols., Philadelphia, 1814) is a condensation of the original journals. There are numerous reprints of this work, the best being that of Elliott Coues (4 vols., New York, 1893), which contains additions from the original manuscripts and a new chapter, in the style of Biddle, inserted as though a part of the original text. As a final authority consult R. G. Thwaites (ed.), *The Original Journals of the Lewis and Clark Expedition* (8 vols., New York, 1904-1905), containing all the known literary records of the expedition. For popular accounts see W. R. Lighton, *Lewis and Clark* (Boston, 1901); O. D. Wheeler, *The Trail of Lewis and Clark* (2 vols., New York, 1904); and Noah Brooks (ed.), *First across the Continent: Expedition of Lewis and Clark* (New York, 1901).



**LEWISBURG**, a borough and the county-seat of Union county, Pennsylvania, U.S.A., on the W. bank of West Branch of the Susquehanna river, about 50 m. N. of Harrisburg. Pop. (1900) 3457 (60 foreign-born); (1910)

3081. It is served by the Pennsylvania and the Philadelphia & Reading railways. It is the seat of Bucknell University (coeducational), opened in 1846 as the university of Lewisburg and renamed in 1886 in honour of William Bucknell (1809-1890), a liberal benefactor. The university comprises a College of Liberal Arts, an Academy for Young Men, an Institute for Young Women, and a School of Music, and in 1908-1909 had 50 instructors and 775 students, of whom 547 were in the College of Liberal Arts. The city is situated in a farming region, and has various manufactures, including flour, lumber, furniture, woollens, nails, foundry products and carriages. Lewisburg (until about 1805 called Derrstown) was founded and laid out in 1785 by Ludwig Derr, a German, and was chartered as a borough in 1812.



**LEWISHAM**, a south-eastern metropolitan borough of London, England, bounded N.W. by Deptford, N.E. by Greenwich, E. by Woolwich, and W. by Camberwell, and extending S. to the boundary of the county of London. Pop. (1901) 127,495. Its area is for the most part occupied by villas. It includes the districts of Blackheath and Lee in the north, Hither Green, Catford and Brockley in the central parts, and Forest Hill and part of Sydenham in the south-west. In the districts last named well-wooded hills rise above 300 ft., and this is an especially favoured residential quarter, its popularity being formerly increased by the presence of medicinal springs, discovered in 1640, on Sydenham Common. Towards the south, in spite of the constant extension of building, there are considerable tracts of ground uncovered, apart from public grounds. In the north the borough includes the greater part of Blackheath (*q.v.*), an open common of considerable historical interest. The other principal pleasure grounds are Hilly Fields (46 acres) and Ladywell Recreation Grounds (46 acres) in the north-west part of the borough; and at Sydenham (but outside the boundary of the county of London) is the Crystal Palace. Among institutions are the Horniman Museum, Forest Hill (1901); Morden's College, on the south of Blackheath, founded at the close of the 17th century by Sir John Morden for Turkey merchants who were received as pensioners, and subsequently extended in scope; numerous schools in the same locality; and the Park Fever Hospital, Hither Green. The parliamentary borough of Lewisham returns one member. The borough council consists of a mayor, 7 aldermen and 42 councillors. Area, 7014.4 acres.



**LEWISTON**, a city of Androscoggin county, Maine, U.S.A., on the Androscoggin river, opposite Auburn, with which it is connected by four steel bridges, and about 36 m. N.E. of Portland. Pop. (1900) 23,761, of whom 9316 were foreign-born; (1910 census) 26,247. It is served by the Maine Central, the Grand Trunk, the Portland & Rumford Falls and the Lewiston, Augusta & Waterville (electric) railways. The surrounding country is hilly and the river is picturesque; in the vicinity there are many lakes and ponds abounding in salmon and trout. The Maine fish hatchery is on Lake Auburn, 3 m. above the city. Lewiston is the seat of Bates College, a non-sectarian institution, which grew out of the Maine State Seminary (chartered in 1855), and was chartered in 1864 under its present name, adopted in honour of Benjamin E. Bates (d. 1877), a liberal benefactor. In 1908-1909 the college had 25 instructors and 440 students, and its library contained 34,000 volumes. The campus of the college is about 1 m. from the business portion of Lewiston and covers 50 acres; among the college buildings are an auditorium (1909) given by W. Scott Libbey of Lewiston, and the Libbey Forum for the use of the three literary societies and the two Christian associations of the college. The literary societies give excellent training in forensics. The matriculation pledge requires from male students total abstinence from intoxicants as a condition of membership. There are no secret fraternities. From the beginning women have been admitted on the same terms as men. The Cobb Divinity School (Free Baptist), which was founded at Parsonfield, Maine, in 1840 as a department of Parsonfield Seminary, and was situated in 1842-1844 at Dracut, Massachusetts, in 1844-1854 at Whitestown, New York, and in 1854-1870 at New Hampton, New Hampshire, was removed to Lewiston in 1870 and became a department (known as Bates Theological Seminary until 1888) of Bates College, with which it was merged in 1908. Lewiston has a fine city hall, a Carnegie library and a public park of 10½ acres, with a bronze soldiers' monument by Franklin Simmons, who was born in 1839 at Webster near Lewiston, and is known for his statues of Roger Williams, William King, Francis H. Pierpont and U. S. Grant in the national Capitol, and for "Grief" and "History" on the Peace Monument at Washington. In Lewiston are the Central Maine General Hospital (1888), the Sisters' Hospital (1888), under the charge of the French Catholic Sisters of Charity, a home for aged women, a young women's home and the Hesley Asylum for boys. The Shrine Building (Kora Temple), dedicated in 1909, is the headquarters of the Shriners of the state. The river at Lewiston breaks over a ledge of mica-schist and gneiss, the natural fall of 40 ft. having been increased to more than 50 ft. by a strong granite dam; and 3 m. above the city at Deer Rips a cement dam furnishes 10,000 horse-power. The water-power thus obtained is distributed by canals from the nearer dam and transmitted by wire from the upper dam. The manufacture of cotton goods is the principal industry, and in 1905 the product of the city's cotton mills was valued at about one-third of that of the mills of the whole state. Among other industries are the manufacture of woollen goods, shirts, dry-plates, carriages, spools and bobbins, and boots and shoes, and the dyeing and finishing of textiles. The total factory product in 1905 was valued at \$8,527,649. The municipality owns its water works and electric lighting plant. Lewiston was settled in 1770, incorporated as a township in 1795 and chartered as a city in 1861. It was the home of Nelson Dingley (1832-1899), who from 1856 until his death controlled the *Lewiston Journal*. He was governor of the state in 1874-1876, Republican representative in Congress in 1881-1899, and the drafter of the Dingley Tariff Bill (1897).



**LEWIS-WITH-HARRIS**, the most northerly island of the Outer Hebrides, Scotland. It is sometimes called the Long Island and is 24 m. from the nearest point of the mainland, from which it is separated by the strait called The Minch. It is 60 m. long and has an extreme breadth of 30 m., its average breadth being 15 m. It is divided into two portions by a line roughly drawn between Loch Resort on the west and Loch Seaforth on the east, of which the larger or more northerly portion, known as Lewis (pron. *Lews*), belongs to the county of Ross and Cromarty and the lesser, known as Harris, to Inverness-shire. The area of the whole island is 492,800 acres, or 770 sq. m., of which 368,000 acres belong to Lewis. In 1891 the population of Lewis was 27,045, of Harris 3681; in 1901 the population of Lewis was 28,357, of Harris 3803, or 32,160 for the island, of whom 17,175 were females, 11,209 spoke Gaelic only, and 17,685 both Gaelic and English. There is communication with certain ports of the Western Highlands by steamer via Stornoway every week—oftener during the tourist and special seasons—the steamers frequently calling at Loch Erisort, Loch Sealg, Ardvourlie, Tarbert, Ardvey, Rodel and The Obe. The coast is indented to a remarkable degree, the principal sea-lochs in Harris being East and West Loch Tarbert; and in Lewis, Loch Seaforth, Loch Erisort and Broad Bay (or Loch a Tuath) on the east coast and Loch Roag and Loch Resort on the west. The mainland is dotted with innumerable fresh-water lakes. The island is composed of gneiss rocks, excepting a patch of granite near Carloway, small bands of intrusive basalt at Gress and in Eye Peninsula and some Torridonian sandstone at Stornoway, Tong, Vatskir and Carloway. Most of Harris is mountainous, there being more than thirty peaks above 1000 ft. high. Lewis is comparatively flat, save in the south-east, where Ben More reaches 1874 ft., and in the south-west, where Mealasbhal (1885) is the highest point; but in this division there are only eleven peaks exceeding 1000 ft. in height. The rivers are small and unimportant. The principal capes are the Butt of Lewis, in the extreme north, where the cliffs are nearly 150 ft. high and crowned with a lighthouse, the light of which is visible for 19 m.; Tolsta Head, Tiumpan Head and Cabag Head, on the east; Renish Point, in the extreme south; and, on the west, Toe Head and Gallon Head. The following inhabited islands in the Inverness-shire division belong to the parish of Harris: off the S.W. coast, Bernera (pop. 524), Ensay, Killigray and Pabbay; off the W. coast, Scarp (160), Soay and Tarrensay (72); off the E. coast, Scalpa (587) and Scotasay. Belonging to the county of Ross and Cromarty are Great Bernera (580) to the W. of Lewis, in the parish of Uig, and the Shiant Isles, about 21 m. S. of Stornoway, in the parish of Lochs, so named from the number of its sea lochs and fresh-water lakes. The south-eastern base of Broad Bay is furnished by the peninsula of Eye, attached to the main mass by so slender a neck as seemingly to be on the point of becoming itself an island. Much of the surface of both Lewis and Harris is composed of peat and swamp; there are scanty fragments of an ancient forest. The rainfall for the year averages 41.7 in., autumn and winter being very wet. Owing to the influence of the Gulf Stream, however, the temperature is fairly high, averaging for the year 46.6° F., for January 39.5° F. and for August 56.5° F.

The economic conditions of the island correspond with its physical conditions. The amount of cultivable land is small and poor. Sir James Matheson (1796-1878), who purchased the island in 1844, is said to have spent nearly £350,000 in reclamation and improvements. Barley and potatoes are the chief crops. A large number of black cattle are reared and some sheep-farming is carried on in Harris. Kelp-making, once important, has been extinct for many years. Harris has obtained great reputation for tweeds. The cloth has an aroma of heather and peat, and is made in the dwellings of the cotters, who use dyes of long-established excellence. The fisheries are the principal mainstay of the people. In spite of the very considerable reductions in rent effected by the Crofters' Commission (appointed in 1886) and the sums expended by government, most of the crofters still live in poor huts amid dismal surroundings. The island affords good sporting facilities. Many of the streams abound with salmon and trout; otters and seals are plentiful, and deer and hares common; while bird life includes grouse, ptarmigan, woodcock, snipe, heron, widgeon, teal, eider duck, swan and varieties of geese and gulls. There are many antiquarian remains, including duns, megaliths, ruined towers and chapels and the like. At **RODEL**, in the extreme south of Harris, is a church, all that is left of an Augustinian monastery. The foundation is Norman and the superstructure Early English. On the towers are curious carved figures and in the interior several tombs of the Macleods, the most remarkable being that of Alastair (Alexander), son of William Macleod of Dunvegan, dated 1528. The monument, a full-length recumbent effigy of a knight in armour, lies at the base of a tablet in the shape of an arch divided into compartments, in which are carved in bas-relief, besides the armorial bearings of the deceased and a rendering of Dunvegan castle, several symbolical scenes, one of which exhibits Satan weighing in the balance the good and evil deeds of Alastair Macleod, the good obviously preponderating. Stornoway, the chief town (pop. 3852) is treated under a separate heading. At **CALLERNISH**, 13 m. due W. of Stornoway, are several stone circles, one of which is probably the most perfect example of so-called "Druidical" structures in the British Isles. In this specimen the stones are huge, moss-covered, undressed blocks of gneiss. Twelve of such monoliths constitute the circle, in the centre of which stands a pillar 17 ft. high. From the circle there runs northwards an avenue of stones, comprising on the right-hand side nine blocks and on the left-hand ten. There also branch off from the circle, on the east and west, a single line of four stones and, on the south, a single line of five stones. From the extreme point of the south file to the farther end of the avenue on the north is a distance of 127 yds. and the width from tip to tip of the east and west arms is 41 yds. Viewed from the north end of the avenue, the design is that of a cross. The most important fishery centre on the west coast is Carloway, where there is the best example of a broch, or fort, in the Hebrides. Rory, the blind harper who translated the Psalms into Gaelic, was born in the village. Tarbert, at the head of East Loch Tarbert, is a neat, clean village, in communication by mail-car with Stornoway. At Coll, a few miles N. by E. of Stornoway, is a mussel cave; and at Gress, 2 m. or so beyond in the same direction, there is a famous seals' cave, adorned with fine stalactites. Port of Ness, where there is a harbour, is the headquarters of the ling fishery. Loch Seaforth gave the title of earl to a branch of the Mackenzies, but in 1716 the 5th earl was attainted for Jacobitism and the title forfeited. In 1797 Francis Humberston Mackenzie (1754-1815), chief of the Clan Mackenzie, was created Lord Seaforth and Baron Mackenzie of Kintail, and made colonel of the 2nd battalion of the North British Militia, afterwards the 3rd battalion of the Seaforth Highlanders. The 2nd battalion of the Seaforth Highlanders was formerly the Ross-shire Buffs, which was raised in 1771.



**LEXICON**, a dictionary (*q.v.*). The word is the Latinized form of Gr. λεξικόν, sc. βιβλίον, a word-book (λέξις, word, λέγειν, to speak). Lexicon, rather than dictionary, is used of word-books of the Greek language, and sometimes of Arabic and Hebrew.



**LEXINGTON, BARON**, a title borne in the English family of Sutton from 1645 to 1723. Robert Sutton (1594-1668), son of Sir William Sutton of Averham, Nottinghamshire, was a member of parliament for his native county in 1625 and again in 1640. He served Charles I. during the Civil War, making great monetary sacrifices for the royal cause, and in 1645 the king created him Baron Lexington, this being a variant of the name of the Nottinghamshire village of Laxton. His estate suffered during the time of the Commonwealth, but some money was returned to him by Charles II. He died on the 13th of October 1668. His only son, Robert, the 2nd baron (1661-1723), supported in the House of Lords the elevation of William of Orange to the throne, and was employed by that king at court and on diplomatic business. He also served as a soldier, but he is chiefly known as the British envoy at Vienna during the conclusion of the treaty of Ryswick, and at Madrid during the negotiations which led to the treaty of Utrecht. He died on the 19th of September 1723. His letters from Vienna, selected and edited by the Hon. H. M. Sutton, were published as the *Lexington Papers* (1851). Lexington's barony became extinct on his death, but his estates descended to the younger sons of his daughter Bridget (d. 1734), the wife of John Manners, 3rd duke of Rutland. Lord George Manners, who inherited these estates in 1762, is the ancestor of the family of Manners-Sutton. An earlier member of this family is Oliver Sutton, bishop of Lincoln from 1280 to 1299.



**LEXINGTON**, a city and the county-seat of Fayette county, Kentucky, U.S.A., about 75 m. S. of Cincinnati. Pop. (1900) 26,369, of whom 10,130 were negroes and 924 were foreign-born; (1910 census), 35,099. It is served by the Louisville & Nashville, the Southern, the Chesapeake & Ohio, the Cincinnati, New Orleans & Texas Pacific, the Lexington & Eastern, and electric railways. The city, which lies at an altitude of about 950 ft., is situated near the centre of the celebrated "blue grass" region, into which extend a number of turnpike roads. Its public buildings include the court house and the Federal building, both built of Bowling Green oolitic limestone. Among the public institutions are two general hospitals—St Joseph's (Roman Catholic) and Good Samaritan (controlled by the Protestant churches of the city)—the Eastern Lunatic Asylum (1815, a state institution since 1824), with 250 acres of grounds; a state House of Reform for Girls and a state House of Reform for Boys (both at Greendale, a suburb); an orphan industrial school (for negroes); and two Widows' and Orphans' Homes, one established by the Odd Fellows of Kentucky and the other by the Knights of Pythias of the state. Lexington is the seat of Transylvania University (non-sectarian; coeducational), formerly Kentucky University (Disciples of Christ), which grew out of Bacon College (opened at Georgetown, Ky., in 1836), was chartered in 1858 as Kentucky University, and was opened at Harrodsburg, Ky., in 1859, whence after a fire in 1864 it removed to Lexington in 1865. At Lexington it was consolidated with the old Transylvania University, a well-known institution which had been chartered as Transylvania Seminary in 1783, was opened near Danville, Ky., in 1785, was removed to Lexington in 1789, was re-chartered as Transylvania University in 1798, and virtually ceased to exist in 1859.<sup>1</sup> In 1908 Kentucky University resumed the old name, Transylvania University. It has a college of Liberal Arts, a College of Law, a Preparatory School, a Junior College for Women, and Hamilton College for women (founded in 1869 as Hocker Female College), over which the university assumed control in 1903, and a College of the Bible, organized in 1865 as one of the colleges of the university, but now under independent control. In 1907-1908 Transylvania University, including the College of the Bible, had 1129 students. At Lexington are the State University, two colleges for girls—the Campbell-Hagerman College and Sayre College—and St Catherine's Academy (Roman Catholic). The city is the meeting-place of a Chatauqua Assembly, and has a public library. The State University was founded (under the Federal Land Grant Act of 1862) in 1865 as the State Agricultural and Mechanical College, was opened in 1866, and was a college of Kentucky University until 1878. In 1890 the college received a second Federal appropriation, and it received various grants from the state legislature, which in 1880 imposed a state tax of one-half of 1% for its support. In connexion with it an Agricultural Experiment Station was established in 1885. In 1908 its title became, by act of Legislature, the State University. The university has a College of Agriculture, a College of Arts and Science, a College of Law, a School of Civil Engineering, a School of Mechanical and Electrical Engineering, and a School of mining Engineering. The university campus is the former City Park, in the southern part of the city. In 1907-1908 the university had 1064 students. The city is the see of a Protestant Episcopal bishopric.

Lexington was the home of Henry Clay from 1797 until his death in 1852, and in his memory a monument has been erected, consisting of a magnesian-limestone column (about 120 ft.) in the Corinthian style and surmounted by a statue of Clay, the head of which was torn off in 1902 by a thunderbolt. Clay's estate, "Ashland," is now one of the best known of the stock-farms in the vicinity; the present house is a replica of Clay's

home. The finest and most extensive of these stock-farms, and probably the finest in the world, is "Elmendorf," 6 m. from the city. On these farms many famous trotting and running horses have been raised. There are two race-tracks in Lexington, and annual running and trotting race meetings attract large crowds. The city's industries consist chiefly in a large trade in tobacco, hemp, grain and live stock—there are large semi-annual horse sales—and in the manufacture of "Bourbon" whisky, tobacco, flour, dressed flax and hemp, carriages, harness and saddles. The total value of the city's factory products in 1905 was \$2,774,329 (46.9% more than in 1900).

Lexington was named from Lexington, Massachusetts, in 1775 by a party of hunters who were encamped here when they received the news of the battle of Lexington; the permanent settlement dates from 1779. It was laid out in 1781, incorporated as a town in 1782, and chartered as a city in 1832. The first newspaper published west of the Alleghany Mountains, the *Kentucky Gazette*, was established here in 1787, to promote the separation of Kentucky from Virginia. The first state legislature met here in 1792, but later in the same year Frankfort became the state capital. Until 1907, when the city was enlarged by annexation, its limits remained as they were first laid out, a circle with a radius of 1 m., the court house being its centre.

See G. W. Ranck, *History of Lexington, Kentucky* (Cincinnati, 1872).

- 1 See Robert Peter, *Transylvania University: Its Origin, Rise, Decline and Fall* (Louisville, 1896), and his *History of the Medical Department of Transylvania University* (Louisville, 1905).



**LEXINGTON**, a township of Middlesex county, Massachusetts, U.S.A., about 11 m. N.W. of Boston. Pop. (1900) 3831, (1910 U.S. census) 4918. It is traversed by the Boston & Maine railroad and by the Lowell & Boston electric railway. Its area is about 17 sq. m., and it contains three villages—Lexington, East Lexington and North Lexington. Agriculture is virtually the only industry. Owing to its historic interest the village of Lexington is visited by thousands of persons annually, for it was on the green or common of this village that the first armed conflict of the American War of Independence occurred. On the green stand a monument erected by the state in 1799 to the memory of the minute-men who fell in that engagement, a drinking fountain surmounted by a bronze statue (1900, by Henry Hudson Kitson) of Captain John Parker, who was in command of the minute-men, and a large boulder, which marks the position of the minute-men when they were fired upon by the British. Near the green, in the old burying-ground, are the graves of Captain Parker and other American patriots—the oldest gravestone is dated 1690. The Hancock-Clarke House (built in part in 1698) is now owned by the Lexington Historical Society and contains a museum of revolutionary and other relics, which were formerly exhibited in the Town Hall. The Buckman Tavern (built about 1690), the rendezvous of the minute-men, and the Munroe Tavern (1695), the headquarters of the British, are still standing, and two other houses, on the common, antedate the War of Independence. The Cary Library in this village, with 23,000 volumes (1908), was founded in 1868, and was housed in the Town Hall from 1871 until 1906, when it was removed to the Cary Memorial Library building. In the library are portraits of Paul Revere, William Dawes and Lord Percy. The Town Hall (1871) contains statues of John Hancock (by Thomas R. Gould) and Samuel Adams (by Martin Millmore), of the "Minute-Man of 1775" and the "Soldier of 1861," and a painting by Henry Sandham, "The Battle of Lexington."

527

Lexington was settled as a part of Cambridge as early as 1642. It was organized as a parish in 1691 and was made a township (probably named in honour of Lord Lexington) in 1713. In the evening of the 18th of April 1775 a British force of about 800 men under Lieut.-Colonel Francis Smith and Major John Pitcairn was sent by General Thomas Gage from Boston to destroy military stores collected by the colonists at Concord, and to seize John Hancock and Samuel Adams, then at Parson Clarke's house (now known as the Hancock-Clarke House) in Lexington. Although the British had tried to keep this movement a secret, Dr Joseph Warren discovered their plans and sent out Paul Revere and William Dawes to give warning of their approach. The expedition had not proceeded far when Smith, discovering that the country was aroused, despatched an express to Boston for reinforcements and ordered Pitcairn to hasten forward with a detachment of light infantry. Early in the morning of the 19th Pitcairn arrived at the green in the village of Lexington, and there found between sixty and seventy minute-men under Captain John Parker drawn up in line of battle. Pitcairn ordered them to disperse, and on their refusal to do so his men fired a volley. Whether a stray shot preceded the first volley, and from which side it came, are questions which have never been determined. After a second volley from the British, Parker ordered his men to withdraw. The engagement lasted only a few minutes, but eight Americans were killed and nine were wounded; not more than two or three of the British were wounded. Hancock and Adams had escaped before the British troops reached Lexington. The British proceeded from Lexington to Concord (*q.v.*). On their return they were continually fired upon by Americans from behind trees, rocks, buildings and other defences, and were threatened with complete destruction until they were rescued at Lexington by a force of 1000 men under Lord Hugh Percy (later, 1786, duke of Northumberland). Percy received the fugitives within a hollow square, checked the onslaught for a time with two field-pieces, used the Munroe Tavern for a hospital, and later in the day carried his command with little further injury back to Boston. The British losses for the entire day were 73 killed, 174 wounded and 26 missing; the American losses were 49 killed, 39 wounded and 5 missing.

In 1839 a state normal school for women (the first in Massachusetts and the first public training school for teachers in the United States) was opened at Lexington; it was transferred to West Newton in 1844 and to Framingham in 1853.

See Charles Hudson, *History of the Town of Lexington* (Boston, 1868), and the publications of the Lexington Historical Society, (1890 seq.).



**LEXINGTON**, a city and the county-seat of Lafayette county, Missouri, U.S.A., situated on the S. bank of the Missouri river, about 40 m. E. of Kansas City. Pop. (1900) 4190, including 1170 negroes and 283 foreign-born; (1910) 5242. It is served by the Atchison, Topeka & Santa Fé, the Wabash (at Lexington Junction, 4 m. N.W.), and the Missouri Pacific railway systems. The city lies for the most part on high broken ground at the summit of the river bluffs, but in part upon their face. Lexington is the seat of the Lexington College for Young Women (Baptist, established 1855), the Central College for Women (Methodist Episcopal, South; opened 1869), and the Wentworth Military Academy (1880). There are steam flour mills, furniture factories and various other small manufactories; but the main economic interest of the city is in brickyards and coal-mines in its immediate vicinity. It is one of the principal coal centres of the state, Higginsville (pop. in 1910, 2628), about 12 m. S.E., in the same county, also being important. Lexington was founded in 1819, was laid out in 1832, and, with various additions, was chartered as a city in 1845. A new charter was received in 1870. Lexington succeeded Sibley as the eastern terminus of the Santa Fé trade, and was in turn displaced by Independence; it long owed its prosperity to the freighting trade up the Missouri, and at the opening of the Civil War it was the most important river town between St Louis and St Joseph and commanded the approach by water to Fort Leavenworth.

After the Confederate success at Wilson's Creek (Aug. 10, 1861), General Sterling Price advanced northward, and with about 15,000 men arrived in the vicinity of Lexington on the 12th of September. Here he found a Federal force of about 2800 men under Colonel James A. Mulligan (1830-1864) throwing up intrenchments on Masonic College Hill, an eminence adjoining Lexington on the N.E. An attack was made on the same day and the Federals were driven within their defences, but at night General Price withdrew to the Fair-grounds not far away and remained there five days waiting for his wagon train and for reinforcements. On the 18th the assault was renewed, and on the 20th the Confederates, advancing behind movable breastworks of water-soaked bales of hemp, forced the besieged, now long without water, to surrender. The losses were: Confederate, 25 killed and 75 wounded; Federal, 39 killed and 120 wounded. At the end of September General Price withdrew, leaving a guard of only a few hundred in the town, and on the 16th of the next month a party of 220 Federal scouts under Major Frank J. White (1842-1875) surprised this guard, released about 15 prisoners, and captured 60 or more Confederates. Another Federal raid on the town was made in December of the same year by General John Pope's cavalry. Again, during General Price's Missouri expedition in 1864, a Federal force entered Lexington on the 16th of October, and three days later there was some fighting about 4 m. S. of the town.



**LEXINGTON**, a town and the county-seat of Rockbridge county, Virginia, U.S.A., on the North river (a branch of the James), about 30 m. N.N.W. of Lynchburg. Pop. (1900) 3203 (1252 negroes); (1910) 2931. It is served by the Chesapeake & Ohio and the Baltimore & Ohio railways. The famous Natural Bridge is about 16 m. S.W., and there are mineral springs in the vicinity—at Rockbridge Baths, 10 m. N., at Wilson's Springs, 12 m. N., and at Rockbridge Alum Springs, 17 m. N.W. Lexington is best known as the seat of Washington and Lee University, and of the Virginia Military Institute. The former grew out of Augusta Academy, which was established in 1749 in Augusta county, about 15 m. S.W. of what is now the city of Staunton, was renamed Liberty Hall and was established near Lexington in 1780, and was chartered as Liberty Hall Academy in 1782. In 1798 its name was changed to Washington Academy, in recognition of a gift from George Washington of some shares of canal stock, which he refused to receive from the Virginia legislature. In 1802 the Virginia branch of the Society of the Cincinnati disbanded and turned over to the academy its funds, about \$25,000; in 1813 the academy took the name Washington College; and in 1871 its corporate name was changed to Washington and Lee University, the addition to the name being made in honour of General Robert E. Lee, who was the president of the college from August 1865 until his death in 1870. He was succeeded by his son, General George Washington Custis Lee (b. 1832), president from 1871 to 1897, and Dr William Lyne Wilson (1843-1900), the eminent political leader and educator, was president from 1897 to 1900. In 1908-1909 the university comprised a college, a school of commerce, a school of engineering and a school of law, and had a library of 47,000 volumes, 23 instructors and 565 students. In the Lee Memorial chapel, on the campus, General Robert E. Lee is buried, and over his grave is a notable recumbent statue of him by Edward Virginius Valentine (b. 1838). The Virginia Military Institute was established in March 1839, when its cadet corps supplanted the company of soldiers maintained by the state to garrison the Western Arsenal at Lexington. The first superintendent (1839-1890) was General Francis Henney Smith (1812-1890), a graduate (1833) of the United States Military Academy; and from 1851 until the outbreak of the Civil War "Stonewall" Jackson was a professor in the Institute—he is buried in the Lexington cemetery and his grave is marked by a monument. On the campus of the institute is a fine statue, "Virginia Mourning Her Dead," by Moses Ezekiel (b. 1844), which commemorates the gallantry of a battalion of 250 cadets from the institute, more than 50 of whom were killed or wounded during the engagement at New Market on the 15th of May 1864. In 1908-1909 the institute had 21 instructors and 330 cadets. Flour is manufactured in Lexington and lime in the vicinity. The town owns and operates its water-works. The first settlers of Rockbridge county established themselves in 1737 near the North river, a short distance below Lexington. The first permanent settlement on the present site was made about 1778. On the 11th of June 1864, during the occupation of the town by Federal troops under General David Hunter, most of the buildings in the town and those of the university were damaged and all those of the institute, except the superintendent's headquarters, were burned.



**LEYDEN, JOHN** (1775-1811), British orientalist and man of letters, was born on the 8th of September 1775 at Denholm on the Teviot, not far from Hawick. Leyden's father was a shepherd, but contrived to send his son to Edinburgh University to study for the ministry. Leyden was a diligent but somewhat miscellaneous student, reading everything apparently, except theology, for which he seems to have had no taste. Though he completed his divinity course, and in 1798 received licence to preach from the presbytery of St Andrews, it soon became clear that the pulpit was not his vocation. In 1794 Leyden had formed the acquaintance of Dr Robert Anderson, editor of *The British Poets*, and of *The Literary Magazine*. It was Anderson who introduced him to Dr Alexander Murray, and Murray, probably, who led him to the study of Eastern languages. They became warm friends and generous rivals, though Leyden excelled, perhaps, in the rapid acquisition of new tongues and acquaintance with their literature, while Murray was the more scientific philologist. Through Anderson also he came to know Richard Heber, by whom he was brought under the notice of Sir Walter Scott, who was then collecting materials for his *Minstrelsy of the Scottish Border*. Leyden was admirably fitted for helping in this kind of work, for he was a borderer himself, and an enthusiastic lover of old ballads and folk-lore. Scott tells how, on one occasion, Leyden walked 40 m. to get the last two verses of a ballad, and returned at midnight, singing it all the way with his loud, harsh voice, to the wonder and consternation of the poet and his household.

Leyden meanwhile compiled a work on the *Discoveries and Settlements of Europeans in Northern and Western Africa*, suggested by Mungo Park's travels, edited *The Complaint of Scotland*, printed a volume of Scottish descriptive poems, and nearly finished his *Scenes of Infancy*, a diffuse poem based on border scenes and traditions. He also made some translations from Eastern poetry, Persian and Arabic. At last his friends got him an appointment in India on the medical staff, for which he qualified by a year's hard work. In 1803 he sailed for Madras, and took his place in the general hospital there. He was promoted to be naturalist to the commissioners going to survey Mysore, and in 1807 his knowledge of the languages of India procured him an appointment as professor of Hindustani at Calcutta; this he soon after resigned for a judgeship, and that again to be a commissioner in the court of requests in 1809, a post which required a familiarity with several Eastern tongues. In 1811 he joined Lord Minto in the expedition to Java. Having entered a library which was said to contain many Eastern MSS., without having the place aired, he was seized with Batavian fever, and died, after three days' illness, on the 28th of August 1811.



**LEYDEN JAR**, or CONDENSER, an electrical appliance consisting in one form of a thin glass jar partly coated inside and outside with tin foil, or in another of a number of glass plates similarly coated. When the two metal surfaces are connected for a short time with the terminals of some source of electromotive force, such as an electric machine, an induction coil or a voltaic battery, electric energy is stored up in the condenser in the form of electric strain in the glass, and can be recovered again in the form of an electric discharge.

The earliest form of Leyden jar consisted of a glass vial or thin Florence flask, partly full of water, having a metallic nail inserted through the cork which touched the water. The bottle was held in the hand, and the nail presented to the prime conductor of an electrical machine. If the person holding the bottle subsequently touched the nail, he experienced an electric shock. This experiment was first made by E. G. von Kleist of Kammin in Pomerania in 1745,<sup>1</sup> and it was repeated in another form in 1746 by Cunaeus and P. van Musschenbroek, of the university of Leyden (Leiden), whence the term Leyden jar.<sup>2</sup> J. H. Winkler discovered that an iron chain wound round the bottle could be substituted for the hand, and Sir William Watson in England shortly afterward showed that iron filings or mercury could replace the water within the jar. Dr John Bevis of London suggested, in 1746, the use of sheet lead coatings within and without the jar, and subsequently the use of tin foil or silver leaf made closely adherent to the glass. Benjamin Franklin and Bevis devised independently the form of condenser known as a Franklin or Leyden pane, which consists of a sheet of glass, partly coated on both sides with tin foil or silver leaf, a margin of glass all round being left to insulate the two tin foils from each other. Franklin in 1747 and 1748 made numerous investigations on the Leyden jar, and devised a method of charging jars in series as well as in parallel. In the former method, now commonly known as charging in *cascade*, the jars are insulated and the outside coating of one jar is connected to the inside coating of the next and so on for a whole series, the inside coating of the first jar and the outside coating of the last jar being the terminals of the condenser. For charging in parallel a number of jars are collected in a box, and all the outside coatings are connected together metallically and all the inside coatings brought to one common terminal. This arrangement is commonly called a battery of Leyden jars. To Franklin also we owe the important knowledge that the electric charge resides really in the glass and not in the metal coatings, and that when a condenser has been charged the metallic coatings can be exchanged for fresh ones and yet the electric charge of the condenser remains.

In its modern form the Leyden jar consists of a wide-mouthed bottle of thin English flint glass of uniform thickness, free from flaws. About half the outside and half the inside surface is coated smoothly with tin foil, and the remainder of the glazed surface is painted with shellac varnish. A wooden stopper closes the mouth of the jar, and through it a brass rod passes which terminates in a chain, or better still, three elastic brass springs, which make good contact with the inner coating. The rod terminates externally in a knob or screw terminal. The jar has a certain capacity  $C$  which is best expressed in microfarads or electrostatic units (see **ELECTROSTATICS**), and is determined by the surface of the tin foil and thickness and quality of the glass. The jar can be charged so that a certain potential difference  $V$ , reckoned in volts, exists between the two coatings. If a certain critical potential is exceeded, the glass gives way under the electric strain and is pierced. The safe voltage for most glass jars is about 20,000 volts for glass  $\frac{1}{10}$ th in. in thickness; this corresponds with an electric spark of about 7 millimetres in length. When the jar is charged, it is usually discharged through a metallic arc called the discharging tongs, and this discharge is in the form of an oscillatory current (see **ELECTROKINETICS**). The energy stored up in the jar in joules is expressed by the value of  $\frac{1}{2} CV^2$ , where  $C$  is the capacity measured in farads and  $V$  the potential difference of the coatings in volts. If the

**Modern construction.**



capacity  $C$  is reckoned in microfarads then the energy storage is equal to  $CV^2/2 \times 10^6$  joules or  $0.737 CV^2/2 \times 10^6$  foot-pounds. The size of jar commonly known as a quart size may have a capacity from  $\frac{1}{400}$ th to  $\frac{1}{800}$ th of a microfarad, and if charged to 20,000 volts stores up energy from a quarter to half a joule or from  $\frac{3}{16}$ ths to  $\frac{3}{8}$ ths of a foot-pound.

Leyden jars are now much employed for the production of the high frequency electric currents used in wireless telegraphy (see [TELEGRAPHY, WIRELESS](#)). For this purpose they are made by Moscicki in the form of glass tubes partly coated by silver chemically deposited on the glass on the inner and outer surfaces. The tubes have walls thicker at the ends than in the middle, as the tendency to puncture the glass is greatest at the edges of the coatings. In other cases, Leyden jars or condensers take the form of sheets of mica or micanite or ebonite partly coated with tin foil or silver leaf on both sides; or a pile of sheets of alternate tin foil and mica may be built up, the tin foil sheets having lugs projecting out first on one side and then on the other. All the lugs on one side are connected together, and so also are all the lugs on the other side, and the two sets of tin foils separated by sheets of mica constitute the two metallic surfaces of the Leyden jar condenser. For the purposes of wireless telegraphy, when large condensers are required, the ordinary Leyden jar occupies too much space in comparison with its electrical capacity, and hence the best form of condenser consists of a number of sheets of crown glass, each partly coated on both sides with tin foil. The tin foil sheets have lugs attached which project beyond the glass. The plates are placed in a vessel full of insulating oil which prevents the glow or brush discharge taking place over their edges. All the tin foils on one side of the glass plates are connected together and all the tin foils on the opposite sides, so as to construct a condenser of any required capacity. The box should be of glass or stoneware or other non-conducting material. When glass tubes are used it is better to employ tubes thicker at the ends than in the middle, as it has been found that when the safe voltage is exceeded and the glass gives way under electric strain, the piercing of the glass nearly always takes place at the edges of the tin foil.

**High tension condensers.**

**Compressed air condensers.**

Glass is still commonly used as a dielectric because of its cheapness, high dielectric strength or resistance to electric puncture, and its high dielectric constant (see [ELECTROSTATICS](#)). It has been found, however, that very efficient condensers can be made with compressed air as dielectric. If a number of metal plates separated by small distance pieces are enclosed in an iron box which is pumped full of air to a pressure, say, of 100 lb. to 1 sq. in., the dielectric strength of the air is greatly increased, and the plates may therefore be brought very near to one another without causing a spark to pass under such voltage as would cause discharge in air at normal pressure. Condensers of this kind have been employed by R. A. Fessenden in wireless telegraphy, and they form a very excellent arrangement for standard condensers with which to compare the capacity of other Leyden jars. Owing to the variation in the value of the dielectric constant of glass with the temperature and with the frequency of the applied electromotive force, and also owing to electric glow discharge from the edges of the tin foil coatings, the capacity of an ordinary Leyden jar is not an absolutely fixed quantity, but its numerical value varies somewhat with the method by which it is measured, and with the other circumstances above mentioned. For the purpose of a standard condenser a number of concentric metal tubes may be arranged on an insulating stand, alternate tubes being connected together. One coating of the condenser is formed by one set of tubes and the other by the other set, the air between being the dielectric. Paraffin oil or any liquid dielectric of constant inductivity may replace the air.

See J. A. Fleming, *Electric Wave Telegraphy* (London, 1906); R. A. Fessenden, "Compressed Air for Condensers," *Electrician*, 1905, 55, p. 795; Moscicki, "Construction of High Tension Condensers," *L'Éclairage électrique*, 1904, 41, p. 14, or *Engineering*, 1904, p. 865.

(J. A. F.)

1 Park Benjamin, *The Intellectual Rise in Electricity*, p. 512.

2 *Ibid.* p. 519.



**LEYS, HENDRIK**, BARON (1815-1869), Belgian painter, was born at Antwerp on the 18th of February 1815. He studied under Wappers at the Antwerp Academy. In 1833 he painted "Combat d'un grenadier et d'un cosaque," and in the following year "Combat de Bourguignons et Flamands." In 1835 he went to Paris where he was influenced by the Romantic movement. Examples of this period of his painting are "Massacre des échevins de Louvain," "Mariage flamand," "Le Roi des arbalétriers" and other works. Leys was an imitative painter in whose works may rapidly be detected the schools which he had been studying before he painted them. Thus after his visit to Holland in 1839 he reproduced many of the characteristics of the Dutch genre painters in such works as "Franz Floris se rendant à une fête" (1845) and "Service divin en Hollande" (1850). So too the methods of Quentin Matsys impressed themselves upon him after he had travelled in Germany in 1852. In 1862 Leys was created a baron. At the time of his death, which occurred in August 1869, he was engaged in decorating with fresco the large hall of the Antwerp Hôtel de Ville.



**LEYTON**, an urban district forming one of the north-eastern suburbs of London, England, in the Walthamstow (S.W.) parliamentary division of Essex. Pop. (1891) 63,106; (1901) 98,912. It lies on the east (left) bank of the Lea, along the flat open valley of which runs the boundary between Essex and the county of London.

The church of St Mary, mainly a brick reconstruction, contains several interesting memorials; including one to William Bowyer the printer (d. 1737), erected by his son and namesake, more famous in the same trade. Here is also buried John Strype the historian and biographer (d. 1737), who held the position of curate and lecturer at this church. Leyton is in the main a residential as distinct from a manufacturing locality. Its name is properly Low Leyton, and the parish includes the district of Leytonstone to the east. Roman remains have been discovered here, but no identification with a Roman station by name has been made with certainty. The ground of the Essex County Cricket Club is at Leyton.



**LHASA** (LHASSA, LASSA, "God's ground"), the capital of Tibet. It lies in 29° 39' N., 91° 5' E., 11,830 ft. above sea-level. Owing to the inaccessibility of Tibet and the political and religious exclusiveness of the lamas, Lhasa was long closed to European travellers, all of whom during the latter half of the 19th century were stopped in their attempts to reach it. It was popularly known as the "Forbidden City." But its chief features were known by the accounts of the earlier Romish missionaries who visited it and by the investigations, in modern times, of native Indian secret explorers, and others, and the British armed mission of 1904 (see [TIBET](#)).

*Site and General Aspect.*—The city stands in a tolerably level plain, which is surrounded on all sides by hills. Along its southern side, about ½ m. south of Lhasa, runs a considerable river called the Kyichu (Ki-chu) or Kyi, flowing here from E.N.E., and joining the great Tsangpo (or upper course of the Brahmaputra) some 38 m. to the south-west. The hills round the city are barren. The plain, however, is fertile, though in parts marshy. There are gardens scattered over it round the city, and these are planted with fine trees. The city is screened from view from the west by a rocky ridge, lofty and narrow, with summits at the north and south, the one flanked and crowned by the majestic buildings of Potala, the chief residence of the Dalai lama, the other by the temple of medicine. Groves, gardens and open ground intervene between this ridge and the city itself for a distance of about 1 m. A gate through the centre of the ridge gives access from the west; the road thence to the north part of the city throws off a branch to the Yutok sampa or turquoise-tiled covered bridge, one of the noted features of Lhasa, which crosses a former channel of the Kyi, and carries the road to the centre of the town.

530

The city is nearly circular in form, and less than 1 m. in diameter. It was walled in the latter part of the 17th century, but the walls were destroyed during the Chinese occupation in 1722. The chief streets are fairly straight, but generally of no great width. There is no paving or metal, nor any drainage system, so that the streets are dirty and in parts often flooded. The inferior quarters are unspeakably filthy, and are rife with evil smells and large mangy dogs and pigs. Many of the houses are of clay and sun-dried brick, but those of the richer people are of stone and brick. All are frequently white-washed, the doors and windows being framed in bands of red and yellow. In the suburbs there are houses entirely built of the horns of sheep and oxen set in clay mortar. This construction is in some cases very roughly carried out, but in others it is solid and highly picturesque. Some of the inferior huts of this type are inhabited by the Ragyaba or scavengers, whose chief occupation is that of disposing of corpses according to the practice of cutting and exposing them to the dogs and birds of prey. The houses generally are of two or three storeys. Externally the lower part generally presents dead walls (the ground floor being occupied by stables and similar apartments); above these rise tiers of large windows with or without projecting balconies, and over all flat broad-eaved roofs at varying levels. In the better houses there are often spacious and well-finished apartments, and the principal halls, the verandahs and terraces are often highly ornamented in brilliant colours. In every house there is a kind of chapel or shrine, carved and gilt, on which are set images and sacred books.

*Temples and Monasteries.*—In the centre of the city is an open square which forms the chief market-place. Here is the great temple of the "Jo" or Lord Buddha, called the Jokhang,<sup>1</sup> regarded as the centre of all Tibet,

from which all the main roads are considered to radiate. This is the great metropolitan sanctuary and church-centre of Tibet, the St Peter's or Lateran of Lamaism. It is believed to have been founded by the Tibetan Constantine, Srong-tsan-gampo, in 652, as the shrine of one of those two very sacred Buddhist images which were associated with his conversion and with the foundation of the civilized monarchy in Tibet. The exterior of the building is not impressive; it rises little above the level of other buildings which closely surround it, and the effect of its characteristic gilt roof, though conspicuous and striking from afar, is lost close at hand.

The main building of the Jokhang is three storeys high. The entrance consists of a portico supported on timber columns, carved and gilt, while the walls are engraved with Chinese, Mongolian and Tibetan characters, and a great prayer-wheel stands on one side. Massive folding doors, ornamented with scrollwork in iron, lead to an antehall, and from this a second gate opens into a courtyard surrounded by a verandah with many pillars and chapels, and frescoes on its walls. On the left is the throne of the grand lama, laid with cushions, together with the seats of other ecclesiastical dignitaries, variously elevated according to the rank of their occupants. An inner door with enclosed vestibule gives access to the quadrangular choir or chancel, as it may be called, though its centre is open to the sky. On either side of it are three chapels, and at the extremity is the rectangular "holy of holies," flanked by two gilded images of the coming Buddha, and screened by lattice-work. In it is the shrine on which sits the great image of Sakya, set about with small figures, lamps and a variety of offerings, and richly jewelled, though the workmanship of the whole is crude. In the second and third storeys of the temple are shrines and representations of a number of gods and goddesses. The temple contains a vast accumulation of images, gold and silver vessels, lamps, reliquaries and precious bric-à-brac of every kind. The daily offices are attended by crowds of worshippers, and a sacred way which leads round the main building is constantly traversed by devotees who perform the circuit as a work of merit, always in a particular direction. The temple was found by the members of the British mission who visited it to be exceedingly dirty, and the atmosphere was foul with the fumes of butter-lamps.

Besides the convent-cells, halls of study and magazines of precious lumber, buildings grouped about the Jokhang are occupied by the civil administration, e.g. as treasuries, customs office, courts of justice, &c., and there are also private apartments for the grand lama and other high functionaries. No woman is permitted to

pass the night within the precinct.

In front of the main entrance to the Jokhang, in the shadow of a sacred willow tree, stands a famous monument, the Doring monolith, which bears the inscribed record of a treaty of peace concluded in 822 (or, according to another view, in 783) between the king of Tibet and the emperor of China. Before this monument the apostate from Lamaism, Langdharma, brother and successor of the last-named king, is said to have been standing when a fanatic recluse, who had been stirred by a vision to avenge his persecuted faith, assassinated him.

The famous Potala hill, covered by the palace of the Dalai lama, forms a majestic mountain of building; with its vast inward-sloping walls broken only in the upper parts by straight rows of many windows, and its flat roofs at various levels, it is not unlike a fortress in appearance. At the south base of the rock is a large space enclosed by walls and gates, with great porticoes on the inner side. This swarms with lamas and with beggars. A series of tolerably easy staircases, broken by intervals of gentle ascent, leads to the summit of the rock. The whole width of this is occupied by the palace. The central part of this group of buildings (for the component parts of Potala are of different dates) rises in a vast quadrangular mass above its satellites to a great height, terminating in gilt canopies similar to those on the Jokhang. Here on the lofty terrace is the grand lama's promenade, and from this great height he looks down upon the crowds of his votaries far below. This central member of Potala is called the red palace from its crimson colour, which distinguishes it from the rest. It contains the principal halls and chapels and shrines of past Dalai lamas. There is in these much rich decorative painting, with jewelled work, carving and other ornament, but the interior of Potala as a whole cannot compare in magnificence with the exterior. Among the numerous other buildings of note on or near Potala hill, one is distinguished by the Chinese as one of the principal beauties of Lhasa. This is a temple not far from the base of the hill, in the middle of a lake which is surrounded by trees and shrubberies. This temple, called Lu-kang, is circular in form, with a *loggia* or portico running all round and adorned with paintings. Its name, "the serpent house," comes from the tradition of a serpent or dragon, which dwelt here and must be propitiated lest it should cause the waters to rise and flood Lhasa.

Another great and famous temple is Ramo-ché, at the north side of the city. This is also regarded as a foundation of Srong-tsan-gampo, and is said to contain the body of his Chinese wife and the second of the primeval palladia, the image that she brought with her to the Snow-land; whence it is known as the "small Jokhang." This temple is noted for the practice of magical arts. Its buildings are in a neglected condition.

Another monastery within the city is that of Moru, also on the north side, remarkable for its external order and cleanliness. Though famous as a school of orthodox magic, it is noted also for the printing-house in the convent garden. This convent was the temporary residence of the regent during the visit of the British mission in 1904. Other monasteries in or near the city are the Tsamo Ling or Chomoling at the north-west corner; the Tangyā Ling or Tengyeling at the west of the city; the Kundā Ling or Kundeling about 1 m. west of the city, at the foot of a low isolated hill called Chapochi. Three miles south, beyond the river, is the Tsemchog Ling or Tsecholing. These four convents are known as "The Four Ling." From their inmates the Dalai lama's regent, during his minority, was formerly chosen. The temple of medicine, as already stated, crowns the summit (Chagpa) at the end of the ridge west of the city, opposite to that on which stands the Potala. It is natural that in a country possessing a religious system like that of Tibet the medical profession should form a branch of the priesthood. "The treatment of disease, though based in some measure upon a judicious use of the commoner simple drugs of the country, is, as was inevitable amongst so superstitious a people, saturated with absurdity" (Waddell, *Lhasa and its Mysteries*).

The three great monasteries in the vicinity of Lhasa, all claiming to be foundations of Tsongkhapa (1356-1418), the medieval reformer and organizer of the modern orthodox Lama Church, "the yellow caps," are the following:

1. *Debung* (written '*Bras spungs*') is 6 m. west of Lhasa at the foot of the hills which flank the plain on the north. It is one of the largest monasteries in the world, having some 8000 monks. In the middle of the convent buildings rises a kind of pavilion, brilliant with colour and gilding, which is occupied by the Dalai Lama when he visits Debung once a year and expounds to the inmates. The place is frequented by the Mongol students who come to Lhasa to graduate, and is known in the country as the Mongol convent; it has also been notorious as a centre of political intrigue. Near it is the seat of the chief magician of Tibet, the Nachung Chos-kyong, a building picturesque in itself and in situation.

531

2. *Sera* is 3 m. north of the city on the acclivity of the hills and close to the road by which pilgrims enter from Mongolia. From a distance the crowd of buildings and temples, rising in amphitheatre against a background of rocky mountains, forms a pleasing picture. In the recesses of the hill, high above the convent, are scattered cells of lamas adopting the solitary life. The chief temple of Sera, a highly ornate building, has a special reputation as the resting-place of a famous *Dorjē*, i.e. the *Vajra* or Thunderbolt of Jupiter, the symbol of the strong and indestructible, which the priest grasps and manipulates in various ways during prayer. The emblem is a bronze instrument, shaped much like a dumbbell with pointed ends, and it is carried solemnly in procession to the Jokhang during the New Year's festival.

The hill adjoining Sera is believed to be rich in silver ore, but it is not allowed to be worked. On the summit is a spring and a holy place of the Lhasa Mahommedans, who resort thither. Near the monastery there is said to be gold, which is worked by the monks. "Should they ... discover a nugget of large size, it is immediately replaced in the earth, under the impression that the large nuggets ... germinate in time, producing the small lumps which they are privileged to search for" (Nain Singh).

3. *Galdan*.—This great convent is some 25 m. east of Lhasa, on the other side of the Kyichu. It is the oldest monastery of the "Yellow" sect, having been founded by Tsongkhapa and having had him for its first superior. Here his body is said to be preserved with miraculous circumstances; here is his tomb, of marble and malachite, with a great shrine said to be of gold, and here are other relics of him, such as the impression of his hands and feet.

*Samyé* is another famous convent intimately connected with Lhasa, being said to be used as a treasury by the government, but it lies some 36 m. south-east on the left bank of the great Tsangpo. It was founded in 770, and is the oldest extant monastery in Tibet. It is surrounded by a very high circular stone wall, 1½ m. in circumference, with gates facing the four points of the compass. On this wall Nain Singh, who was here on his journey in 1874, counted 1030 votive piles of brick. One very large temple occupies the centre, and round it are four smaller but still large temples. Many of the idols are said to be of pure gold, and the wealth is very great. The interiors of the temples are covered with beautiful writing in enormous characters, which the vulgar believe to be the writing of

*Population and Trade.*—The total population of Lhasa, including the lamas in the city and vicinity, is probably about 30,000; a census in 1854 made the figure 42,000, but it is known to have greatly decreased since. There are only some 1500 resident Tibetan laymen and about 5500 Tibetan women. The permanent population embraces, besides Tibetans, settled families of Chinese (about 2000 persons), as well as people from Nepal, from Ladak, and a few from Bhotan and Mongolia. The Ladakis and some of the other foreigners are Mahommedans, and much of the trade is in their hands. Desideri (1716) speaks also of Armenians and even "Muscovites." The Chinese have a crowded burial-ground at Lhasa, tended carefully after their manner. The Nepalese (about 800) supply the mechanics and metal-workers. There are among them excellent gold- and silversmiths; and they make the elaborate gilded canopies crowning the temples. The chief industries are the weaving of a great variety of stuffs from the fine Tibetan wool; the making of earthenware and of the wooden porringers (varying immensely in elaboration and price) of which every Tibetan carries one about with him; also the making of certain fragrant sticks of incense much valued in China and elsewhere.

As Lhasa is not only the nucleus of a cluster of vast monastic establishments, which attract students and aspirants to the religious life from all parts of Tibet and Mongolia, but is also a great place of pilgrimage, the streets and public places swarm with visitors from every part of the Himalayan plateau,<sup>2</sup> and from all the steppes of Asia between Manchuria and the Balkhash Lake. Naturally a great traffic arises quite apart from the pilgrimage. The city thus swarms with crowds attracted by devotion and the love of gain, and presents a great diversity of language, costume and physiognomy; though, in regard to the last point, varieties of the broad face and narrow eye greatly predominate. Much of the retail trade of the place is in the hands of the women. The curious practice of the women in plastering their faces with a dark-coloured pigment is less common in Lhasa than in the provinces.

During December especially traders arrive from western China by way of Tachienlu bringing every variety of silk-stuffs, carpets, china-ware and tea; from Siningfu come silk, gold lace, Russian goods, carpets of a superior kind, semi-precious stones, horse furniture, horses and a very large breed of fat-tailed sheep; from eastern Tibet, musk in large quantities, which eventually finds its way to Europe through Nepal; from Bhotan and Sikkim, rice; from Sikkim also tobacco; besides a variety of Indian and European goods from Nepal and Darjeeling, and *charas* (resinous exudation of hemp) and saffron from Ladakh and Kashmir. The merchants leave Lhasa in March, before the setting in of the rains renders the rivers impassable.

The tea importation from China is considerable, for tea is an absolute necessary to the Tibetan. The tea is of various qualities, from the coarsest, used only for "buttered" tea (a sort of broth), to the fine quality drunk by the wealthy. This is pressed into bricks or cakes weighing about 5½ lb, and often passes as currency. The quantity that pays duty at Tachienlu is about 10,000,000 lb, besides some amount smuggled. No doubt a large part of this comes to Lhasa.

*Lhasa Festivities.*—The greatest of these is at the new year. This lasts fifteen days, and is a kind of lamaic carnival, in which masks and mummings, wherein the Tibetans take especial delight, play a great part. The celebration commences at midnight, with shouts and clangour of bells, gongs, chank-shells, drums and all the noisy repertory of Tibetan music; whilst friends exchange early visits and administer coarse sweetmeats and buttered tea. On the second day the Dalai Lama gives a grand banquet, at which the Chinese and native authorities are present, whilst in the public spaces and in front of the great convents all sorts of shows and jugglers' performances go on. Next day a regular Tibetan exhibition takes place. A long cable, twisted of leather thongs, is stretched from a high point in the battlements of Potala slanting down to the plain, where it is strongly moored. Two men slide from top to bottom of this huge hypotenuse, sometimes lying on the chest (which is protected by a breast-plate of strong leather), spreading their arms as if to swim, and descending with the rapidity of an arrow-flight. Occasionally fatal accidents occur in this performance, which is called "the dance of the gods"; but the survivors are rewarded by the court, and the Grand Lama himself is always a witness of it. This practice occurs more or less over the Himalayan plateau, and is known in the neighbourhood of the Ganges as *Barat*. It is employed as a kind of expiatory rite in cases of pestilence and the like. Exactly the same performance is described as having been exhibited in St Paul's Churchyard before King Edward VI., and again before Philip of Spain, as well as, about 1750, at Hertford and other places in England (see Strutt's *Sports, &c.*, 2nd ed., p. 198).

The most remarkable celebration of the new year's festivities is the great jubilee of the *Monlam* (*s Mon-lam*, "prayer"), instituted by Tsongkhapa himself in 1408. Lamas from all parts of Tibet, but chiefly from the great convents in the neighbourhood, flock to Lhasa, and every road leading thither is thronged with troops of monks on foot or horseback, on yaks or donkeys, carrying with them their breviaries and their cooking-pots. Those who cannot find lodging bivouac in the streets and squares, or pitch their little black tents in the plain. The festival lasts six days, during which there reigns a kind of saturnalia. Unspeakable confusion and disorder reign, while gangs of lamas parade the streets, shouting, singing and coming to blows. The object of this gathering is, however, supposed to be devotional. Vast processions take place, with mystic offerings and lama-music, to the Jokhang and Moru convents; the Grand Lama himself assists at the festival, and from an elevated throne beside the Jokhang receives the offerings of the multitude and bestows his benediction.

On the 15th of the first month multitudes of torches are kept ablaze, which lighten up the city to a great distance, whilst the interior of the Jokhang is illuminated throughout the night by innumerable lanterns shedding light on coloured figures in bas-relief, framed in arabesques of animals, birds and flowers, and representing the history of Buddha and other subjects, all modelled in butter. The figures are executed on a large scale, and, as described by Huc, who witnessed the festival at Kunbum on the frontier of China, with extraordinary truth and skill. These singular works of art occupy some months in preparation, and on the morrow are thrown away. On other days horse-races take place from Sera to Potala, and foot-races from Potala to the city. On the 27th of the month the holy *Dorjê* is carried in solemn procession from Sera to the Jokhang, and to the presence of the lama at Potala.

Of other great annual feasts, one, in the fourth month, is assigned to the conception of Sakya, but appears to connect itself with the old nature-feast of the entering of spring, and to be more or less identical with the *Hûli* of India. A second, the consecration of the waters, in September-October, appears, on the confines of India, to be associated with the Dasehra.

On the 30th day of the second month there takes place a strange ceremony, akin to that of the scapegoat

(which is not unknown in India). It is called the driving out of the demon. A man is hired to perform the part of demon (or victim rather), a part which sometimes ends fatally. He is fantastically dressed, his face mottled with white and black, and is then brought forth from the Jokhang to engage in quasi-theological controversy with one who represents the Grand Lama. This ends in their throwing dice against each other (as it were for the weal or woe of Lhasa). If the demon were to win the omen would be appalling; so this is effectually barred by false dice. The victim is then marched outside the city, followed by the troops and by the whole populace, hooting, shouting and firing volleys after him. Once he is driven off, the people return, and he is carried off to the Samyé convent. Should he die shortly after, this is auspicious; if not, he is kept in ward at Samyé for a twelvemonth.

Nain Singh, whose habitual accuracy is attested by many facts, mentions a strange practice of comparatively recent origin, according to which the civil power in the city is put up to auction for the first twenty-three days of the new year. The purchaser, who must be a member of the Debung monastery, and is termed the *Jalno*, is a kind of lord of misrule, who exercises arbitrary authority during that time for his own benefit, levying taxes and capricious fines upon the citizens.

*History.*—The seat of the princes whose family raised Tibet to a position among the powers of Asia was originally on the Yarlung river, in the extreme east of the region now occupied by Tibetan tribes. It was transplanted to Lhasa in the 7th century by the king Srong-tsan-gampo, conqueror, civilizer and proselytizer, the founder of Buddhism in Tibet, the introducer of the Indian alphabet. On the three-peaked crag now occupied by the palace-monastery of the Grand Lama this king is said to have established his fortress, while he founded in the plain below temples to receive the sacred images, brought respectively from Nepal and from China by the brides to whom his own conversion is attributed.

Tibet endured as a conquering power some two centuries, and the more famous among the descendants of the founder added to the city. This rong-de-tsan (who reigned 740-786) is said to have erected a great temple-palace of which the basement followed the Tibetan style, the middle storey the Chinese, and the upper storey the Indian—a combination which would aptly symbolize the elements that have moulded the culture of Lhasa. His son, the last of the great orthodox kings, in the next century, is said to have summoned artists from Nepal and India, and among many splendid foundations to have erected a sanctuary (at Samyé) of vast height, which had nine storeys, the three lower of stone, the three middle of brick, the three uppermost of timber. With this king the glory of Tibet and of ancient Lhasa reached its zenith, and in 822, a monument recording his treaty on equal terms with the Great T'ang emperor of China was erected in the city. There followed dark days for Lhasa and the Buddhist church in the accession of this king's brother Langdharma, who has been called the Julian of the lamas. This king rejected the doctrine, persecuted and scattered its ministers, and threw down its temples, convents and images. It was more than a century before Buddhism recovered its hold and its convents were rehabilitated over Tibet. The country was then split into an infinity of petty states, many of them ruled from the convents by warlike ecclesiastics; but, though the old monarchy never recovered, Lhasa seems to have maintained some supremacy, and probably never lost its claim to be the chief city of that congeries of principalities, with a common faith and a common language, which was called Tibet.

The Arab geographers of the 10th century speak of Tibet, but without real knowledge, and none speaks of any city that we can identify with Lhasa. The first passage in any Western author in which such identification can be probably traced occurs in the narrative of Friar Odoric of Pordenone (*c.* 1330). This remarkable traveller's route from Europe to India, and thence by sea to China, can be traced satisfactorily, but of his journey homeward through Asia the indications are very fragmentary. He speaks, however, on this return journey of the realm of Tibet, which lay on the confines of India proper: "The folk of that country dwell in tents made of black felt. But the chief and royal city is all built with walls of black and white, and all its streets are very well paved. In this city no one shall dare to shed the blood of any, whether man or beast, for the reverence they bear a certain idol that is there worshipped. In that city dwelleth the *Abassi*, *i.e.* in their tongue the pope, who is the head of all the idolaters, and has the disposal of all their benefices such as they are after their manner."

We know that Kublai Khan had constituted a young prince of the Lama Church, Mati Dhwaja, as head of that body, and tributary ruler of Tibet, but besides this all is obscure for a century. This passage of Odoric shows that such authority continued under Kublai's descendants, and that some foreshadow of the position since occupied by the Dalai Lama already existed. But it was not till a century after Odoric that the strange heredity of the dynasty of the Dalai Lamas of Lhasa actually began. In the first two centuries of its existence the residence of these pontiffs was rather at Debung or Sera than at Lhasa itself, though the latter was the centre of devout resort. A great event for Lhasa was the conversion, or reconversion, of the Mongols to Lamaism (*c.* 1577), which made the city the focus of sanctity and pilgrimage to so vast a tract of Asia. It was in the middle of the 17th century that Lhasa became the residence of the Dalai Lama. A native prince, known as the Tsangpo, with his seat at Shigatse, had made himself master of southern Tibet, and threatened to absorb the whole. The fifth Dalai Lama, Nagwang Lobzang, called in the aid of a Kalmuck prince, Gushi Khan, from the neighbourhood of the Koko-nor, who defeated and slew the Tsangpo and made over full dominion in Tibet to the lama (1641). The latter now first established his court and built his palace on the rock-site of the fortress of the ancient monarchy, which apparently had fallen into ruin, and to this he gave the name of Potala.

The founder of Potala died in 1681. He had appointed as "regent" or civil administrator (*Deisri*, or *Deba*) one supposed to be his own natural son. This remarkable personage, Sangye Gyamtso, of great ambition and accomplishment, still renowned in Tibet as the author of some of the most valued works of the native literature, concealed the death of his master, asserting that the latter had retired, in mystic meditation or trance, to the upper chambers of the palace. The government continued to be carried on in the lama's name by the regent, who leagued with Galdan Khan of Dzungaria against the Chinese (Manchu) power. It was not till the great emperor Kang-hi was marching on Tibet that the death of the lama, sixteen years before, was admitted. A solemn funeral was then performed, at which 108,000 lamas assisted, and a new incarnation was set up in the person of a youth of fifteen, Tsangs-yang Gyamtso. This young man was the scandal of the Lamaist Church in every kind of evil living and debauchery, so that he was deposed and assassinated in 1701. But it was under him and the regent Sangye Gyamtso that the Potala palace attained its present scale of grandeur, and that most of the other great buildings of Lhasa were extended and embellished.

For further history and bibliography, see [TIBET](#). Consult also [LAMAISM](#).

(H. Y.; L. A. W.)

- 1 The name given by Köppen (*Die lamaische Kirche*, Berlin, 1859, p. 74) is "La Brang," by which it is sometimes known.
- 2 Among articles sold in the Lhasa bazaars are fossil bones, called by the people "lightning bones," and believed to have healing virtues.



**L'HÔPITAL** (or L'HOSPITAL), **MICHEL DE** (c. 1505-1573), French statesman, was born near Aigueperse in Auvergne (now Puy-de-Dôme). His father, who was physician to the constable Charles of Bourbon, sent him to study at Toulouse, whence at the age of eighteen he was driven, a consequence of the evil fortunes of the family patron, to Padua, where he studied law and letters for about six years. On the completion of his studies he joined his father at Bologna, and afterwards, the constable having died, went to Rome in the suite of Charles V. For some time he held a position in the papal court at Rome, but about 1534 he returned to France, and becoming an advocate, his marriage, in 1537, procured for him the post of counsellor to the parlement of Paris. This office he held until 1547, when he was sent by Henry II. on a mission to Bologna, where the council of Trent was at that time sitting; after sixteen months of wearisome inactivity there, he was by his own desire recalled at the close of 1548. L'Hôpital now for some time held the position of chancellor to the king's sister, Margaret, duchess of Berry. In 1553, on the recommendation of the Cardinal of Lorraine, he was named master of the requests, and afterwards president of the chambre des comptes. In 1559 he accompanied the princess Margaret, now duchess of Savoy, to Nice, where, in the following year, tidings reached him that he had been chosen to succeed François Olivier (1487-1560) in the chancellorship of France.

533

One of his first acts after entering on the duties of his office was to cause the parlement of Paris to register the edict of Romorantin, of which he is sometimes, but erroneously, said to have been the author. Designed to protect heretics from the secret and summary methods of the Inquisition, it certainly had his sympathy and approval. In accordance with the consistent policy of inclusion and toleration by which the whole of his official life was characterized, he induced the council to call the assembly of notables, which met at Fontainebleau in August 1560 and agreed that the States General should be summoned, all proceedings against heretics being meanwhile suppressed, pending the reformation of the church by a general or national council. The States General met in December; the edict of Orleans (January 1561) followed, and finally, after the colloquy of Poissy, the edict of January 1562, the most liberal, except that of Nantes, ever obtained by the Protestants of France. Its terms, however, were not carried out, and during the war which was the inevitable result of the massacre of Vassy in March, L'Hôpital, whose dismissal had been for some time urged by the papal legate Hippolytus of Este, found it necessary to retire to his estate at Vignay, near Étampes, whence he did not return until after the pacification of Amboise (March 19, 1563). It was by his advice that Charles IX. was declared of age at Rouen in August 1563, a measure which really increased the power of Catherine de' Medici; and it was under his influence also that the royal council in 1564 refused to authorize the publication of the acts of the council of Trent, on account of their inconsistency with the Gallican liberties. In 1564-1566 he accompanied the young king on an extended tour through France; and in 1566 he was instrumental in the promulgation of an important edict for the reform of abuses in the administration of justice. The renewal of the religious war in September 1567, however, was at once a symptom and a cause of diminished influence to L'Hôpital, and in February 1568 he obtained his letters of discharge, which were registered by the parlement on the 11th of May, his titles, honours and emoluments being reserved to him during the remainder of his life. Henceforward he lived a life of unbroken seclusion at Vignay, his only subsequent public appearance being by means of a *mémoire* which he addressed to the king in 1570 under the title *Le But de la guerre et de la paix, ou discours du chancelier l'Hospital pour exhorter Charles IX. à donner la paix à ses sujets*. Though not exempt from considerable danger, he passed in safety through the troubles of St Bartholomew's eve. His death took place either at Vignay or at Bellébat on the 13th of March 1573.

After his death Pibrac, assisted by De Thou and Scévole de Sainte-Marthe, collected a volume of the *Poemata* of L'Hôpital, and in 1585 his grandson published *Epistolarum seu Sermonum libri sex*. The complete *Œuvres de l'Hôpital* were published for the first time by P. J. S. Dufey (5 vols., Paris, 1824-1825). They include his "Harangues" and "Remonstrances," the *Epistles*, the *Mémoire* to Charles IX., a *Traité de la réformation de la justice*, and his will. See also A. F. Villemain, *Vie du Chancelier de l'Hôpital* (Paris, 1874); R. G. E. T. St-René Taillandier, *Le Chancelier de l'Hospital* (Paris, 1861); Dupré-Lasalle, *Michel de l'Hospital avant son élévation au poste de chancelier de France* (Paris, 1875-1899); Amphoux, *Michel de l'Hospital et la liberté de conscience au XVI<sup>e</sup> siècle* (Paris, 1900); C. T. Atkinson, *Michel de l'Hospital* (London, 1900), containing an appendix on bibliography and sources; A. E. Shaw, *Michel de l'Hospital and his Policy* (London, 1905); and Eugène and Emile Haag, *La France protestante* (2nd ed., 1877 seq.).



**LIAO-YANG**, a city of China, formerly the chief town of the province of Liao-tung or Shêng-king (southern Manchuria), 35 m. S of Mukden. It is situated in a rich cotton district in the fertile valley of the Liao, on the road between Niuchwang and Mukden, and carries on a considerable trade. The walls include an area about 2½ m. long by 2 m. broad, and there are fairly extensive suburbs; but a good deal even of the enclosed area is under cultivation. The population is estimated at 100,000. Liao-yang was one of the first objectives of the Japanese during the Russo-Japanese War, and its capture by them resulted in some of the fiercest fighting during the campaign, from the 24th of August to the 4th of September 1904.



**LIAS**, in geology, the lowermost group of Jurassic strata. Originally the name seems to have been written "Lyas"; it is most probably a provincial form of "layers," strata, employed by quarrymen in the west of England; it has been suggested, however, that the Fr. *liais*, Breton *leach* = a stone, Gaelic *leac* = flat stone, may have given rise to the English "Lias." Liassic strata occupy an important position in England, where they crop out at Lyme Regis on the Dorsetshire coast and extend thence by Bath, along the western flank of the Cotswold Hills, forming Edge Hill and appearing at Banbury, Rugby, Melton, Grantham, Lincoln, and Redcar on the coast of Yorkshire. They occur also in Glamorganshire, Shropshire, near Carlisle, in Skye, Raasay (Pabba, Scalpa and Broadfoot beds), and elsewhere in the north of Scotland, and in the north-east of Ireland. East of the belt of outcrop indicated, the Lias is known to occur beneath the younger rocks for some distance farther east, but it is absent from beneath London, Reading, Ware, Harwich, Dover, and in the southern portion of the area in which these towns lie; the Liassic rocks are probably thinned out against a concealed ridge of more ancient rocks. The table on following page will serve to illustrate the general characters of the English Lias and the subdivisions adopted by the Geological Survey. By the side are shown the principal zonal ammonites, and, for comparison, the subdivisions preferred by Messrs Tate and Blake and by A. de Lapparent.

The important fact is clearly demonstrated in the table, that where the Lias is seen in contact with the Trias below or the Inferior Oolite above, there is, as a rule, a gradual passage from the Liassic formation, both downwards and upwards; hence Professor de Lapparent includes in his *Liassique System* the zone of *Ammonites opalinus* at the top, and the Rhaetic beds at the bottom (see [OOLITE](#); [RHAETIC](#)). Owing to the transgression of the Liassic sea the strata rest in places upon older Palaeozoic rocks. The thickness of the Lias varies considerably; in Dorsetshire it is 900 ft., near Bath it has thinned to 280 ft., and beneath Oxford it is further reduced. In north Gloucestershire it is 1360 ft., Northampton 760 ft., Rutland 800 ft., Lincolnshire 950 ft., and in Yorkshire about 500 ft.

The Lias of England was laid down in conditions very similar to those which obtained at the same time in north France and north Germany, that is to say, on the floor of a shallow sea; but in the Alpine region limestones are developed upon a much greater scale. Many of the limestones are red and crystalline marbles such as the "ammonitico-rosso-inferiore" of the Apennines; a grey, laminated limestone is known as the "Fleckenmergel." The whitish "Hierlatzkalke," the Adnet beds and the "Grestener beds" in the eastern Alps and Balkan Mountains are important phases of Alpine Lias. The Grestener beds contain a considerable amount of coal. The Lias of Spain and the Pyrenees contains much dolomitic limestone. This formation is widely spread in western Europe; besides the localities already cited it occurs in Swabia, the Rhenish provinces, Alsace-Lorraine, Luxemburg, Ardennes, Normandy, Austria-Hungary, the Balkan States, Greece and Scania. It has not been found north of Kharkov in Russia, but it is present in the south and in the Caucasus, in Anatolia, Persia and the Himalayas. It appears on the eastern side of Japan, in Borneo, Timor, New Caledonia and New Zealand (Bastion beds); in Algeria, Tunisia and elsewhere in North Africa, and on the west coast of Madagascar. In South America it is found in the Bolivian Andes, in Chile and Argentina; it appears also on the Pacific coast of North America.

	S. W. England and Midlands.	Yorkshire.	Ammonite Zones.*	Divisions according to A. de Lapparent.**
Upper Lias.	Midford Sands (passage beds)	Alum shale	<i>Am. jurensis</i>	U. (Including the <i>opalinus</i> zone of the Inferior Oolite.) Toarcien.
	Clays with Cement-stones Limestones and Clays	Jet Rock Grey Shale	<i>Am. communis</i> <i>Am. serpentinus</i> <i>Am. annulatus</i>	
Middle Lias.	Marlstone and Sands (Rock Bed and Ironstones)	Ironstone Series	<i>Am. spinatus</i>	M. Charmouthien.
	Micaceous Clays and Sands	Sandy Series	<i>Am. margaritatus</i> <i>Am. capricornus</i> <i>Am. Jamesoni</i> and <i>Am. armatus</i>	
Lower Lias.	Clays with occasional bands of Limestone	Upper Series with Ironstone nodules	<i>Am. oxynotus</i> <i>Am. Bucklandi</i> <i>Am. angulatus</i> <i>Am. planorbis</i>	L. Sinémourien. Hettangien including "White Lias."
	Limestones and Clays	Lower Series with Sandy and Marly Beds		
				Rhétien.

\* The brackets indicate the divisions made by R. Tate and J. F. Blake.

\*\* *Traité de géologie* (5th ed., Paris, 1906).

The economic products of the Lias are of considerable importance. In the Lower Lias of Lincolnshire and the Middle Lias of Oxfordshire, Northamptonshire, Lincolnshire, Leicestershire and Yorkshire the beds of ironstone are of great value. Most of these ores are limestones that have been converted into iron carbonate with some admixture of silicates; they weather near the surface into hydrated peroxide. At Frodingham in Lincolnshire the oolitic iron ore reaches 30 ft. in thickness, of which 12 ft. are workable. In Gloucestershire the top beds of the Lower Lias and lower beds of the Middle division are the most ferruginous; the best ores near Woodstock and Banbury and between Market Harborough and Leicester are at the summit of the Middle Lias in the Marlstone or Rock bed. The ironstone of Fawler is sometimes known as Blenheim ore. The ores of the Cleveland district in Yorkshire have a great reputation; the main seam is 11 ft. thick at Eston, where it rests directly upon the Pecten Seam, the two together aggregating 15 ft. 6 in. Similar iron ores of this age are worked at Meurthe-et-Moselle, Villerupt, Marbache, Longuy, Champagneulles, &c. Some of the Liassic limestones are used as building stones, the more important ones being the Lower Lias Sutton stone of Glamorganshire and Middle Lias Hornton stone, the best of the Lias building stones, from Edge Hill. The limestones are often used for paving. The limestones of the Lower Lias are much used for the production of hydraulic cement and "Blue Lias" lime at Rugby, Barrow-on-Soar, Barnstone, Lyme Regis, Abertham and many other places. Roman cement has been made from the nodules

in the Upper Lias of Yorkshire; alum is obtained from the same horizon. A considerable trade was formerly done in jet, the best quality being obtained from the "Serpentinus" beds, but "bastard" or soft jet is found in many of the other strata in the Yorkshire Lias. Both Lower and Upper Lias clays have been used in making bricks and tiles.

Fossils are abundant in the Lias; Lyme Regis, Shepton Mallet, Rugby, Robin Hood's Bay, Ilminster, Whitby and Golden Cap near Charmouth are well-known localities. The saurian reptiles, *Ichthyosaurus* and *Plesiosaurus*, are found in excellent preservation along with the Pterodactyl. Among the fishes are *Hybodus*, *Dapedius*, *Pholidophorus*, *Acrodus*. The crinoids, *Pentacrinus* and *Extracrinus* are locally abundant. Insect remains are very abundant in certain beds. Many ammonites occur in this formation in addition to the forms used as zonal indexes mentioned in the table. *Lima gigantea*, *Posidonomya Bronni*, *Inoceramus dubius*, *Gryphaea cymbium* and *G. arcuata* are common pelecypods. *Amberleya capitanea*, *Pleurotomaria anglica* are Lias gasteropods. *Leptaena*, *Spiriferina*, *Terebratella* and *Rhynchonella tetrahedra* and *R. variabilis* are among the brachiopods.

Certain dark limestones with regular bedding which occur in the Carboniferous System are sometimes called "Black Lias" by quarrymen.

See "The Lias of England and Wales" (Yorkshire excepted), by H. B. Woodward, *Geol. Survey Memoir* (London, 1893); and, for Yorkshire, "The Jurassic Rocks of Britain," vol. i., "Yorkshire," by C. Fox-Strangways, *Geol. Survey Memoir*. See also [JURASSIC](#).

(J. A. H.)



**LIBANIUS** (A.D. 314-393), Greek sophist and rhetorician, was born at Antioch, the capital of Syria. He studied at Athens, and spent most of his earlier manhood in Constantinople and Nicomedia. His private classes at Constantinople were much more popular than those of the public professors, who had him expelled in 346 (or earlier) on the charge of studying magic. He removed his school to Nicomedia, where he remained five years. After another attempt to settle in Constantinople, he finally retired to Antioch (354). Though a pagan, he enjoyed the favour of the Christian emperors. When Julian, his special patron, restored paganism as the state religion, Libanius showed no intolerance. Among his pupils he numbered John Chrysostom, Basil (bishop of Caesarea) and Ammianus Marcellinus. His works, consisting chiefly of orations (including his autobiography), declamations on set topics, letters, life of Demosthenes, and arguments to all his orations are voluminous. He devoted much time to the classical Greek writers, and had a thorough contempt for Rome and all things Roman. His speeches and letters throw considerable light on the political and literary history of the age. The letters number 1607 in the Greek original; with these were formerly included some 400 in Latin, purporting to be a translation, but now proved to be a forgery by the Italian humanist F. Zambeccari (15th century).

Editions: Orations and declamations, J. J. Reiske (1791-1797); letters, J. C. Wolf (1738); two additional declamations, R. Förster (*Hermes*, ix. 22, xii. 217), who in 1903 began the publication of a complete edition; *Apologia Socratis*, Y. H. Rogge (1891). See also E. Monnier, *Histoire de Libanius* (1866); L. Petit, *Essai sur la vie et la correspondance du sophiste Libanius* (1866); G. R. Sievers, *Das Leben des Libanius* (1868); R. Förster, *F. Zambeccari und die Briefe des Libanius* (1878). Some letters from the emperor Julian to Libanius will be found in R. Hercher, *Epistolographi Graeci* (1873). Sixteen letters to Julian have been translated by J. Duncombe (*The Works of the Emperor Julian*, i. 303-332, 3rd ed., London, 1798). The oration on the emperor Julian is translated by C. W. King (in Bohn's "Classical Library," London, 1888), and that in Defence of the Temples of the Heathen by Dr Lardner (in a volume of translations by Thomas Taylor, from Celsus and others, 1830). See further J. E. Sandys, *Hist. of Classical Scholarship*, i. (1906), and A. Harrent, *Les Écoles d'Antioche* (1898).



**LIBATION** (Lat. *libatio*, from *libare*, to take a portion of something, to taste, hence to pour out as an offering to a deity, &c.; cf. Gr. λιβέειν), a drink offering, the pouring out of a small quantity of wine, milk or other liquid as a ceremonial act. Such an act was performed in honour of the dead (Gr. χοαί, Lat. *profusiones*), in making of treaties (Gr. σπονδή, σπένδειν = *libare*, whence σπονδαί, treaty), and particularly in honour of the gods (Gr. λοιβή, Lat. *libatio*, *libamentum*, *libamen*). Such libations to the gods were made as part of the daily ritual of domestic worship, or at banquets or feasts to the Lares, or to special deities, as by the Greeks to Hermes, the god of sleep, when going to rest.



**LIBAU** (Lettish, *Leepaya*), a seaport of Russia, in the government of Courland, 145 m. by rail S.W. of Riga, at the northern extremity of a narrow sandy peninsula which separates Lake Libau (12 m. long and 2 m. wide) from the Baltic Sea. Its population has more than doubled since 1881 (30,000), being 64,505 in 1897. The town is well built of stone, with good gardens, and has a naval cathedral (1903). The harbour was 2 m. S. of the town until a canal was dug through the peninsula in 1697; it is now deepened to 23 ft., and is mostly free from ice throughout the year. Since being brought, in 1872, into railway connexion with Moscow, Orel and Kharkov, Libau has become an important port. New Libau possesses large factories for colours, explosives, machinery



belts, sails and ropes, tobacco, furniture, matches, as well as iron works, agricultural machinery works, tin-plate works, soap works, saw-mills, breweries, oil-mills, cork and linoleum factories and flour-mills. The exports reach the annual value of £3,250,000 to £5,500,000, oats being the chief export, with flour, wheat, rye, butter, eggs, spirits, flax, linseed, oilcake, pork, timber, horses and petroleum. The imports average £1,500,000 to £2,000,000 annually. Shipbuilding, including steamers for open-sea navigation, is on the increase. North of the commercial harbour and enclosing it the Russian government made (1893-1906) a very extensive fortified naval port, protected by moles and breakwaters. Libau is visited for sea-bathing in summer.

The port of Libau, *Lyra portus*, is mentioned as early as 1263; it then belonged to the Livonian Order or Brothers of the Sword. In 1418 it was burnt by the Lithuanians, and in 1560 it was mortgaged by the grandmaster of the Teutonic Order, to which it had passed, to the Prussian duke Albert. In 1701 it was captured by Charles XII. of Sweden, and was annexed to Russia in 1795.

See Wegner, *Geschichte der Stadt Libau* (Libau, 1898).



**LIBEL** and **SLANDER**, the terms employed in English law to denote injurious attacks upon a man's reputation or character by words written or spoken, or by equivalent signs. In most early systems of law verbal injuries are treated as a criminal or quasi-criminal offence, the essence of the injury lying not in pecuniary loss, which may be compensated by damages, but in the personal insult which must be atoned for—a vindictive penalty coming in the place of personal revenge. By the law of the XII. Tables, the composition of scurrilous songs and gross noisy public affronts were punished by death. Minor offences of the same class seem to have found their place under the general conception of *injuria*, which included ultimately every form of direct personal aggression which involved contumely or insult. In the later Roman jurisprudence, which has, on this point, exercised considerable influence over modern systems of law, verbal injuries are dealt with in the edict under two heads. The first comprehended defamatory and injurious statements made in a public manner (*convicium contra bonos mores*). In this case the essence of the offence lay in the unwarrantable public proclamation. In such a case the truth of the statements was no justification for the unnecessarily public and insulting manner in which they had been made. The second head included defamatory statements made in private, and in this case the offence lay in the imputation itself, not in the manner of its publication. The truth was therefore a sufficient defence, for no man had a right to demand legal protection for a false reputation. Even belief in the truth was enough, because it took away the intention which was essential to the notion of *injuria*. The law thus aimed at giving sufficient scope for the discussion of a man's character, while it protected him from needless insult and pain. The remedy for verbal injuries was long confined to a civil action for a money penalty, which was estimated according to the gravity of the case, and which, although vindictive in its character, doubtless included practically the element of compensation. But a new remedy was introduced with the extension of the criminal law, under which many kinds of defamation were punished with great severity. At the same time increased importance attached to the publication of defamatory books and writings, the *libri* or *libelli famosi*, from which we derive our modern use of the word libel; and under the later emperors the latter term came to be specially applied to anonymous accusations or pasquils, the dissemination of which was regarded as peculiarly dangerous, and visited with very severe punishment, whether the matter contained in them were true or false.

The earlier history of the English law of defamation is somewhat obscure. Civil actions for damages seem to have been tolerably frequent so far back as the reign of Edward I. There was no distinction drawn between words written and spoken. When no pecuniary penalty was involved such cases fell within the old jurisdiction of the ecclesiastical courts, which was only finally abolished in the 19th century. It seems, to say the least, uncertain whether any generally applicable criminal process was in use. The crime of *scandalum magnatum*, spreading false reports about the magnates of the realm, was established by statutes, but the first fully reported case in which libel is affirmed generally to be punishable at common law is one tried in the star chamber in the reign of James I. In that case no English authorities are cited except a previous case of the same nature before the same tribunal; the law and terminology appear to be taken directly from Roman sources, with the insertion that libels tended to a breach of the peace; and it seems probable that that not very scrupulous tribunal had simply found it convenient to adopt the very stringent Roman provisions regarding the *libelli famosi* without paying any regard to the Roman limitations. From that time we find both the criminal and civil remedies in full operation, and the law with regard to each at the present time may now be considered.

*Civil Law.*—The first important distinction encountered is that between slander and libel, between the oral and written promulgation of defamatory statements. In the former case the remedy is limited. The law will not take notice of every kind of abusive or defamatory language. It must be shown either that the plaintiff has suffered actual damage as a direct consequence of the slander, or that the imputation is of such a nature that we are entitled to infer damage as a necessary consequence. The special damage on which an action is founded for slanderous words must be of the nature of pecuniary loss. Loss of reputation or of position in society, or even illness, however clearly it may be traced to the slander, is insufficient. When we cannot prove special damage, the action for slander is only allowed upon certain strictly defined grounds. These are the imputation of a crime or misdemeanour which is punishable corporeally, *e.g.* by imprisonment; the imputation of a contagious or infectious disease; statements which tend to the disherison of an apparent heir (other cases of slander of title when the party is in possession requiring the allegation of special damage); the accusing a woman of unchastity (Slander of Women Act 1891); and, lastly, slanders directed against a man's professional or business character, which tend directly to prejudice him in his trade, profession, or means of livelihood. In the latter case the words must either be directly aimed at a man in his business or official character, or they must be such as necessarily to imply unfitness for his particular office or occupation. Thus words which merely reflect generally upon the moral character of a tradesman or professional man are not actionable, but they are actionable if directed against his dealings in the course of his trade or profession. But, in the case of a merchant or trader, an

allegation which affects his credit generally is enough, and it has been held that statements are actionable which affect the ability or moral characters of persons who hold offices, or exercise occupation which require a high degree of ability, or infer peculiar confidence. In every case the plaintiff must have been at the time of the slander in the actual exercise of the occupation or enjoyment of the office with reference to which the slander is supposed to have affected him.

The action for libel is not restricted in the same way as that for slander. Originally there appears to have been no essential distinction between them, but the establishment of libel as a criminal offence had probably considerable influence, and it soon became settled that written defamatory statements, or pictures and other signs which bore a defamatory meaning, implied greater malice and deliberation, and were generally fraught with greater injury than those made by word of mouth. The result has been that the action for libel is not limited to special grounds, or by the necessity of proving special damage. It may be founded on any statement which disparages a man's private or professional character, or which tends to hold him up to hatred, contempt or ridicule. In one of the leading cases, for example, the plaintiff obtained damages because it was said of him that he was a hypocrite, and had used the cloak of religion for unworthy purposes. In another case a charge of ingratitude was held sufficient. In civil cases the libel must be published by being brought by the defendant under the notice of a third party; it has been held that it is sufficient if this has been done by gross carelessness, without deliberate intention to publish. Every person is liable to an action who is concerned in the publication of a libel, whether he be the author, printer or publisher; and the extent and manner of the publication, although not affecting the ground of the action, is a material element in estimating the damages.

536

It is not necessary that the defamatory character of the words or writing complained of should be apparent on their face. They may be couched in the form of an insinuation, or may derive their sting from a reference to circumstances understood by the persons to whom they are addressed. In such a case the plaintiff must make the injurious sense clear by an averment called an innuendo, and it is for the jury to say whether the words bore the meaning thus ascribed to them.

In all civil actions for slander and libel the falsity of the injurious statements is an essential element, so that the defendant is always entitled to justify his statements by their truth; but when the statements are in themselves defamatory, their falsity is presumed, and the burden of proving their truth is laid upon the defendant. There are however a large class of false defamatory statements, commonly called privileged, which are not actionable on account of the particular circumstances in which they are made. The general theory of law with regard to these cases is this. It is assumed that in every case of defamation intention is a necessary element; but in the ordinary case, when a statement is false and defamatory, the law presumes that it has been made or published with an evil intent, and will not allow this presumption to be rebutted by evidence or submitted as matter of fact to a jury. But there are certain circumstances in which the natural presumption is quite the other way. There are certain natural and proper occasions on which statements may be made which are in themselves defamatory, and which may be false, but which naturally suggest that the statements may have been made from a perfectly proper motive and with entire belief in their truth. In the cases of this kind which are recognized by law, the presumption is reversed. It lies with the plaintiff to show that the defendant was actuated by what is called *express malice*, by an intention to do harm, and in this case the question is not one of legal inference for the court, but a matter of fact to be decided by the jury. Although, however, the theory of the law seems to rest entirely upon natural presumption of intention, it is pretty clear that in determining the limits of privilege the courts have been almost wholly guided by considerations of public or general expediency.

In some cases the privilege is absolute, so that we cannot have an action for defamation even although we prove express malice. Thus no action of this kind can be maintained for statements made in judicial proceedings if they are in any sense relevant to the matter in hand. In the same way no statements or publications are actionable which are made in the ordinary course of parliamentary proceedings. Papers published under the authority of parliament are protected by a special act, 3 & 4 Vict. c. 9, 1840, which was passed after a decree of the law courts adverse to the privilege claimed. The reports of judicial and parliamentary proceedings stand in a somewhat different position, which has only been attained after a long and interesting conflict. The general rule now is that all reports of parliamentary or judicial proceedings are privileged in so far as they are honest and impartial. Even *ex parte* proceedings, in so far as they take place in public, now fall within the same rule. But if the report is garbled, or if part of it only is published, the party who is injured in consequence is entitled to maintain an action, and to have the question of malice submitted to a jury.

Both absolute and qualified privilege are given to newspaper reports under certain conditions by the Law of Libel Amendment Act 1888. The reports must, however, be published in a newspaper as defined in the Newspaper Libel and Registration Act 1881. Under this act a newspaper must be published "at intervals not exceeding twenty-six days."

By s. 3 of the act of 1888 fair and accurate reports of judicial proceedings are absolutely privileged provided that the report is published contemporaneously with the proceedings and no blasphemous or indecent matter is contained therein. By s. 4 a limited privilege is given to fair and accurate reports (1) of the proceedings of a *bona fide* public meeting lawfully held for a lawful purpose and for the furtherance and discussion of any matter of public concern, even when the admission thereto is restricted; (2) of any meeting, open either to the public or to a reporter, of a vestry, town council, school board, board of guardians, board of local authority, formed or constituted under the provisions of any act of parliament, or of any committee appointed by any of these bodies; or of any meeting of any commissioners authorized to act by letters patent, act of parliament, warrant under royal sign manual, or other lawful warrant or authority, select committees of either House of parliament, justices of the peace in quarter sessions assembled for administrative or deliberative purposes; (3) of the publication of any notice or report issued for the information of the public by any government office or department, officer of state, commissioner of police or chief constable, and published at their request. But the privilege given in s. 4 does not authorize the publication of any blasphemous or indecent matter; nor is the protection available as a defence if it be proved that the reports or notices were published maliciously, in the legal sense of the word, or the defendant has been requested to insert in the newspaper in which the report was issued a reasonable letter or statement by way of contradiction or explanation, and has refused or neglected to do so. Moreover, nothing in s. 4 is to interfere with any privilege then existing, or to protect the publication of any matter not of public concern, or in cases where publication is not for the public benefit. Consequently no criminal prosecution should be commenced where the interests of the public are not affected. By the Law of Libel Amendment Act 1888, s. 8, no criminal prosecution for libel is to be commenced against any newspaper proprietor, publisher or editor

unless the order of a judge at chambers has been first obtained. This protection does not cover the actual writer of the alleged libel.

In private life a large number of statements are privileged so long as they remain matters of strictly private communication. It is difficult to define the limits of private privilege without extensive reference to concrete cases; but generally it may be said that it includes all communications made in performance of a duty not merely legal but moral or social, answers to *bona fide* inquiries, communications made by persons in confidential relations regarding matters in which one or both are interested, and even statements made within proper limits by persons in the *bona fide* prosecution of their own interest. Common examples of this kind of privilege are to be found in answer to inquiries as to the character of servants or the solvency of a trader, warnings to a friend, communications between persons who are jointly interested in some matters of business. But in every case care must be taken not to exceed the limits of publication required by the occasion, or otherwise the privilege is lost. Thus defamatory statements may be privileged when made to a meeting of shareholders, but not when published to others who have no immediate concern in the business.

In a few instances in which an action cannot be maintained even by the averment of malice, the plaintiff may maintain an action by averring not only malice but also want of reasonable and probable cause. The most common instances of this kind are malicious charges made in the ordinary course of justice and malicious prosecutions. In such cases it would be contrary to public policy to punish or prevent every charge which was made from a purely malicious motive, but there is no reason for protecting accusations which are not only malicious, but destitute of all reasonable probability.

*Criminal Law.*—Publications which are blasphemous, immoral or seditious are frequently termed libels, and are punishable both at common law and by various statutes. The matter, however, which constitutes the offence in these publications lies beyond our present scope. Libels upon individuals may be prosecuted by criminal information or indictment, but there can be no criminal prosecution for slander. So far as concerns the definition of libel, and its limitation by the necessity of proving in certain cases express malice, there is no substantial difference between the rules which apply to criminal prosecutions and to civil actions, with the one important exception (now considerably modified) that the falsity of a libel is not in criminal law an essential element of the offence. If the matter alleged were in itself defamatory, the court would not permit inquiry into its truth. The sweeping application of this rule seems chiefly due to the indiscriminate use, in earlier cases, of a rule in Roman law which was only applicable to certain modes of publication, but has been supported by various reasons of general policy, and especially by the view that one main reason for punishing a libel was its tendency to provoke a breach of the peace.

537

An important dispute about the powers of the jury in cases of libel arose during the 19th century in connexion with some well-known trials for seditious libels. The point is familiar to readers of Macaulay in connexion with the trial of the seven bishops, but the cases in which it was brought most prominently forward, and which led to its final settlement, were those against Woodfall (the printer of *Junius*), Wilkes and others, and especially the case against Shipley, the dean of St Asaph (21 St. Tr. 925), in which the question was fought by Lord Erskine with extraordinary energy and ability. The controversy turned upon the question whether the jury were to be strictly confined to matters of fact which required to be proved by evidence, or whether in every case they were entitled to form their own opinion upon the libellous character of the publication and the intention of the author. The jury, if they pleased, had it in their power to return a general verdict of guilty or not guilty, but both in theory and practice they were subject in law to the directions of the court, and had to be informed by it as to what they were to take into consideration in determining upon their verdict. There is no difficulty about the general application of this principle in criminal trials. If the crime is one which is inferred by law from certain facts, the jury are only concerned with these facts, and must accept the construction put upon them by law. Applying these principles to the case of libel, juries were directed that it was for the court to determine whether the publication fell within the definition of libel, and whether the case was one in which malice was to be inferred by construction of law. If the case were one in which malice was inferred by law, the only facts left to the jury were the fact of publication and the meaning averred by innuendoes; they could not go into the question of intention, unless the case were one of privilege, in which express malice had to be proved. In general principle, therefore, the decisions of the court were in accordance with the ordinary principles of criminal law. But there were undoubtedly some peculiarities in the case of libel. The sense of words, the inferences to be drawn from them, and the effect which they produce are not so easily defined as gross matters of fact. They seem to belong to those cases in which the impression made upon a jury is more to be trusted than the decision of a judge. Further, owing to the mode of procedure, the defendant was often punished before the question of law was determined. But, nevertheless, the question would scarcely have been raised had the libels related merely to private matters. The real ground of dispute was the liberty to be accorded to political discussion. Had the judges taken as wide a view of privilege in discussing matters of public interest as they do now, the question could scarcely have arisen; for Erskine's whole contention really amounted to this, that the jury were entitled to take into consideration the good or bad intent of the authors, which is precisely the question which would now be put before them in any matter which concerned the public. But at that time the notion of a special privilege attaching to political discussion had scarcely arisen, or was confined within very narrow limits, and the cause of free political discussion seemed to be more safely entrusted to juries than to courts. The question was finally settled by the Libel Act 1792, by which the jury were entitled to give a general verdict on the whole matter put in issue.

*Scots Law.*—In Scots law there were originally three remedies for defamation. It might be prosecuted by or with the concurrence of the lord advocate before the court of justiciary; or, secondly, a criminal remedy might be obtained in the commissary (ecclesiastical) courts, which originally dealt with the defender by public retraction or penance, but subsequently made use of fines payable to their own procurator or to the party injured, these latter being regarded as solatium to his feelings; or, lastly, an action of damages was competent before the court of session, which was strictly civil in its character and aimed at the reparation of patrimonial loss. The first remedy has fallen into disuse; the second and third (the commissary courts being now abolished) are represented by the present action for damages or solatium. Originally the action before the court of session was strictly for damages—founded, not upon the *animus injuriandi*, but upon culpa, and could be defended by proving the truth of the statements. But in time the court of session began to assume the original jurisdiction of the commissary courts, and entertained actions for solatium in which the *animus injuriandi* was a necessary element, and to which, as in Roman law, the truth was not necessarily a defence. Ultimately the two actions got very much

confused. We find continual disputes as to the necessity for the *animus injuriandi* and the applicability of the plea of *veritas convicii*, which arose from the fact that the courts were not always conscious that they were dealing with two actions, to one of which these notions were applicable, and to the other not. On the introduction of the jury court, presided over by an English lawyer, it was quite natural that he, finding no very clear distinction maintained between damage and solatium, applied the English plea of truth as a justification to every case, and retained the *animus injuriandi* both in ordinary cases and cases of privilege in the same shape as the English conception of malice. The leading and almost only differences between the English and Scots law now are that the latter makes no essential distinction between oral and written defamation, that it practically gives an action for every case of defamation, oral or written, upon which in England a civil action might be maintained for libel, and that it possesses no criminal remedy. In consequence of the latter defect and the indiscriminate application of the plea of *veritas* to every case both of damages and solatium, there appears to be no remedy in Scotland even for the widest and most needless publication of offensive statements if only they are true.

*American Law.*—American law scarcely if at all differs from that of England. In so far indeed as the common law is concerned, they may be said to be substantially identical. The principal statutes which have altered the English criminal law are represented by equivalent legislation in most American states.

See generally W. B. Odgers, *Libel and Slander*; Fraser, *Law of Libel and Slander*.



**LIBELLATICI**, the name given to a class of persons who, during the persecution of Decius, A.D. 250, evaded the consequences of their Christian belief by procuring documents (*libelli*) which certified that they had satisfied the authorities of their submission to the edict requiring them to offer incense or sacrifice to the imperial gods. As thirty-eight years had elapsed since the last period of persecution, the churches had become in many ways lax, and the number of those who failed to hold out under the persecution was very great. The procedure of the courts which had cognizance of the matter was, however, by no means strict, and the judges and subordinate officials were often not ill-disposed towards Christians, so that evasion was fairly easy. Many of those who could not hold out were able to secure certificates which gave them immunity from punishment without actually renouncing the faith, just as "parliamentary certificates" of conformity used to be given in England without any pretext of fact. It is to the persons who received such certificates that the name *libellatici* belonged (those who actually fulfilled the edict being called *thurificati* or *sacrificati*). To calculate their number would be impossible, but we know from the writings of Cyprian, Dionysius of Alexandria and other contemporaries, that they were a numerous class, and that they were to be found in Italy, in Egypt and in Africa, and among both clergy and laity. Archbishop Benson is probably right in thinking that "there was no systematic and regular procedure in the matter," and that the *libelli* may have been of very different kinds. They must, however, as a general rule, have consisted of a certificate *from the authorities* to the effect that the accused person had satisfied them. [The name *libellus* has also been applied to another kind of document—to the letters given by confessors, or by those who were about to suffer martyrdom, to persons who had fallen, to be used to secure forgiveness for them from the authorities of the Church. With such *libelli* we are not here concerned.] The subject has acquired a fresh interest from the fact that two of these actual *libelli* have been recovered, in 1893 and 1894 respectively, both from Egypt; one is now in the Brugsch Pasha collection in the Berlin Museum; the other is in the collection of papyri belonging to the Archduke Rainer. The former is on a papyrus leaf about 8 by 3 in., the latter on mere fragments of papyrus which have been pieced together. The former was first deciphered and described by Dr Fritz Krebs, the latter by Dr K. Wessely: both are given and commented upon by Dr Benson. There is a remarkable similarity between them: in each the form is that N. "was ever constant in sacrificing to the gods"; and that he now, in the presence of the commissioners of the sacrifices (οἱ ἡρημέοι τῶν θυσῶν), has both sacrificed and drunk [*or has poured libations*], and has tasted of the victims, in witness whereof he begs them to sign this certificate. Then follows the signature, with attestations. The former of the two is dated, and the date must fall in the year 250. It is impossible to prove that either of the documents actually refers to Christians: they may have been given to pagans who had been accused and had cleared themselves, or to former Christians who had apostatized. But no doubt *libelli* in this same form were delivered, in Egypt at least, to Christians who secured immunity without actual apostasy; and the form in Italy and Africa probably did not differ widely from this. The practice gave rise to complicated problems of ecclesiastical discipline, which are reflected in the correspondence of Cyprian and especially in the Novatian controversy.

See E. W. Benson, *Cyprian* (London, 1897); *Theol. Literaturzeitung*, 20th of January and 17th of March 1894. (W. E. Co.)



**LIBER** and **LIBERA**, in Roman mythology, deities, male and female, identified with the Greek Dionysus and Persephone. In honour of Liber (also called Liber Pater and Bacchus) two festivals were celebrated. In the country feast of the vintage, held at the time of the gathering of the grapes, and the city festival of March 17th called *Liberalia* (Ovid, *Fasti*, iii. 711) we find purely Italian ceremonial unaffected by Greek religion. The country festival was a great merry-making, where the first-fruits of the new must were offered to the gods. It was characterized by the grossest symbolism, in honour of the fertility of nature. In the city festival, growing civilization had impressed a new character on the primitive religion, and connected it with the framework of society. At this time the youths laid aside the boy's *toga praetexta* and assumed the man's *toga libera* or *virilis* (*Fasti*, iii. 771). Cakes of meal, honey and oil were offered to the two deities at this festival. Liber was originally an old Italian god of the productivity of nature, especially of the vine. His name indicated the free, unrestrained character of his worship. When, at an early period, the Hellenic religion of Demeter spread to Rome, Liber and

Libera were identified with Dionysus and Persephone, and associated with another Italian goddess Ceres, who was identified with Demeter. By order of the Sibylline books, a temple was built to these three deities near the Circus Flaminius; the whole cultus was borrowed from the Greeks, down even to the terminology, and priestesses were brought from the Greek cities.



**LIBERAL PARTY**, in Great Britain, the name given to and accepted by the successors of the old Whig party (see **WHIG AND TORY**), representing the political party opposed to Toryism or Conservatism, and claiming to be the originators and champions of political reform and progressive legislation. The term came into general use definitely as the name of one of the two great parties in the state when Mr Gladstone became its leader, but before this it had already become current coin, as a political appellation, through a natural association with the use of such phrases as "liberal ideas," in the sense of "favourable to change," or "in support of political freedom and democracy." In this respect it was the outcome of the French Revolution, and in the early years of the 19th century the term was used in a French form; thus Southey in 1816 wrote about the "British *Liberales*." But the Reform Act and the work of Bentham and Mill resulted in the crystallization of the term. In Leigh Hunt's autobiography (1850) we read of "newer and more thorough-going Whigs ... known by the name of Radicals ... since called Liberals"; and J. S. Mill in 1865 wrote (from his own Liberal point of view), "A Liberal is he who looks forward for his principles of government; a Tory looks backward." The gradual adoption of the term for one of the great parties, superseding "Whig," was helped by the transition period of "Liberal Conservatism," describing the position of the later Peelites; and Mr Gladstone's own career is the best instance of its changing signification; moreover the adjective "liberal" came meanwhile into common use in other spheres than that of parliamentary politics, *e.g.* in religion, as meaning "intellectually advanced" and free from the trammels of tradition. Broadly speaking, the Liberal party stands for progressive legislation in accordance with freedom of social development and advanced ethical ideas. It claims to represent government by the people, by means of trust in the people, in a sense which denies genuine popular sympathy to its opponents. Being largely composed of dissenters, it has identified itself with opposition to the vested interests of the Church of England; and, being apt to be thwarted by the House of Lords, with attempts to override the veto of that house. Its old watchword, "Peace, retrenchment and reform," indicated its tendency to avoidance of a "spirited" foreign policy, and to parsimony in expenditure. But throughout its career the Liberal party has always been pushed forward by its extreme Radical wing, and economy in the spending of public money is no longer cherished by those who chiefly represent the non-taxpaying classes. The party organization lends itself to the influence of new forces. In 1861 a central organization was started in the "Liberal Registration Association," composed "of gentlemen of known Liberal opinions"; and a number of "Liberal Associations" soon rose throughout the country. Of these, that at Birmingham became, under Mr J. Chamberlain and his active supporter Mr Schnadhorst, particularly active in the 'seventies; and it was due to Mr Schnadhorst that in 1877 a conference was held at Birmingham which resulted in the formation of the "National Federation of Liberal Associations," or "National Liberal Federation," representing a system of organization which was dubbed by Lord Beaconsfield "the Caucus." The Birmingham Caucus and the Central Liberal Association thus coexisted, the first as an independent democratic institution, the second as the official body representing the whips of the party, the first more advanced and "Radical," the second inclined to Whiggishness. Friction naturally resulted, but the 1880 elections confirmed the success of the Caucus and consolidated its power. And in spite of the Home Rule crisis in 1886, resulting in the splitting off of the Liberal Unionists—"dissentient Liberals," as Mr Gladstone called them—from the Liberal party, the organization of the National Liberal Federation remained, in the dark days of the party, its main support. Its headquarters were, however, removed to London, and under Mr Schnadhorst it was practically amalgamated with the old Central Association.

It is impossible here to write in detail the later history of the Liberal party, but the salient facts will be found in such articles as those on Mr Gladstone, Mr J. Chamberlain, Lord Rosebery, Sir Henry Campbell-Bannerman, Mr H. H. Asquith and Mr David Lloyd George.

See, apart from general histories of the period, M. Ostrogorski's *Democracy and the Organization of Political Parties* (Eng. trans. 1902).



**LIBER DIURNUS ROMANORUM PONTIFICUM**, or "Journal of the Roman Pontiffs," the name given to a collection of formulae used in the papal chancery in preparing official documents, such as the installation of a pope, the bestowal of the pallium and the grant of papal privileges. It was compiled between 685 and 751, and was constantly employed until the 11th century, when, owing to the changed circumstances of the Church, it fell into disuse, and was soon forgotten and lost. During the 17th century a manuscript of the *Liber* was discovered in Rome by the humanist, Lucas Holstenius, who prepared an edition for publication; for politic reasons, however, the papal authorities would not allow this to appear, as the book asserted the superiority of a general council over the pope. It was, however, published in France by the Jesuit, Jean Garnier, in 1680, and other editions quickly followed.

The best modern editions are one by Eugène de Rozière (Paris, 1869) and another by T. E. von Sichel (Vienna, 1889), both of which contain critical introductions. The two existing manuscripts of the *Liber* are in the Vatican library, Rome, and in the library of St Ambrose at Milan.



**LIBERIA**, a negro republic in West Africa, extending along the coast of northern Guinea about 300 m., between the British colony of Sierra Leone on the N.W. and the French colony of the Ivory Coast on the S.E. The westernmost point of Liberia (at the mouth of the river Mano) lies in about 6° 55' N. and 11° 32' W. The southernmost point of Liberia, and at the same time almost its most eastern extension, is at the mouth of the Cavalla, beyond Cape Palmas, only 4° 22' N. of the equator, and in about 7° 33' W. The width of Liberia inland varies very considerably; it is greatest, about 200 m., from N.E. to S.W. The Liberia-Sierra Leone boundary was determined by a frontier commission in 1903. Commencing at the mouth of the river Mano, it follows the Mano up stream till that river cuts 10° 40' W. It then followed this line of longitude to its intersection with N. latitude 9° 6', but by the Franco-Liberian understanding of 1907 the frontier on this side was withdrawn to 8° 25' N., where the river Makona crosses 10° 40' W. The Liberian frontier with the adjacent French possessions was defined by the Franco-Liberian treaty of 1892, but as the definition therein given was found to be very difficult of reconciliation with geographical features (for in 1892 the whole of the Liberian interior was unmapped) further negotiations were set on foot. In 1905 Liberia proposed to France that the boundary line should follow the river Moa from the British frontier of Sierra Leone up stream to near the source of the Moa (or Makona), and that from this point the boundary should run eastwards along the line of water-parting between the system of the Niger on the north and that of the coast rivers (Moa, Lofa, St Paul's) on the south, until the 8th degree of N. latitude was reached, thence following this 8th degree eastwards to where it cuts the head stream of the Cavalla river. From this point the boundary between France and Liberia would be the course of the Cavalla river from near its source to the sea. Within the limits above described Liberia would possess a total area of about 43,000 to 45,000 sq. m. But after deliberation and as the result of certain "frontier incidents" France modified her counter-proposals in 1907, and the actual definition of the northern and eastern frontiers of Liberia is as follows:

Starting from the point on the frontier of the British colony of Sierra Leone where the river Moa or Makona crosses that frontier, the Franco-Liberian frontier shall follow the left bank of the river Makona up stream to a point 5 kilometres to the south of the town of Bofosso. From this point the frontier shall leave the line of the Makona and be carried in a south-easterly direction to the source of the most north-westerly affluent of the Nuon river or Western Cavalla. This line shall be so drawn as to leave on the French side of the boundary the following towns: Kutumai, Kisi Kurumai, Sundibú, Zuapa, Nzibila, Koiana, Bangwedú and Lola. From the north-westernmost source of the Nuon the boundary shall follow the right bank of the said Nuon river down stream to its presumed confluence with the Cavalla, and thenceforward the right bank of the river Cavalla down to the sea. If the ultimate destination of the Nuon is not the Cavalla river, then the boundary shall follow the right bank of the Nuon down stream as far as the town of Tuleplan. A line shall then be drawn from the southern outskirts of the town of Tuleplan due E. to the Cavalla river, and thence shall follow the right bank of the Cavalla river to the sea.

(The delimitation commission proved that the Nuon does not flow into the Cavalla, but about 6° 30' N. it flows very near the north-westernmost bend of that river. Tuleplan is in about lat. 6° 50' N. The river Makona takes a much more northerly course than had been estimated. The river Nuon also is situated 20 or 30 m. farther to the east than had been supposed. Consequently the territory of Liberia as thus demarcated is rather larger than it would appear on the uncorrected English maps of 1907—about 41,000 sq. m.)

It is at the southern extremity of Liberia, Cape Palmas, that the West African coast from Morocco to the southernmost extremity of Guinea turns somewhat abruptly eastwards and northwards and faces the Gulf of Guinea. As the whole coastline of Liberia thus fronts the sea route from Europe to South Africa it is always likely to possess a certain degree of strategical importance. The coast, however, is unprovided with a single good harbour. The anchorage at Monrovia is safe, and with some expenditure of money a smooth harbour could be made in front of Grand Basa.

*Coast Features.*—The coast is a good deal indented, almost all the headlands projecting from north-east to south-west. A good deal of the seaboard is dangerous by reason of the sharp rocks which lie near the surface. As most of the rivers have rapids or falls actually at the sea coast or close to it, they are, with the exception of the Cavalla, useless for penetrating far inland, and the whole of this part of Africa from Cape Palmas north-west to the Senegal suggests a sunken land. In all probability the western projection of Africa was connected by a land bridge with the opposite land of Brazil as late as the Eocene period of the Tertiary epoch. The Liberian coast has few lagoons compared with the adjoining littoral of Sierra Leone or that of the Ivory Coast. The coast, in fact, rises in some places rather abruptly from the sea. Cape Mount (on the northern side of which is a large lagoon—Fisherman Lake) at its highest point is 1050 ft. above sea level. Cape Mesurado is about 350 ft., Cape Palmas about 200 ft. above the sea. There is a salt lake or lagoon between the Cape Palmas river and the vicinity of the Cavalla. Although very little of the coast belt is actually swampy, a kind of natural canalization connects many of the rivers at their mouths with each other, though some of these connecting creeks are as yet unmarked on maps.

*Mountains.*—Although there are patches of marsh—generally the swampy bottoms of valleys—the whole surface of Liberia inclines to be hilly or even mountainous at a short distance inland from the coast. In the north-east, French explorers have computed the altitudes of some mountains at figures which would make them the highest land surfaces of the western projection of Africa—from 6000 to 9000 ft. But these altitudes are largely matters of conjecture. The same mountains have been sighted by English explorers coming up from the south and are pronounced to be "very high." It is possible that they may reach to 6000 ft. in some places. Between the western bend of the Cavalla river and the coast there is a somewhat broken mountain range with altitudes of from 2000 to 5000 ft. (approximate). The Pó range to the west of the St Paul's river may reach in places to 3000 ft.

*Rivers.*—The work of the Franco-Liberian delimitation commission in 1908-1909 cleared up many points connected with the hydrography of the country. Notably it traced the upper Cavalla, proving that that river was not connected either with the Nuon on the west or the Ko or Zo on the east. The upper river and the left bank of the lower river of the Cavalla are in French territory. It rises in about 7° 50' N., 8° 30' W. in the Nimba

mountains, where also rise the Nuon, St John's and Dukwia rivers. After flowing S.E. the Cavalla, between 7° and 6° N., under the name of Dugu, makes a very considerable elbow to the west, thereafter resuming its south-easterly course. It is navigable from the sea for some 80 m. from its mouth and after a long series of rapids is again navigable. Unfortunately the Cavalla does not afford a means of easy penetration into the rich hinterland of Liberia on account of the bad bar at its mouth. The Nuon (or Nipwe), which up to 1908 was described sometimes as the western Cavalla and sometimes as the upper course of the St John's river, has been shown to be the upper course of the Cestos. About 6° 30' N. it approaches within 16 m. of the Cavalla. It rises in the Nimba mountains some 10 m. S. of the source of the Cavalla, and like all the Liberian rivers (except the Cavalla) it has a general S.W. flow. The St Paul, though inferior to the Cavalla in length, is a large river with a considerable volume of water. The main branch rises in the Beila country nearly as far north as 9° N. under the name of Diani. Between 8° and 7° N. it is joined by the Wé from the west and the Walé from the east. The important river Lofa flows nearly parallel with the St Paul's river and enters the sea about 40 m. to the west, under the name of Little Cape Mount river. The Mano or Bewa river rises in the dense Gora forest, but is of no great importance until it becomes the frontier between Liberia and Sierra Leone. The Dukwia and Farmington are tortuous rivers entering the sea under the name of the river Junk (Portuguese, *Junco*). The Farmington is a short stream, but the Dukwia is believed to be the lower course of the Mani, which rises as the Tigney (Tige), north of the source of the Cavalla, just south of 8° N. The St John's river of the Basa country appears to be of considerable importance and volume. The Sino river rises in the Niete mountains and brings down a great volume of water to the sea, though it is not a river of considerable length. The Duobe rises at the back of the Satro Mountains and flows nearly parallel with the Cavalla, which it joins. The Moa or Makona river is a fine stream of considerable volume, but its course is perpetually interrupted by rocks and rapids. Its lower course is through the territory of Sierra Leone, and it enters the sea as the Sulima.

*Climate and Rainfall.*—Liberia is almost everywhere well watered. The climate and rainfall over the whole of the coast region for about 120 m. inland are equatorial, the rainfall in the western half of the country being about 150 in. per annum and in the eastern half about 100 in. North of a distance of about 120 m. inland the climate is not quite so rainy, and the weather is much cooler during the dry season. This region beyond the hundred-miles coast belt is far more agreeable and healthy to Europeans.

*Forests.*—Outside a coast belt of about 20 m. and south of 8° N. the country is one vast forest, except where the natives have cleared the land for cultivation. In many districts the land has been cleared and cultivated and then abandoned, and has relapsed into scrub and jungle which is gradually returning to the condition of forest. The densest forest of all would seem to be that known as Gora, which is almost entirely uninhabited and occupies an area of about 6000 sq. m. between the Pō hills and the British frontier. There is another very dense forest stretching with little interruption from the eastern side of the St Paul's river nearly to the Cavalla. The Nidi forest is noteworthy for its magnificent growth of *Funtumia* rubber trees. It extends between the Duobe and the Cavalla rivers. The extreme north of Liberia is still for the most part a very well-watered country, covered with a rich vegetation, but there are said to be a few breaks that are rather stony and that have a very well-marked dry season in which the vegetation is a good deal burnt up. In the main Liberia is the forest country par excellence of West Africa, and although this region of dense forests overlaps the political frontiers of both Sierra Leone and the Ivory Coast, it is a feature of physical geography so nearly coincident with the actual frontiers of Liberia as to give this country special characteristics clearly marked in its existing fauna.

*Fauna.*—The fauna of Liberia is sufficiently peculiar, at any rate as regards vertebrates, to make it very nearly identical with a "district" or sub-province of the West African province, though in this case the Liberian "district" would not include the northern-most portions of the country and would overlap on the east and west into Sierra Leone and the French Ivory Coast. It is probable that the Liberian chimpanzee may offer one or more distinct varieties; there is an interesting local development of the Diana monkey, sometimes called the bay-thighed monkey (*Cercopithecus diana ignita*) on account of its brilliant orange-red thighs. One or more species of bats are peculiar to the country—*Vespertilio stampflii*, and perhaps *Roussettus büttikoferi*; two species of shrew (*Crocidura*), one dormouse (*Graphiurus nagtglasii*); the pygmy hippopotamus (*H. liberiensis*)—differing from the common hippopotamus by its much smaller size and by the reduction of the incisor teeth to a single pair in either jaw, or occasionally to the odd number of three; and two remarkable *Cephalophus* antelopes peculiar to this region so far as is known—these are the white-shouldered duiker, *Cephalophus jentinki*, and the zebra antelope, *C. doriae*, a creature the size of a small goat, of a bright bay brown, with broad black zebra-like stripes. Amongst other interesting mammals are four species of the long-haired *Colobus* monkeys (black, black and white, greenish-grey and reddish-brown); the Potto lemur, fruit bats of large size with monstrous heads (*Hypsignathus monstrosus*); the brush-tailed African porcupine; several very brightly coloured squirrels; the scaly-tailed flying *Anomalurus*; the common porcupine; the leopard, serval, golden cat (*Felis celidogaster*) in two varieties, the copper-coloured and the grey, possibly the same animal at different ages; the striped and spotted hyenas (beyond the forest region); two large otters; the tree hyrax, elephant and manati; the red bush pig (*Potamochoerus porcus*); the West African chevrotain (*Dorcatherium*); the Senegalese buffalo; Bongo antelope (*Boocercus*); large yellow-backed duiker (*Cephalophus sylvicultrix*), black duiker, West African hartebeest (beyond the forest), pygmy antelope (*Neotragus*); and three species of *Manis* or pangolin (*M. gigantea*, *M. longicaudata* and *M. tricuspis*).

The birds of Liberia are not quite so peculiar as the mammals. There is the interesting white-necked guineafowl, *Agelastes* (which is found on the Gold Coast and elsewhere west of the lower Niger); there is one peculiar species of eagle owl (*Bubo lettii*) and a very handsome sparrow-hawk (*Accipiter büttikoferi*); a few sun-birds, warblers and shrikes are peculiar to the region. The other birds are mainly those of Senegambia and of the West African forest region generally. A common and handsome bird is the blue plantain-eater (*Corythaëola*). The fishing vulture (*Gypohierax*) is found in all the coast districts, but true vultures are almost entirely absent except from the north, where the small brown *Percnopterus* makes its appearance. A flamingo (*Phoeniconaias*) visits Fisherman Lake, and there are a good many species of herons. Cuckoos are abundant, some of them of lovely plumage, also rollers, kingfishers and horn-bills. The last family is well represented, especially by the three forest forms—the elate hornbill and black hornbill (*Ceratogymna*), and the long-tailed, white-crested hornbill (*Ortholophus leucolophus*). There is one trogon—green and crimson, a brightly coloured ground thrush (*Pitta*), numerous woodpeckers and barbets; glossy starlings, the black and white African crow and a great variety of brilliantly coloured weaver birds, waxbills, shrikes and sun-birds.

As regards reptiles, there are at least seven poisonous snakes—two cobras, two puff-adders and three vipers. The brilliantly coloured red and blue lizard (*Agama colonorum*) is found in the coast region of eastern Liberia. There are three species of crocodile, at least two chameleons (probably more when the forest is further explored), the large West African python (*P. sebae*) and a rare Boine snake (Calabaria). On the sea coast there is

the leathery turtle (*Dermochelis*) and also the green turtle (*Chelone*). In the rivers and swamps there are soft-shelled turtle (*Trionyx* and *Sternotherus*). The land tortoises chiefly belong to the genus *Cynyxis*. The freshwater fish seem in their affinities to be nearly allied to those of the Niger and the Nile. There is a species of *Polypterus*, and it is probable that the *Protopterus* or lung fish is also found there, though its existence has not as yet been established by a specimen. As regards invertebrates, very few species or genera are peculiar to Liberia so far as is yet known, though there are probably one or two butterflies of local range. The gigantic scorpions (*Pandinus imperator*)—more than 6 in. long—are a common feature in the forest. One noteworthy feature in Liberia, however, is the relative absence of mosquitoes, and the white ants and some other insect pests are not so troublesome here as in other parts of West Africa. The absence or extreme paucity of mosquitoes no doubt accounts for the infrequency of malarial fever in the interior.

*Flora.*—Nowhere, perhaps, does the flora of West Africa attain a more wonderful development than in the republic of Liberia and in the adjoining regions of Sierra Leone and the Ivory Coast. This is partly due to the equatorial position and the heavy rainfall. The region of dense forest, however, does not cover the whole of Liberia; the Makona river and the northern tributaries of the Lofa and St Paul's flow through a mountainous country covered with grass and thinly scattered trees, while the ravines and watercourses are still richly forested. A good deal of this absence of forest is directly due to the action of man. Year by year the influence of the Mahomedan tribes on the north leads to the cutting down of the forest, the extension of both planting and pasture and the introduction of cattle and even horses. In the regions bordering the coast also a good deal of the forest has disappeared, its place being taken (where the land is not actually cultivated) by very dense scrub. The most striking trees in the forest region are, in the basin of the Cavalla, the giant *Funtumia elastica*, which grows to an altitude of 200 ft.; various kinds of *Parinarium*, *Oldfieldia* and *Khaya*; the bombax or cotton tree, giant dracaenas, many kinds of fig; *Borassus* palms, oil palms, the climbing *Calamus* palms, and on the coast the coconut. The most important palm of the country perhaps is the *Raphia vinifera*, which produces the piassava fibre of commerce. There are about twenty-two different trees, shrubs and vines producing rubber of more or less good quality. These belong chiefly to the Apocynaceous order. In this order is the genus *Strophanthus*, which is represented in Liberia by several species, amongst others *S. gratus*. This *Strophanthus* is not remarkable for its rubber—which is mere bird lime—but for the powerful poison of its seeds, often used for poisoning arrows, but of late much in use as a drug for treating diseases of the heart. Coffee of several species is indigenous and grows wild. The best known is the celebrated *Coffea liberica*. The kola tree is also indigenous. Large edible nuts are derived from *Coula edulis* of the order Olacineae. The country is exceedingly rich in Aroids, many of which are epiphytic, festooning the trunks of tall trees with a magnificent drapery of abundant foliage. A genus much represented is *Culcasia*, and swampy localities are thickly set with the giant *Cyrtosperma* arum, with flower spathe that are blotched with deep purple. Ground orchids and tree orchids are well represented; *Polystachya liberica*, an epiphytic orchid with sprays of exquisite small flowers of purple and gold, might well be introduced into horticulture for its beauty. The same might be said of the magnificent *Lissochilus roseus*, a terrestrial orchid, growing to 7 ft. in height, with rose-coloured flowers nearly 1 in. long; there are other orchids of fantastic design in their green and white flowers, some of which have spurs (nectaries) nearly 7 in. long.

Many trees offer magnificent displays of flowers at certain seasons of the year; perhaps the loveliest effect is derived from the bushes and trailing creepers of the *Combretum* genus, which, during the "winter" months from December to March, cover the scrub and the forest with mantles of rose colour. *Smaethmannia* trees are thickly set at this season with large blossoms of waxen white. Very beautiful also are the red velvet or white velvet sepals of the *Mussaenda* genus. Bamboos of the genus *Oxytenanthera* are indigenous. Tree ferns are found on the mountains above 4000 ft. The bracken grows in low sandy tracts near the coast. The country in general is a fern paradise, and the iridescent creeping *Selaginella* (akin to *Lycopodium*) festoons the undergrowth by the wayside. The cultivated trees and plants of importance are, besides rubber, the manioc or cassava, the orange tree, lime, cacao, coffee, pineapple (which now runs wild over the whole of Liberia), sour sop, ginger, papaw, alligator apple, avocado pear, okro, cotton (*Gossypium peruvianum*—the kidney cotton), indigo, sweet potato, capsicum (chillie), bread-fruit, arrowroot (*Maranta*), banana, yam, "coco"-yam (*Colocasia antiquorum*, var. *esculenta*), maize, sorghum, sugar cane, rice and eleusine (*Eleusine*), besides gourds, pumpkins, cabbages and onions.

*Minerals.*—The hinterland of Liberia has been but slightly explored for mineral wealth. In a general way it is supposed that the lands lying between the lower St Paul's river and the Sierra Leone frontier are not much mineralized, except that in the vicinity of river mouths there are indications of bitumen. The sand of nearly all the rivers contains a varying proportion of gold. Garnets and mica are everywhere found. There have been repeated stories of diamonds obtained from the Finley Mountains (which are volcanic) in the central province, but all specimens sent home, except one, have hitherto proved to be quartz crystals. There are indications of sapphires and other forms of corundum. Corundum indeed is abundantly met with in the eastern half of Liberia. The sand of the rivers contains monazite. Graphite has been discovered in the Pō Hills. Lead has been reported from the Nidi or Niete Mountains. Gold is present in some abundance in the river sand of central Liberia, and native reports speak of the far interior as being rich in gold. Iron—haematite—is present almost everywhere. There are other indications of bitumen, besides those mentioned, in the coast region of eastern Liberia.

*History and Population.*—Tradition asserts that the Liberian coast was first visited by Europeans when it was reached by the Dieppoise merchant-adventurers in the 14th century. The French in the 17th century claimed that but for the loss of the archives of Dieppe they would be able to prove that vessels from this Norman port had established settlements at Grand Basa, Cape Mount, and other points on the coast of Liberia. No proof has yet been forthcoming, however, that the Portuguese were not the first white men to reach this coast. The first Portuguese pioneer was Pedro de Sintra, who discovered and noted in 1461 the remarkable promontory of Cape Mount, Cape Mesurado (where the capital, Monrovia, is now situated) and the mouth of the Junk river. In 1462 de Sintra returned with another Portuguese captain, Sueiro da Costa, and penetrated as far as Cape Palmas and the Cavalla river. Subsequently the Portuguese mapped the whole coast of Liberia, and nearly all the prominent features—capes, rivers, islets—off that coast still bear Portuguese names. From the 16th century onwards, English, Dutch, German, French and other European traders contested the commerce of this coast with the Portuguese, and finally drove them away. In the 18th century France once or twice thought of establishing colonies here. At the end of the 18th century, when the tide was rising in favour of the abolition of slavery and the repatriation of slaves, the Grain Coast [so called from the old trade in the "Grains of Paradise" or *Amomum* pepper] was suggested once or twice as a suitable home for repatriated negroes. Sierra Leone, however, was chosen first on account of its possessing an admirable harbour. But in 1821 Cape Mesurado was selected by the American Colonization Society as an appropriate site for the first detachment of American freed negroes, whom



difficulties in regard to extending the suffrage in the United States were driving away from a still slave-holding America. From that date, 1821, onwards to the present day, negroes and mulattos—freed slaves or the descendants of such—have been crossing the Atlantic in small numbers to settle on the Liberian coast. The great migrations took place during the first half of the 19th century. Only two or three thousand American emigrants—at most—have come to Liberia since 1860.

The colony was really founded by Jehudi Ashmun, a white American, between 1822 and 1828. The name “Liberia” was invented by the Rev. R. R. Gurley in 1824. In 1847 the American colonists declared their country to be an independent republic, and its status in this capacity was recognized in 1848-1849 by most of the great powers with the exception of the United States. Until 1857 Liberia consisted of two republics—Liberia and Maryland. These American settlements were dotted at intervals along the coast from the mouth of the Sewa river on the west to the San Pedro river on the east (some 60 m. beyond Cape Palmas). Some tracts of territory, such as the greater part of the Kru coast, still, however, remain without foreign—American—settlers, and in a state of quasi-independence. The uncertainty of Liberian occupation led to frontier troubles with Great Britain and disputes with France. Finally, by the English and French treaties of 1885 and 1892 Liberian territory on the coast was made continuous, but was limited to the strip of about 300 m. between the Mano river on the west and the Cavalla river on the east. The Sierra Leone-Liberia frontier was demarcated in 1903; then followed the negotiations with France for the exact delimitation of the Ivory Coast-Liberia frontier, with the result that Liberia lost part of the hinterland she had claimed. Reports of territorial encroachments aroused much sympathy with Liberia in America and led in February 1909 to the appointment by President Roosevelt of a commission which visited Liberia in the summer of that year to investigate the condition of the country. As a result of the commissioners’ report negotiations were set on foot for the adjustment of the Liberian debt and the placing of United States officials in charge of the Liberian customs. In July 1910 it was announced that the American government, acting in general agreement with Great Britain, France and Germany, would take charge of the finances, military organization, agriculture and boundary questions of the republic. A loan for £400,000 was also arranged. Meantime the attempts of the Liberian government to control the Kru coast led to various troubles, such as the fining or firing upon foreign steamships for alleged contraventions of regulations. During 1910 the natives in the Cape Palmas district were at open warfare with the Liberian authorities.

One of the most notable of the Liberian presidents was J. J. Roberts, who was nearly white, with only a small proportion of negro blood in his veins. But perhaps the ablest statesman that this American-Negro republic has as yet produced is a pure-blooded negro—President Arthur Barclay, a native of Barbados in the West Indies, who came to Liberia with his parents in the middle of the 19th century, and received all his education there. President Barclay was of unmixed negro descent, but came of a Dahomey stock of superior type.<sup>1</sup> Until the accession to power of President Barclay in 1904 (he was re-elected in 1907), the Americo-Liberian government on the coast had very uncertain relations with the indigenous population, which is well armed and tenacious of local independence. But of late Liberian influence has been extending, more especially in the counties of Maryland and Montserrado.

The president is now elected for a term of four years. There is a legislature of eight senators and thirteen representatives. The type of the constitution is very like that of the United States. Increasing attention is being given to education, to deal with which there are several colleges and a number of schools. The judicial functions are discharged by four grades of officials—the local magistrates, the courts of common pleas, the quarterly courts (five in number) and the supreme court.

The customs service includes British customs officers lent to the Liberian service. A gunboat for preventive service purchased from the British government and commanded by an Englishman, with native petty officers and crew, is employed by the Liberian government. The language of government and trade is English, which is understood far and wide throughout Liberia. As the origin of the Sierra Leonis and the Americo-Liberian settlers was very much the same, an increasing intimacy is growing up between the English-speaking populations of these adjoining countries. Order is maintained in Liberia to some extent by a militia.

The population of Americo-Liberian origin in the coast regions is estimated at from 12,000 to 15,000. To these must be added about 40,000 civilized and Christianized negroes who make common cause with the Liberians in most matters, and have gradually been filling the position of Liberian citizens.

For administrative purposes the country is divided into four counties, Montserrado, Basa, Sino and Maryland, but Cape Mount in the far west and the district round it has almost the status of a fifth county. The approximate revenue for 1906 was £65,000, and the expenditure about £60,000, but some of the revenue was still collected in paper of uncertain value. There are three custom-houses, or ports of entry on the Sierra Leone land frontier between the Moa river on the north and the Mano on the south, and nine ports of entry along the coast. At all of these Europeans are allowed to settle and trade, and with very slight restrictions they may now trade almost anywhere in Liberia. The rubber trade is controlled by the Liberian Rubber Corporation, which holds a special concession from the Liberian government for a number of years, and is charged with the preservation of the forests. Another English company has constructed motor roads in the Liberian hinterland to connect centres of trade with the St Paul’s river. The trade is done almost entirely with Great Britain, Germany and Holland, but friendly relations are maintained with Spain, as the Spanish plantations in Fernando Põ are to a great extent worked by Liberian labour.

The indigenous population must be considered one of the assets of Liberia. The native population—apart from the American element—is estimated at as much as 2,000,000; for although large areas appear to be uninhabited forest, other parts are most densely populated, owing to the wonderful fertility of the soil. The native tribes belong more or less to the following divisions, commencing on the west, and proceeding eastwards: (1) Vai, Gbandi, Kpwesi, Mende, Buzi and Mandingo (the Vai, Mende and Mandingo are Mahommedans); all these tribes speak languages derived from a common stock. (2) In the densest forest region between the Mano and the St Paul’s river is the powerful Gora tribe of unknown linguistic affinities. (3) In the coast region between the St Paul’s river and the Cavalla (and beyond) are the different tribes of Kru stock and language family—Dê, Basâ, Gibi, Kru, Grebo, Putu, Sikoñ, &c. &c. The actual Kru tribe inhabits the coast between the river Cestos on the west and Grand Sesters on the east. It is known all over the Atlantic coasts of Africa, as it furnishes such a large proportion of the seamen employed on men-of-war and merchant ships in these tropical waters. Many of the indigenous races of Liberia in the forest belt beyond 40 m. from the coast still practise cannibalism. In some of these forest tribes the women still go quite naked, but clothes of a Mahommedan type are fast spreading over

the whole country. Some of the indigenous races are of very fine physique. In the Nidi country the women are generally taller than the men. No traces of a Pygmy race have as yet been discovered, nor any negroes of low physiognomy. Some of the Krumen are coarse and ugly, and this is the case with the Mende people; but as a rule the indigenes of Liberia are handsome, well-proportioned negroes, and some of the Mandingos have an almost European cast of feature.

AUTHORITIES.—Col. Wauwerman, *Liberia; Histoire de la fondation d'un état nègre* (Brussels, 1885); J. Büttikofer, *Reisebilder aus Liberia* (Leiden, 1890); Sir Harry Johnston, *Liberia* (2 vols., London, 1906), with full bibliography; Maurice Delafosse, *Vocabulaires comparatifs de plus de 60 langues et dialectes parlés à la Côte d'Ivoire et dans la région limitrophe* (1904), a work which, though it professes to deal mainly with philology, throws a wonderful light on the relationships and history of the native tribes of Liberia.

(H. H. J.)

- 1 Amongst other remarkable negroes that Liberian education produced was Dr E. W. Blyden (b. 1832), the author of many works dealing with negro questions.



**LIBERIUS**, pope from 352 to 366, the successor of Julius I., was consecrated according to the *Catalogus Liberianus* on the 22nd of May. His first recorded act was, after a synod had been held at Rome, to write to Constantius, then in quarters at Arles (353-354), asking that a council might be called at Aquileia with reference to the affairs of Athanasius; but his messenger Vincentius of Capua was compelled by the emperor at a conciliabulum held in Arles to subscribe against his will a condemnation of the orthodox patriarch of Alexandria. In 355 Liberius was one of the few who, along with Eusebius of Vercelli, Dionysius of Milan and Lucifer of Cagliari, refused to sign the condemnation of Athanasius, which had anew been imposed at Milan by imperial command upon all the Western bishops; the consequence was his relegation to Beroea in Thrace, Felix II. (antipope) being consecrated his successor by three "catascopi haud episcopi," as Athanasius called them. At the end of an exile of more than two years he yielded so far as to subscribe a formula giving up the "homoousios," to abandon Athanasius, and to accept the communion of his adversaries—a serious mistake, with which he has justly been reproached. This submission led the emperor to recall him from exile; but, as the Roman see was officially occupied by Felix, a year passed before Liberius was sent to Rome. It was the emperor's intention that Liberius should govern the Church jointly with Felix, but on the arrival of Liberius, Felix was expelled by the Roman people. Neither Liberius nor Felix took part in the council of Rimini (359). After the death of the emperor Constantius in 361, Liberius annulled the decrees of that assembly, but, with the concurrence of SS. Athanasius and Hilarius, retained the bishops who had signed and then withdrawn their adherence. In 366 Liberius gave a favourable reception to a deputation of the Eastern episcopate, and admitted into his communion the more moderate of the old Arian party. He died on the 24th of September 366.

His biographers used to be perplexed by a letter purporting to be from Liberius, in the works of Hilary, in which he seems to write, in 352, that he had excommunicated Athanasius at the instance of the Oriental bishops; but the document is now held to be spurious. See Hefele, *Conciliengesch.* i. 648 seq. Three other letters, though contested by Hefele, seem to have been written by Liberius at the time of his submission to the emperor.

(L. D.\*)



**LIBER PONTIFICALIS**, or *GESTA PONTIFICUM ROMANORUM* (*i.e.* book of the popes), consists of the lives of the bishops of Rome from the time of St Peter to the death of Nicholas I. in 867. A supplement continues the series of lives almost to the close of the 9th century, and several other continuations were written later. During the 16th century there was some discussion about the authorship of the *Liber*, and for some time it was thought to be the work of an Italian monk, Anastasius Bibliothecarius (d. 886). It is now, however, practically certain that it was of composite authorship and that the earlier part of it was compiled about 530, three centuries before the time of Anastasius. This is the view taken by Louis Duchesne and substantially by G. Waitz and T. Mommsen, although these scholars think that it was written about a century later. The *Liber* contains much information about papal affairs in general, and about endowments, martyrdoms and the like, but a considerable part of it is obviously legendary. It assumes that the bishops of Rome exercised authority over the Christian Church from its earliest days.

The *Liber*, which was used by Bede for his *Historia Ecclesiastica*, was first printed at Mainz in 1602. Among other editions is the one edited by T. Mommsen for the *Monumenta Germaniae historica. Gesta Romanorum pontificum*, Band i., but the best is the one by L. Duchesne, *Le Liber pontificalis: texte, introduction, commentaire* (Paris, 1884-1892). See also the same writer's *Étude sur le Liber pontificalis* (Paris, 1877); and the article by A. Brackmann in Herzog-Hauck's *Realencyklopädie*, Band xi. (Leipzig, 1902).



**LIBERTAD**, or LA LIBERTAD, a coast department of Peru, bounded N. by Lambayeque and Cajamarca, E. by

San Martin, S. by Ancachs, S.W. and W. by the Pacific. Pop. (1906 estimate) 188,200; area 10,209 sq. m. Libertad formerly included the present department of Lambayeque. The Western Cordillera divides it into two nearly equal parts; the western consisting of a narrow, arid, sandy coast zone and the western slopes of the Cordillera broken into valleys by short mountain spurs, and the eastern a high inter-Andine valley lying between the Western and Central Cordilleras and traversed by the upper Marañon or Amazon, which at one point is less than 90 m. in a straight line from the Pacific coast. The coast region is traversed by several short streams, which are fed by the melting snows of the Cordillera and are extensively used for irrigation. These are (the names also applying to their valleys) the Jequetepeque or Pacasmayo, in whose valley rice is an important product, the Chicama, in whose valley the sugar plantations are among the largest and best in Peru, the Moche, Viru, Chao and Santa; the last, with its northern tributary, the Tablachaca, forming the southern boundary line of the department. The Santa Valley is also noted for its sugar plantations. Cotton is produced in several of these valleys, coffee in the Pacasmayo district, and coca on the mountain slopes about Huamachuco and Otuzco, at elevations of 3000 to 6000 ft. above sea-level. The upland regions, which have a moderate rainfall and a cool, healthy climate, are partly devoted to agriculture on a small scale (producing wheat, Indian corn, barley, potatoes, quinoa, alfalfa, fruit and vegetables), partly to grazing and partly to mining. Cattle and sheep have been raised on the upland pastures of Libertad and Ancachs since early colonial times, and the llama and alpaca were reared throughout this "sierra" country long before the Spanish conquest. Gold and silver mines are worked in the districts of Huamachuco, Otuzco and Pataz, and coal has been found in the first two. The department had 169 m. of railway in 1906, viz.: from Pacasmayo to Yonán (in Cajamarca) with a branch to Guadalupe, 60 m.; from Salaverry to Trujillo with its extension to Ascope, 47 m.; from Trujillo to Laredo, Galindo and Menocucho, 18½ m.; from Huanchaco to Roma, 25 m.; and from Chicama to Pampas, 18½ m. The principal ports are Pacasmayo and Salaverry, which have long iron piers built by the national government; Malabrigo, Huanchuco, Guañape and Chao are open roadsteads. The capital of the department is Trujillo. The other principal towns are San Pedro, Otuzco, Huamachuco, Santiago de Chuco and Tuyabamba—all provincial capitals and important only through their mining interests, except San Pedro, which stands in the fertile district of the Jequetepeque. The population of Otuzco (35 m. N.E. of Trujillo) was estimated to be about 4000 in 1896, that of Huamachuco (65 m. N.E. of Trujillo) being perhaps slightly less.



**LIBERTARIANISM** (from Lat. *libertas*, freedom), in ethics, the doctrine which maintains the freedom of the will, as opposed to necessitarianism or determinism. It has been held in various forms. In its extreme form it maintains that the individual is absolutely free to choose this or that action indifferently (the *liberum arbitrium indifferentiae*), but most libertarians admit that acquired tendencies, environment and the like, exercise control in a greater or less degree.



**LIBERTINES**, the nickname, rather than the name, given to various political and social parties. It is futile to deduce the name from the Libertines of Acts vi. 9; these were "sons of freedmen," for it is vain to make them citizens of an imaginary Libertum, or to substitute (with Beza) Libustines, in the sense of inhabitants of Libya. In a sense akin to the modern use of the term "libertine," *i.e.* a person who sets the rules of morality, &c., at defiance, the word seems first to have been applied, as a stigma, to Anabaptists in the Low Countries (Mark Pattison, *Essays*, ii. 38). It has become especially attached to the liberal party in Geneva, opposed to Calvin and carrying on the tradition of the Liberators in that city; but the term was never applied to them till after Calvin's death (F. W. Kampschulte, *Johann Calvin*). Calvin, who wrote against the "Libertins qui se nomment Spirituelz" (1545), never confused them with his political antagonists in Geneva, called Perrinistes from their leader Amadeo Perrin. The objects of Calvin's polemic were the Anabaptists above mentioned, whose first obscure leader was Coppin of Lisle, followed by Quintin of Hennegau, by whom and his disciples, Bertram des Moulins and Claude Perseval, the principles of the sect were disseminated in France. Quintin was put to death as a heretic at Tournai in 1546. His most notable follower was Antoine Pocquet, a native of Enghien, Belgium, priest and almoner (1540-1549), afterwards pensioner of the queen of Navarre, who was a guest of Bucer at Strassburg (1543-1544) and died some time after 1560. Calvin (who had met Quintin in Paris) describes the doctrines he impugns as pantheistic and antinomian.

See Choisy in Herzog-Hauck's *Realencyklopädie* (1902).

(A. Go.\*)



**LIBERTINES, SYNAGOGUE OF THE**, a section of the Hellenistic Jews who attacked Stephen (Acts vi. 9). The passage reads, τίνες τῶν ἐκ τῆς συναγωγῆς τῆς λεγομένης Λιβερίτωνων, καὶ Κυρηναίων καὶ Ἀλεξανδρέων, καὶ τῶν ἀπὸ Κιλικίας καὶ Ἀσίας, and opinion is divided as to the number of synagogues here named. The probability is that there are three, corresponding to the geographical regions involved, (1) Rome and Italy, (2) N.E. Africa, (3) Asia Minor. In this case "the Synagogue of the Libertines" is the assembly of "the

Freedmen” from Rome, descendants of the Jews enslaved by Pompey after his conquest of Judaea 63 B.C. If, however, we take Λιβερτίνων καὶ Κυρηναίων καὶ Ἀλεξανδρέων closely together, the first name must denote the people of some city or district. The obscure town Libertum (inferred from the title Episcopus Libertinensis in connexion with the synod of Carthage, A.D. 411) is less likely than the reading (Λιβύων or) Λιβυστίων underlying certain Armenian versions and Syriac commentaries. The Greek towns lying west from Cyrene would naturally be called Libyan. In any case the interesting point is that these returned Jews, instead of being liberalized by their residence abroad, were more tenacious of Judaism and more bitter against Stephen than those who had never left Judaea.



**LIBERTY** (Lat. *libertas*, from *liber*, free), generally the state of freedom, especially opposed to subjection, imprisonment or slavery, or with such restricted or figurative meaning as the circumstances imply. The history of political liberty is in modern days identified practically with the progress of civilization. In a more particular sense, “a liberty” is the term for a franchise, a privilege or branch of the crown’s prerogative granted to a subject, as, for example, that of executing legal process; hence the district over which the privilege extends. Such liberties are exempt from the jurisdiction of the sheriff and have separate commissions of the peace, but for purposes of local government form part of the county in which they are situated. The exemption from the jurisdiction of the sheriff was recognized in England by the Sheriffs Act 1887, which provides that the sheriff of a county shall appoint a deputy at the expense of the lord of the liberty, such deputy to reside in or near the liberty. The deputy receives and opens in the sheriff’s name all writs, the return or execution of which belongs to the bailiff of the liberty, and issues to the bailiff the warrant required for the due execution of such writs. The bailiff then becomes liable for non-execution, mis-execution or insufficient return of any writs, and in the case of non-return of any writ, if the sheriff returns that he has delivered the writ to a bailiff of a liberty, the sheriff will be ordered to execute the writ notwithstanding the liberty, and must cause the bailiff to attend before the high court of justice and answer why he did not execute the writ.

In nautical phraseology various usages of the term are derived from its association with a sailor’s leave on shore, *e.g.* liberty-man, liberty-day, liberty-ticket.

*A History of Modern Liberty*, in eight volumes, of which the third appeared in 1906, has been written by James Mackinnon; see also Lord Acton’s lectures, and such works as J. S. Mill’s *On Liberty* and Sir John Seeley’s *Introduction to Political Science*.



**LIBERTY PARTY**, the first political party organized in the United States to oppose the spread and restrict the political power of slavery, and the lineal precursor of the Free Soil and Republican parties. It originated in the Old North-west. Its organization was preceded there by a long anti-slavery religious movement. James G. Birney (*q.v.*), to whom more than to any other man belongs the honour of founding and leading the party, began to define the political duties of so-called “abolitionists” about 1836; but for several years thereafter he, in common with other leaders, continued to disclaim all idea of forming a political party. In state and local campaigns, however, non-partisan political action was attempted through the questioning of Whig and Democratic candidates. The utter futility of seeking to obtain in this way any satisfactory concessions to anti-slavery sentiment was speedily and abundantly proved. There arose, consequently, a division in the American Anti-slavery Society between those who were led by W. L. Garrison (*q.v.*), and advocated political non-resistance—and, besides, had loaded down their anti-slavery views with a variety of religious and social vagaries, unpalatable to all but a small number—and those who were led by Birney, and advocated independent political action. The sentiment of the great majority of “abolitionists” was, by 1838, strongly for such action; and it was clearly sanctioned and implied in the constitution and declared principles of the Anti-slavery Society; but the capture of that organization by the Garrisonians, in a “packed” convention in 1830, made it unavailable as a party nucleus—even if it had not been already outgrown—and hastened a separate party organization. A convention of abolitionists at Warsaw, New York, in November 1839 had resolved that abolitionists were bound by every consideration of duty and expediency to organize an independent political party. Accordingly, the political abolitionists, in another convention at Albany, in April 1840, containing delegates from six states but not one from the North-west, launched the “Liberty Party,” and nominated Birney for the presidency. In the November election he received 7069 votes.<sup>1</sup>

The political “abolitionists” were abolitionists only as they were restrictionists: they wished to use the federal government to exclude (or abolish) slavery from the federal Territories and the District of Columbia, but they saw no opportunity to attack slavery in the states—*i.e.* to attack the institution *per se*; also they declared there should be “absolute and unqualified division of the General Government from slavery”—which implied an amendment of the constitution. They proposed to use ordinary moral and political means to attain their ends—not, like the Garrisonians, to abstain from voting, or favour the dissolution of the Union.

After 1840 the attempt began in earnest to organize the Liberty Party thoroughly, and unite all anti-slavery men. The North-west, where “there was, after 1840, very little known of Garrison and his methods” (T. C. Smith), was the most promising field, but though the contest of state and local campaigns gave morale to the party, it made scant political gains (in 1843 it cast hardly 10% of the total vote); it could not convince the people that slavery should be made the paramount question in politics. In 1844, however, the Texas question gave

slavery precisely this pre-eminence in the presidential campaign. Until then, neither Whigs nor Democrats had regarded the Liberty Party seriously; now, however, each party charged that the Liberty movement was corruptly auxiliary to the other. As the campaign progressed, the Whigs alternately abused the Liberty men and made frantic appeals for their support. But the Liberty men were strongly opposed to Clay personally; and even if his equivocal campaign letters (see [CLAY, HENRY](#)) had not left exceedingly small ground for belief that he would resist the annexation of Texas, still the Liberty men were not such as to admit that an end justifies the means; therefore they again nominated Birney. He received 62,263 votes<sup>2</sup>—many more than enough in New York to have carried that state and the presidency for Clay, had they been thrown to his support. The Whigs, therefore, blamed the Liberty Party for Democratic success and the annexation of Texas; but—quite apart from the issue of political ethics—it is almost certain that though Clay’s chances were injured by the Liberty ticket, they were injured much more outside the Liberty ranks, by his own quibbles.<sup>3</sup> After 1844 the Liberty Party made little progress. Its leaders were never very strong as politicians, and its ablest organizer, Birney, was about this time compelled by an accident to abandon public life. Moreover, the election of 1844 was in a way fatal to the party; for it seemed to prove that though “abolition” was not the party programme, still its antecedents and personnel were too radical to unite the North; and above all it could not, after 1844, draw the disaffected Whigs, for though their party was steadily moving toward anti-slavery their dislike of the Liberty Party effectually prevented union. Indeed, no party of one idea could hope to satisfy men who had been Whigs or Democrats. At the same time, anti-slavery Whigs and Democrats were segregating in state politics, and the issue of excluding slavery from the new territory acquired from Mexico afforded a golden opportunity to unite all anti-slavery men on the principle of the Wilmot Proviso (1846). The Liberty Party reached its greatest strength (casting 74,017 votes) in the state elections of 1846. Thereafter, though growing somewhat in New England, it rapidly became ineffective in the rest of the North. Many, including Birney, thought it should cease to be an isolated party of one idea—striving for mere balance of power between Whigs and Democrats, welcoming small concessions from them, almost dependent upon them. Some wished to revivify it by making it a party of general reform. One result was the secession and formation of the Liberty League, which in 1847 nominated Gerrit Smith for the presidency. No adequate effort was made to take advantage of the disintegration of other parties. In October 1847, at Buffalo, was held the third and last national convention. John P. Hale—whose election to the United States Senate had justified the first successful union of Liberty men with other anti-slavery men in state politics—was nominated for the presidency. But the nomination by the Democrats of Lewis Cass shattered the Democratic organization in New York and the North-west; and when the Whigs nominated General Taylor, adopted a non-committal platform, and showed hostility to the Wilmot Proviso, the way was cleared for a union of all anti-slavery men. The Liberty Party, abandoning therefore its independent nominations, joined in the first convention and nominations of the Free Soil Party (*q.v.*), thereby practically losing its identity, although it continued until after the organization of the Republican Party to maintain something of a semi-independent organization. The Liberty Party has the unique honour among third-parties in the United States of seeing its principles rapidly adopted and realized.

See T. C. Smith, *History of the Liberty and Free Soil Parties in the Northwest* (Harvard University Historical Studies, New York, 1897), and lives and writings of all the public men mentioned above; also of G. W. Julian, J. R. Giddings and S. P. Chase.



**LIBITINA**, an old Roman goddess of funerals. She had a sanctuary in a sacred grove (perhaps on the Esquiline), where, by an ordinance of Servius Tullius, a piece of money (*lucar Libitinae*) was deposited whenever a death took place. Here the undertakers (*libitinarii*), who carried out all funeral arrangements by contract, had their offices, and everything necessary was kept for sale or hire; here all deaths were registered for statistical purposes. The word *Libitina* then came to be used for the business of an undertaker, funeral requisites, and (in the poets) for death itself. By later antiquarians Libitina was sometimes identified with Persephone, but more commonly (partly or completely) with Venus Lubentia or Lubentina, an Italian goddess of gardens. The similarity of name and the fact that Venus Lubentia had a sanctuary in the grove of Libitina favoured this idea. Further, Plutarch (*Quaest. Rom.* 23) mentions a small statue at Delphi of Aphrodite Epitymbia (A. of tombs = Venus Libitina), to which the spirits of the dead were summoned. The inconsistency of selling funeral requisites in the temple of Libitina, seeing that she is identified with Venus, is explained by him as indicating that one and the same goddess presides over birth and death; or the association of such things with the goddess of love and pleasure is intended to show that death is not a calamity, but rather a consummation to be desired. Libitina may, however, have been originally an earth goddess, connected with luxuriant nature and the enjoyments of life (cf. *lub-et, lib-ido*); then, all such deities being connected with the underworld, she also became the goddess of death, and that side of her character predominated in the later conceptions.

See Plutarch, *Numa*, 12; Dion. Halic. iv. 15; Festus xvi., s.v. “*Rustica Vinalia*”; Juvenal xii. 121, with Mayor’s note; G. Wissowa in Roscher’s *Lexicon der Mythologie*, s.v.

- 1 Mr T. C. Smith estimates that probably not one in ten of even professed abolitionists supported Birney; only in Massachusetts did he receive as much as 1% of the total vote cast.
- 2 Birney’s vote was reduced by a disgraceful election trick by the Whigs (the circulation of a forged letter on the eve of the election); a trick to which he had exposed himself by an ingenuously honest reception of Democratic advances in a matter of local good-government in Michigan.
- 3 E.g. Horace Greeley made the Whig charge; but in later life he repeatedly attributed Clay’s defeat simply to Clay’s own letters; and for Millard Fillmore’s important opinion see footnote to [KNOW NOTHING PARTY](#).



**LIBMANAN**, a town of the province of Ambos Camarines, Luzon, Philippine Islands, on the Libmanan river, 11 m. N.W. of Nueva Cáceres, the capital. Pop. (1903) 17,416. It is about 4½ m. N.E. of the Bay of San Miguel. Rice, coco-nuts, hemp, Indian corn, sugarcane, bejuco, arica nuts and camotes, are grown in the vicinity, and the manufactures include hemp goods, alcohol (from coco-nut-palm sap), copra, and baskets, chairs, hammocks and hats of bejuco and bamboo. The Libmanan river, a tributary of the Bicol, into which it empties 2 m. below the town, is famous for its clear cold water and for its sulphur springs. The language is Bicol.



**LIBO**, in ancient Rome, the name of a family belonging to the Scribonian gens. It is chiefly interesting for its connexion with the Puteal Scribonianum or Puteal Libonis in the forum at Rome,<sup>1</sup> dedicated or restored by one of its members, perhaps the praetor of 204 B.C., or the tribune of the people in 149. In its vicinity the praetor's tribunal, removed from the comitium in the 2nd century B.C., held its sittings, which led to the place becoming the haunt of litigants, money-lenders and business people. According to ancient authorities, the Puteal Libonis was between the temples of Castor and Vesta, near the Porticus Julia and the Arcus Fabiorum, but no remains have been discovered. The idea that an irregular circle of travertine blocks, found near the temple of Castor, formed part of the puteal is now abandoned.

545

See Horace, *Sat.* ii. 6. 35, *Epp.* i. 19. 8; Cicero, *Pro Sestio*, 8; for the well-known coin of L. Scribonius Libo, representing the puteal of Libo, which rather resembles a *cippus* (sepulchral monument) or an altar, with laurel wreaths, two lyres and a pair of pincers or tongs below the wreaths (perhaps symbolical of Vulcanus as forger of lightning), see C. Hülsen, *The Roman Forum* (Eng. trans. by J. B. Carter, 1906), p. 150, where a marble imitation found at Veii is also given.

- <sup>1</sup> *Puteal* was the name given to an erection (or enclosure) on a spot which had been struck by lightning; it was so called from its resemblance to the stone kerb or low enclosure round a well (*puteus*).



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



**LIBOURNE**, a town of south-western France, capital of an arrondissement of the department of Gironde, situated at the confluence of the Isle with the Dordogne, 22 m. E.N.E. of Bordeaux on the railway to Angoulême. Pop. (1906) town, 15,280; commune, 19,323. The sea is 56 m. distant, but the tide affects the river so as to admit of vessels drawing 14 ft. reaching the town at the highest tides. The Dordogne is here crossed by a stone bridge 492 ft. long, and a suspension bridge across the Isle connects Libourne with Fronsac, built on a hill on which in feudal times stood a powerful fortress. Libourne is regularly built. The Gothic church, restored in the 19th century, has a stone spire 232 ft. high. On the quay there is a machicolated clock-tower which is a survival of the ramparts of the 14th century; and the town-house, containing a small museum and a library, is a quaint relic of the 16th century. There is a statue of the Duc Decazes, who was born in the neighbourhood. The sub-prefecture, tribunals of first instance and of commerce, and a communal college are among the public institutions. The principal articles of commerce are the wines and brandies of the district. Printing and cooperage are among the industries.

Like other sites at the confluence of important rivers, that of Libourne was appropriated at an early period. Under the Romans *Condate* stood rather more than a mile to the south of the present Libourne; it was destroyed during the troubles of the 5th century. Resuscitated by Charlemagne, it was rebuilt in 1269, under its present name and on the site and plan it still retains, by Roger de Leybourne (of Leybourne in Kent), seneschal of Guienne, acting under the authority of King Edward I. of England. It suffered considerably in the struggles of the French and English for the possession of Guienne in the 14th century.

See R. Guinodie, *Hist. de Libourne* (2nd ed., 2 vols., Libourne, 1876-1877).



**LIBRA** (“THE BALANCE”), in astronomy, the 7th sign of the zodiac (*q.v.*), denoted by the symbol ♎, resembling a pair of scales, probably in allusion to the fact that when the sun enters this part of the ecliptic, at the autumnal equinox, the days and nights are equal. It is also a constellation, not mentioned by Eudoxus or Aratus, but by Manetho (3rd century B.C.) and Geminus (1st century B.C.), and included by Ptolemy in his 48 asterisms; Ptolemy catalogued 17 stars, Tycho Brahe 10, and Hevelius 20. δ *Librae* is an Algol (*q.v.*) variable, the range of magnitude being 5.0 to 6.2, and the period 2 days 7 hrs. 51 min.; and the cluster *M. 5 Librae* is a faint globular cluster of which only about one star in eleven is variable.



**LIBRARIES.** A library (from Lat. *liber*, book), in the modern sense, is a collection of printed or written literature. As such, it implies an advanced and elaborate civilization. If the term be extended to any considerable collection of written documents, it must be nearly as old as civilization itself. The earliest use to which the invention of inscribed or written signs was put was probably to record important religious and political transactions. These records would naturally be preserved in sacred places, and accordingly the earliest libraries of the world were probably temples, and the earliest librarians priests. And indeed before the extension of the arts of writing and reading the priests were the only persons who could perform such work as, *e.g.* the compilation of the *Annales Maximi*, which was the duty of the pontifices in ancient Rome. The beginnings of literature proper in the shape of ballads and songs may have continued to be conveyed orally only from one generation to another, long after the record of important religious or civil events was regularly committed to writing. The earliest collections of which we know anything, therefore, were collections of archives. Of this character appear to have been such famous collections as that of the Medians at Ecbatana, the Persians at Susa or the hieroglyphic archives of Knossos discovered by A. J. Evans (*Scripta Minoa*, 1909) of a date synchronizing with the XIIth Egyptian dynasty. It is not until the development of arts and sciences, and the growth of a considerable written literature, and even of a distinct literary class, that we find collections of books which can be called libraries in our modern sense. It is of libraries in the modern sense, and not, except incidentally, of archives that we are to speak.

#### ANCIENT LIBRARIES

The researches which have followed the discoveries of P. E. Botta and Sir H. Layard have thrown unexpected light not only upon the history but upon the arts, the sciences and the literatures of the ancient civilizations of Babylonia and Assyria. In all these wondrous revelations no facts are more interesting than those which show the existence of extensive libraries so many ages ago, and none are more eloquent of the elaborateness of these forgotten civilizations. In the course of his excavations at Nineveh in 1850, Layard came upon some chambers in the south-west palace, the floor of which, as well as the adjoining rooms, was covered to the depth of a foot with tablets of clay, covered with cuneiform characters, in many cases so small as to require a magnifying glass. These varied in size from 1 to 12 in. square. A great number of them were broken, as Layard supposed by the falling in of the roof, but as George Smith thought by having fallen from the upper storey, upon which he believed the collection to have been placed. These tablets formed the library of the great monarch Assur-bani-pal—the Sardanapalus of the Greeks—the greatest patron of literature amongst the Assyrians. It is estimated that this library consisted of some ten thousand distinct works and documents, some of the works extending over several tablets. The tablets appear to have been methodically arranged and catalogued, and the library seems to have been thrown open for the general use of the king's subjects.<sup>1</sup> A great portion of this library has already been brought to England and deposited in the British museum, but it is calculated that there still remain some 20,000 fragments to be gathered up. For further details as to Assyrian libraries, and the still earlier Babylonian libraries at Tello, the ancient Lagash, and at Niffer, the ancient Nippur, from which the Assyrians drew their science and literature, see [BABYLONIA](#) and [NIPPUR](#).

Of the libraries of ancient Egypt our knowledge is scattered and imperfect, but at a time extending to more than 6000 years ago we find numerous scribes of many classes who recorded official events in the life of their royal masters or details of their domestic affairs and business transactions. Besides this official literature we possess examples of many commentaries on the sacerdotal books, as well as historical treatises, works on moral philosophy and proverbial wisdom, science, collections of medical receipts as well as a great variety of popular novels and humoristic pieces. At an early date Heliopolis was a literary centre of great importance with culture akin to the Babylonian.

Attached to every temple were professional scribes whose function was partly religious and partly scientific. The sacred books of Thoth constituted as it were a complete encyclopaedia of religion and science, and on these books was gradually accumulated an immense mass of exposition and commentary. We possess a record relating to “the land of the collected works [library] of Khufu,” a monarch of the IVth dynasty, and a similar inscription relating to the library of Khafra, the builder of the second pyramid. At Edfu the library was a small chamber in the temple, on the wall of which is a list of books, among them a manual of Egyptian geography (Brugsch, *History of Egypt*, 1881, i. 240). The exact position of Akhenaten's library (or archives) of clay tablets is known and the name of the room has been read on the books of which it has been built. A library of charred books has been found at Mendes (Egypt Expl. Fund, *Two Hieroglyphic Papyri*), and we have references to temple libraries in the Silsileh “Nile” stelae and perhaps in the great Harris papyri. The most famous of the Egyptian libraries is that of King Osymandyas, described by Diodorus Siculus, who relates that it bore an inscription which he renders by the Greek words ΨΥΧΗΣ ΙΑΤΡΕΙΟΝ “the Dispensary of the Soul.” Osymandyas has been identified with the great king Rameses II. (1300-1236 B.C.) and the seat of the library is supposed to have been the Ramessaeum at Western Thebes. Amen-em-hant was the name of one of the directors of the Theban libraries. Papyri from the palace, of a later date, have been discovered by Professor W. F. Flinders Petrie. At Thebes the scribes of the “Foreign Office” are depicted at work in a room which was perhaps rather an office than a library. The famous Tel-el-Amarna tablets (1383-1365 B.C.) were stored in “the place of the records of the King.” There were record

offices attached to the granary and treasury departments and we know of a school or college for the reproduction of books, which were kept in boxes and in jars. According to Eustathius there was a great collection at Memphis. A heavy blow was dealt to the old Egyptian literature by the Persian invasion, and many books were carried away by the conquerors. The Egyptians were only delivered from the yoke of Persia to succumb to that of Greece and Rome and henceforward their civilization was dominated by foreign influences. Of the Greek libraries under the Ptolemies we shall speak a little further on.

Of the libraries of ancient Greece we have very little knowledge, and such knowledge as we possess comes to us for the most part from late compilers. Amongst those who are known to have collected books are Pisistratus, Polycrates of Samos, Euclid the Athenian, Nicocrates of Cyprus, Euripides and Aristotle (Athenaeus i. 4). At Cnidus there is said to have been a special collection of works upon medicine. Pisistratus is reported to have been the first of the Greeks who collected books on a large scale. Aulus Gellius, indeed, tells us, in language perhaps "not well suited to the 6th century B.C.,"<sup>2</sup> that he was the first to establish a public library. The authority of Aulus Gellius is hardly sufficient to secure credit for the story that this library was carried away into Persia by Xerxes and subsequently restored to the Athenians by Seleucus Nicator. Plato is known to have been a collector; and Xenophon tells us of the library of Euthydemus. The library of Aristotle was bequeathed by him to his disciple Theophrastus, and by Theophrastus to Neleus, who carried it to Scepsis, where it is said to have been concealed underground to avoid the literary cupidity of the kings of Pergamum. Its subsequent fate has given rise to much controversy, but, according to Strabo (xiii. pp. 608, 609), it was sold to Apellicon of Teos, who carried it to Athens, where after Apellicon's death it fell a prey to the conqueror Sulla, and was transported by him to Rome. The story told by Athenaeus (i. 4) is that the library of Neleus was purchased by Ptolemy Philadelphus. The names of a few other libraries in Greece are barely known to us from inscriptions; of their character and contents we know nothing. If, indeed, we are to trust Strabo entirely, we must believe that Aristotle was the first person who collected a library, and that he communicated the taste for collecting to the sovereigns of Egypt. It is at all events certain that the libraries of

**Alexandria.** Alexandria were the most important as they were the most celebrated of the ancient world. Under the enlightened rule of the Ptolemies a society of scholars and men of science was attracted to their capital. It seems pretty certain that Ptolemy Soter had already begun to collect books, but it was in the reign of Ptolemy Philadelphus that the libraries were properly organized and established in separate buildings. Ptolemy Philadelphus sent into every part of Greece and Asia to secure the most valuable works, and no exertions or expense were spared in enriching the collections. Ptolemy Euergetes, his successor, is said to have caused all books brought into Egypt by foreigners to be seized for the benefit of the library, while the owners had to be content with receiving copies of them in exchange. Nor did the Alexandrian scholars exhibit the usual Hellenic exclusiveness, and many of the treasures of Egyptian and even of Hebrew literature were by their means translated into Greek. There were two libraries at Alexandria; the larger, in the Bruchem quarter, was in connexion with the Museum, a sort of academy, while the smaller was placed in the Serapeum. The number of volumes in these libraries was very large, although it is difficult to attain any certainty as to the real numbers amongst the widely varying accounts. According to a scholium of Tzetzes, who appears to draw his information from the authority of Callimachus and Eratosthenes, who had been librarians at Alexandria, there were 42,800 vols. or rolls in the Serapeum and 490,000 in the Bruchem.<sup>3</sup> This enumeration seems to refer to the librarianship of Callimachus himself under Ptolemy Euergetes. In any case the figures agree tolerably well with those given by Aulus Gellius<sup>4</sup> (700,000) and Seneca<sup>5</sup> (400,000). It should be observed that, as the ancient roll or volume usually contained a much smaller quantity of matter than a modern book—so that, *e.g.* the history of Herodotus might form nine "books" or volumes, and the *Iliad* of Homer twenty-four—these numbers must be discounted for the purposes of comparison with modern collections. The series of the first five librarians at Alexandria appears to be pretty well established as follows: Zenodotus, Callimachus, Eratosthenes, Apollonius and Aristophanes; and their activity covers a period of about a century. The first experiments in bibliography appear to have been made in producing catalogues of the Alexandrian libraries. Amongst other lists, two catalogues were prepared by order of Ptolemy Philadelphus, one of the tragedies, the other of the comedies contained in the collections. The Πίνακες of Callimachus formed a catalogue of all the principal books arranged in 120 classes. When Caesar set fire to the fleet in the harbour of Alexandria, the flames accidentally extended to the larger library of the Bruchem, and it was destroyed.<sup>6</sup> Antony endeavoured to repair the loss by presenting to Cleopatra the library from Pergamum. This was very probably placed in the Bruchem, as this continued to be the literary quarter of Alexandria until the time of Aurelian. Thenceforward the Serapeum became the principal library. The usual statement that from the date of the restoration of the Bruchem under Cleopatra the libraries continued in a flourishing condition until they were destroyed after the conquest of Alexandria by the Saracens in A.D. 640 can hardly be supported. It is very possible that one of the libraries perished when the Bruchem quarter was destroyed by Aurelian, A.D. 273. In 389 or 391 an edict of Theodosius ordered the destruction of the Serapeum, and its books were pillaged by the Christians. When we take into account the disordered condition of the times, and the neglect into which literature and science had fallen, there can be little difficulty in believing that there were but few books left to be destroyed by the soldiers of Amru. The familiar anecdote of the caliph's message to his general rests mainly upon the evidence of Abulfaraj, so that we may be tempted to agree with Gibbon that the report of a stranger who wrote at the end of six hundred years is overbalanced by the silence of earlier and native annalists. It is, however, so far from easy to settle the question that a cloud of names could easily be cited upon either side, while some of the most careful inquirers confess the difficulty of a decision<sup>7</sup> (see *ALEXANDRIA*, III.).

The magnificence and renown of the libraries of the Ptolemies excited the rivalry of the kings of Pergamum, who vied with the Egyptian rulers in their encouragement of literature. The German researches in the acropolis of Pergamum between 1878 and 1886 revealed four rooms which had originally been appropriated to the library (Alex. Conze, *Die pergamen. Bibliothek*, 1884). Despite the obstacles presented by the embargo placed by the Ptolemies upon the export of papyrus, the library of the Attali attained considerable importance, and, as we have seen, when it was transported to Egypt numbered 200,000 vols. We learn from a notice in Suidas that in 221 B.C. Antiochus the Great summoned the poet and grammarian Euphorion of Chalcis to be his librarian.

The early Romans were far too warlike and practical a people to devote much attention to literature, and it is not until the last century of the republic that we hear of libraries in Rome. The collections of Carthage, which fell into their hands when Scipio sacked that city (146 B.C.), had no attractions for them; and with the exception of the writings of Mago upon agriculture, which the senate reserved for translation into Latin, they



**Rome.**

bestowed all the books upon the kinglets of Africa (Pliny, *H.N.* xviii. 5). It is in accordance with the military character of the Romans that the first considerable collections of which we hear in Rome were brought there as the spoils of war. The first of these was that brought by Aemilius Paulus from Macedonia after the conquest of Perseus (167 B.C.). The library of the conquered monarch was all that he reserved from the prizes of victory for himself and his sons, who were fond of letters. Next came the library of Apellicon the Teian, brought from Athens by Sulla (86 B.C.). This passed at his death into the hands of his son, but of its later history nothing is known. The rich stores of literature brought home by Lucullus from his eastern conquests (about 67 B.C.) were freely thrown open to his friends and to men of letters. Accordingly his library and the neighbouring walks were much resorted to, especially by Greeks. It was now becoming fashionable for rich men to furnish their libraries well, and the fashion prevailed until it became the subject of Seneca's scorn and Lucian's wit. The zeal of Cicero and Atticus in adding to their collections is well known to every reader of the classics. Tyrannion is said to have had 30,000 vols. of his own; and that M. Terentius Varro had large collections we may infer from Cicero's writing to him: "Si hortum in bibliotheca habes, nihil deerit." Not to prolong the list of private collectors, Serenus Sammonicus is said to have left to his pupil the young Gordian no less than 62,000 vols. Amongst the numerous projects entertained by Caesar was that of presenting Rome with public libraries, though it is doubtful whether any steps were actually taken towards its execution. The task of collecting and arranging the books was entrusted to Varro. This commission, as well as his own fondness for books, may have led Varro to write the book upon libraries of which a few words only have come down to us, preserved by a grammarian. The honour of being the first actually to dedicate a library to the public is said by Pliny and Ovid to have fallen to G. Asinius Pollio, who erected a library in the Atrium Libertatis on Mount Aventine, defraying the cost from the spoils of his Illyrian campaign. The library of Pollio was followed by the public libraries established by Augustus. That emperor, who did so much for the embellishment of the city, erected two libraries, the Octavian and the Palatine. The former was founded (33 B.C.) in honour of his sister, and was placed in the Porticus Octaviae, a magnificent structure, the lower part of which served as a promenade, while the upper part contained the library. The charge of the books was committed to C. Melissus. The other library formed by Augustus was attached to the temple of Apollo on the Palatine hill, and appears from inscriptions to have consisted of two departments, a Greek and a Latin one, which seem to have been separately administered. The charge of the Palatine collections was given to Pompeius Macer, who was succeeded by Julius Hyginus, the grammarian and friend of Ovid. The Octavian library perished in the fire which raged at Rome for three days in the reign of Titus. The Palatine was, at all events in great part, destroyed by fire in the reign of Commodus. The story that its collections were destroyed by order of Pope Gregory the Great in the 6th century is now generally rejected. The successors of Augustus, though they did not equal him in their patronage of learning, maintained the tradition of forming libraries. Tiberius, his immediate successor, established one in his splendid house on the Palatine, to which Gellius refers as the "Tiberian library," and Suetonius relates that he caused the writings and images of his favourite Greek poets to be placed in the public libraries. Vespasian established a library in the Temple of Peace erected after the burning of the city under Nero. Domitian restored the libraries which had been destroyed in the same conflagration, procuring books from every quarter, and even sending to Alexandria to have copies made. He is also said to have founded the Capitoline library, though others give the credit to Hadrian. The most famous and important of the imperial libraries, however, was that created by Ulpian Trajanus, known as the Ulpian library, which was first established in the Forum of Trajan, but was afterwards removed to the baths of Diocletian. In this library were deposited by Trajan the "libri lintei" and "libri elephantini," upon which the senatus consulta and other transactions relating to the emperors were written. The library of Domitian, which had been destroyed by fire in the reign of Commodus, was restored by Gordian, who added to it the books bequeathed to him by Serenus Sammonicus. Altogether in the 4th century there are said to have been twenty-eight public libraries in Rome.

Nor were public libraries confined to Rome. We possess records of at least 24 places in Italy, the Grecian provinces, Asia Minor, Cyprus and Africa in which libraries had been established, most of them attached to temples, usually through the liberality of generous individuals. The library which the younger Pliny dedicated to his townsmen at Comum cost a million sesterces and he contributed a large sum to the support of a library at Milan. Hadrian established one at Athens, described by Pausanias, and recently identified with a building called the Stoa of Hadrian, which shows a striking similarity with the precinct of Athena at Pergamum. Strabo mentions a library at Smyrna; Aulus Gellius one at Patrae and another at Tibur from which books could be borrowed. Recent discoveries at Ephesus in Asia Minor and Timgad in Algeria have furnished precise information as to the structural plan of these buildings. The library at Ephesus was founded by T. Julius Aquila Polemaeanus in memory of his father, pro-consul of Asia in the time of Trajan, about A.D. 106-107. The library at Timgad was established at a cost of 400,000 sesterces by M. Julius Quintianus Flavius Rogatianus, who probably lived in the 3rd century (R. Cagnat, "Les Bibliothèques municipales dans l'Empire Romain," 1906, *Mém. de l'Acad. des Insc.*, tom. xxxviii. pt. 1). At Ephesus the light came through a circular opening in the roof; the library at Timgad greatly resembles that discovered at Pompeii and possesses a system of book stores. All these buildings followed the same general plan, consisting of a reading-room and more or less ample book stores; the former was either rectangular or semi-circular in shape and was approached under a stately portico and colonnade. In a niche facing the entrance a statue was always erected; that formerly at Pergamum—a figure of Minerva—is now preserved at Berlin. From a well-known line of Juvenal (*Sat.* iii. 219) we may assume that a statue of the goddess was usually placed in libraries. The reading-room was also ornamented with busts or life-sized images of celebrated writers. The portraits or authors were also painted on medallions on the presses (*armaria*) in which the books or rolls were preserved as in the library of Isidore of Seville; sometimes these medallions decorated the walls, as in a private library discovered by Lanciani in 1883 at Rome (*Ancient Rome*, 1888, p. 193). Movable seats, known to us by pictorial representations, were in use. The books were classified, and the presses (framed of precious woods and highly ornamented) were numbered to facilitate reference from the catalogues. A private library discovered at Herculaneum contained 1756 MSS. placed on shelves round the room to a height of about 6 ft. with a central press. In the public rooms some of the books were arranged in the reading-room and some in the adjacent book stores. The Christian libraries of later foundation closely followed the classical prototypes not only in their structure but also in smaller details. The general appearance of a Roman library is preserved in the library of the Vatican fitted up by Sextus V. in 1587 with painted presses, busts and antique vases.

As the number of libraries in Rome increased, the librarian, who was generally a slave or freedman, became a recognized public functionary. The names of several librarians are preserved to us in inscriptions, including that

of C. Hymenaeus, who appears to have fulfilled the double function of physician and librarian to Augustus. The general superintendence of the public libraries was committed to a special official. Thus from Nero to Trajan, Dionysius, an Alexandrian rhetorician, discharged this function. Under Hadrian it was entrusted to his former tutor C. Julius Vestinus, who afterwards became administrator of the Museum at Alexandria.

When the seat of empire was removed by Constantine to his new capital upon the Bosphorus, the emperor established a collection there, in which Christian literature was probably admitted for the first time into an imperial library. Diligent search was made after the Christian books which had been doomed to **Constantinople.** destruction by Diocletian. Even at the death of Constantine, however, the number of books which had been brought together amounted only to 6900. The smallness of the number, it has been suggested, seems to show that Constantine's library was mainly intended as a repository of Christian literature. However this may be, the collection was greatly enlarged by some of Constantine's successors, especially by Julian and Theodosius, at whose death it is said to have increased to 100,000 vols. Julian, himself a close student and voluminous writer, though he did his best to discourage learning among the Christians, and to destroy their libraries, not only augmented the library at Constantinople, but founded others, including one at Nisibis, which was soon afterwards destroyed by fire. From the Theodosian code we learn that in the time of that emperor a staff of seven copyists was attached to the library at Constantinople under the direction of the librarian. The library was burnt under the emperor Zeno in 477, but was again restored.

Meanwhile, as Christianity made its way and a distinctively Christian literature grew up, the institution of libraries became part of the ecclesiastical organization. Bishop Alexander (d. A.D. 250) established a church library at Jerusalem, and it became the rule to attach to every church a collection necessary for the inculcation of Christian doctrine. There were libraries at Cirta, at Constantinople and at Rome. The basilica of St Lawrence at Rome contained a library or *archivum* founded by Pope Damasus at the end of the 4th century. Most of these collections were housed in the sacred edifices and consisted largely of copies of the Holy Scriptures, liturgical volumes and works of devotion. They also included the *Gesta Martyrum* and *Matriculae Pauperum* and official correspondence. Many of the basilicas had the apse subdivided into three smaller hemicycles, one of which contained the library (Lanciani, op. cit. p. 187). The largest of these libraries, that founded by Pamphilus (d. A.D. 309) at Caesarea, and said to have been increased by Eusebius, the historian of the church, to 30,000 vols., is frequently mentioned by St Jerome. St Augustine bequeathed his collection to the library of the church at Hippo, which was fortunate enough to escape destruction at the hands of the Vandals. The hermit communities of the Egyptian deserts formed organizations which developed into the later monastic orders of Western Europe and the accumulation of books for the brethren was one of their cares.

The removal of the capital to Byzantium was in its result a serious blow to literature. Henceforward the science and learning of the East and West were divorced. The libraries of Rome ceased to collect the writings of the Greeks, while the Greek libraries had never cared much to collect Latin literature. The influence of the church became increasingly hostile to the study of pagan letters. The repeated irruptions of the barbarians soon swept the old learning and libraries alike from the soil of Italy. With the close of the Western empire in 476 the ancient history of libraries may be said to cease.

#### MEDIEVAL PERIOD

During the first few centuries after the fall of the Western empire, literary activity at Constantinople had fallen to its lowest ebb. In the West, amidst the general neglect of learning and literature, the collecting of books, though not wholly forgotten, was cared for by few. Sidonius Apollinaris tells us of the libraries **Gaul.** of several private collectors in Gaul. Publius Consentius possessed a library at his villa near Narbonne which was due to the labour of three generations. The most notable of these appears to have been the prefect Tonantius Ferreolus, who had formed in his villa of Prusiana, near Nîmes, a collection which his friend playfully compares to that of Alexandria. The Goths, who had been introduced to the Scriptures in their own language by Ulfilas in the 4th century, began to pay some attention to Latin literature. Cassiodorus, the favourite minister of Theodoric, was a collector as well as an author, and on giving up the cares of government retired to a monastery which he founded in Calabria, where he employed his monks in the transcription of books.

Henceforward the charge of books as well as of education fell more and more exclusively into the hands of the church. While the old schools of the rhetoricians died out new monasteries arose everywhere. Knowledge was no longer pursued for its own sake, but became subsidiary to religious and theological teaching. The proscription of the old classical literature, which is symbolized in the fable of the destruction of the Palatine library by Gregory the Great, was only too effectual. The Gregorian tradition of opposition to pagan learning long continued to dominate the literary pursuits of the monastic orders and the labours of the scriptorium.

During the 6th and 7th centuries the learning which had been driven from the Continent took refuge in the British Islands, where it was removed from the political disturbances of the mainland. In the Irish monasteries during this period there appear to have been many books, and the Venerable Bede was superior to any scholar of his age. Theodore of Tarsus brought a considerable number of books to **Alcuin.** Canterbury from Rome in the 7th century, including several Greek authors. The library of York, which was founded by Archbishop Egbert, was almost more famous than that of Canterbury. The verses are well known in which Alcuin describes the extensive library under his charge, and the long list of authors whom he enumerates is superior to that of any other library possessed by either England or France in the 12th century, when it was unhappily burnt. The inroads of the Northmen in the 9th and 10th centuries had been fatal to the monastic libraries on both sides of the channel. It was from York that Alcuin came to Charlemagne to superintend the school attached to his palace; and it was doubtless inspired by Alcuin that Charles issued the memorable document which enjoined that in the bishoprics and monasteries within his realm care should be taken that there shall be not only a regular manner of life, but also the study of letters. When Alcuin finally retired from the court to the abbacy of Tours, there to carry out his own theory of monastic discipline and instruction, he wrote to Charles for leave to send to York for copies of the books of which they had so much need at Tours. While Alcuin thus increased the library at Tours, Charlemagne enlarged that at Fulda, **Charlemagne.** which had been founded in 774, and which all through the middle ages stood in great respect. Lupus Servatus, a pupil of Hrabanus Maurus at Fulda, and afterwards abbot of Ferrières, was a

devoted student of the classics and a great collector of books. His correspondence illustrates the difficulties which then attended the study of literature through the paucity and dearness of books, the declining care for learning, and the increasing troubles of the time. Nor were private collections of books altogether wanting during the period in which Charlemagne and his successors laboured to restore the lost traditions of liberal education and literature. Pepin le Bref had indeed met with scanty response to the request for books which he addressed to the pontiff Paul I. Charlemagne, however, collected a considerable number of choice books for his private use in two places. Although these collections were dispersed at his death, his son Louis formed a library which continued to exist under Charles the Bald. About the same time Everard, count of Friuli, formed a considerable collection which he bequeathed to a monastery. But the greatest private collector of the middle ages was doubtless Gerbert, Pope Sylvester II., who showed the utmost zeal and spent large sums in collecting books, not only in Rome and Italy, but from Germany, Belgium and even from Spain.

The hopes of a revival of secular literature fell with the decline of the schools established by Charles and his successors. The knowledge of letters remained the prerogative of the church, and for the next four or five centuries the collecting and multiplication of books were almost entirely confined to the monasteries. Several of the greater orders made these an express duty; this was especially the case with the Benedictines. It was the first care of St Benedict, we are told, that in each newly founded monastery there should be a library, "et velut curia quaedam illustrium auctorum." Monte Cassino became the starting-point of a long line of institutions which were destined to be the centres of religion and of literature. It must indeed be remembered that literature in the sense of St Benedict meant Biblical and theological works, the lives of the saints and martyrs, and the lives and writings of the fathers. Of the reformed Benedictine orders the Carthusians and the Cistercians were those most devoted to literary pursuits. The abbeys of Fleury, of Melk and of St Gall were remarkable for the splendour of their libraries. In a later age the labours of the congregation of St Maur form one of the most striking chapters in the history of learning. The Augustinians and the Dominicans rank next to the Benedictines in their care for literature. The libraries of St Geneviève and St Victor, belonging to the former, were amongst the largest of the monastic collections. Although their poverty might seem to put them at a disadvantage as collectors, the mendicant orders cultivated literature with much assiduity, and were closely connected with the intellectual movement to which the universities owed their rise. In England Richard of Bury praises them for their extraordinary diligence in collecting books. Sir Richard Whittington built a large library for the Grey Friars in London, and they possessed considerable libraries at Oxford.

It would be impossible to attempt here an account of all the libraries established by the monastic orders. We must be content to enumerate a few of the most eminent.

In Italy Monte Cassino is a striking example of the dangers and vicissitudes to which monastic collections were exposed. Ruined by the Lombards in the 6th century, the monastery was rebuilt and a library established, to fall a prey to Saracens and to fire in the 9th. The collection then reformed survived many other chances and changes, and still exists. Boccaccio gives a melancholy description of its condition in his day. It affords a conspicuous example of monastic industry in the transcription not only of theological but also of classical works. The library of Bobbio, which owed its existence to Irish monks, was famous for its palimpsests. The collection, of which a catalogue of the 10th century is given by Muratori (*Antiq. Ital. Med. Aev.* iii. 817-824), was mainly transferred to the Ambrosian library at Milan. Of the library of Pomposia, near Ravenna, Montfaucon has printed a catalogue dating from the 11th century (*Diarium Italicum*, chap. xxii.).

Of the monastic libraries of France the principal were those of Fleury, of Cluny, of St Riquier and of Corbie. At Fleury Abbot Macharius in 1146 imposed a contribution for library purposes upon the officers of the community and its dependencies, an example which was followed elsewhere. After many vicissitudes, its MSS., numbering 238, were deposited in 1793 in the town library of Orleans. The library of St Riquier in the time of Louis the Pious contained 256 MSS., with over 500 works. Of the collection at Corbie in Picardy we have also catalogues dating from the 12th and from the 17th centuries. Corbie was famous for the industry of its transcribers, and appears to have stood in active literary intercourse with other monasteries. In 1638, 400 of its choicest manuscripts were removed to St Germain-des-Prés. The remainder were removed after 1794, partly to the national library at Paris, partly to the town library of Amiens.

The chief monastic libraries of Germany were at Fulda, Corvey, Reichenau and Sponheim. The library at Fulda owed much to Charlemagne and to its abbot Hrabanus Maurus. Under Abbot Sturmius four hundred monks were hired as copyists. In 1561 the collection numbered 774 volumes. The library of Corvey on the Weser, after being despoiled of some of its treasures in the Reformation age, was presented to the university of Marburg in 1811. It then contained 109 vols., with 400 or 500 titles. The library of Reichenau, of which several catalogues are extant, fell a prey to fire and neglect, and its ruin was consummated by the Thirty Years' War. The library of Sponheim owes its great renown to John Trithem, who was abbot at the close of the 15th century. He found it reduced to 10 vols., and left it with upwards of 2000 at his retirement. The library at St Gall, formed as early as 816 by Gozbert, its second abbot, still exists.

In England the principal collections were those of Canterbury, York, Wearmouth, Jarrow, Whitby, Glastonbury, Croyland, Peterborough and Durham. Of the library of the monastery of Christ Church, Canterbury, originally founded by Augustine and Theodore, and restored by Lanfranc and Anselm, a catalogue has been preserved dating from the 13th or 14th century, and containing 698 volumes, with about 3000 works. Bennet Biscop, the first abbot of Wearmouth, made five journeys to Rome, and on each occasion returned with a store of books for the library. It was destroyed by the Danes about 867. Of the library at Whitby there is a catalogue dating from the 12th century. The catalogue of Glastonbury has been printed by Hearne in his edition of John of Glastonbury. When the library of Croyland perished by fire in 1091 it contained about 700 vols. The library at Peterborough was also rich; from a catalogue of about the end of the 14th century it had 344 vols., with nearly 1700 titles. The catalogues of the library at the monastery of Durham have been printed by the Surtees Society, and form an interesting series. These catalogues with many others<sup>8</sup> afford abundant evidence of the limited character of the monkish collections, whether we look at the number of their volumes or at the nature of their contents. The scriptoria were manufactories of books and not centres of learning. That in spite of the labours of so many transcribers the costliness and scarcity of books remained so great may have been partly, but cannot have been wholly, due to the scarcity of writing materials. It may be

suspected that indolence and carelessness were the rule in most monasteries, and that but few of the monks keenly realized the whole force of the sentiment expressed by one of their number in the 12th century—"Clastrum sine armario quasi castrum sine armamentario." Nevertheless it must be admitted that to the labours of the monastic transcribers we are indebted for the preservation of Latin literature.

The subject of the evolution of the arrangement of library rooms and fittings as gradually developed throughout medieval Europe should not be passed over.<sup>9</sup> The real origin of library organization in the Christian world, one may almost say the origin of modern library methods, began with the rule of St Benedict early in the 6th century. In the 48th chapter the monks were ordered to borrow a book apiece and to read it straight through. There was no special apartment for the books in the primitive Benedictine house. After the books became too numerous to be kept in the church they were preserved in *armaria*, or chests, in the cloister; hence the word *armarius*, the Benedictine librarian, who at first joined with it the office of precentor. The Benedictine regulations were developed in the stricter observances of the Cluniacs, which provided for a kind of annual report and stocktaking. The Carthusians were perhaps the first to lend books away from the convent; and the Cistercians to possess a separate library official as well as a room specially devoted to books. The observances of the Augustinians contained rules for the binding, repairing, cataloguing and arranging the books by the librarian, as well as a prescription of the exact kind of chest to be used. Among the Premonstratensians or Reformed Augustinians, it was one of the duties of the librarian to provide for the borrowing of books elsewhere for the use of the monks. The Mendicant Friars found books so necessary that at last Richard de Bury tells us with some exaggeration that their libraries exceeded all others. Many volumes still exist which belonged to the library at Assisi, the parent house of the Franciscans, of which a catalogue was drawn up in 1381. No authentic monastic bookcase can now be found; the doubtful example shown at Bayeux probably contained ecclesiastical utensils. At the Augustinian priory at Barnwell the presses were lined with wood to keep out the damp and were partitioned off both vertically and horizontally. Sometimes there were recesses in the walls of the cloisters fitted with shelves and closed with a door. These recesses developed into a small windowless room in the Cistercian houses. At Clairvaux, Kirkstall, Fountains, Tintern, Netley and elsewhere this small chamber was placed between the chapter-house and the transept of the church. At Meaux in Holderness the books were lodged on shelves against the walls and even over the door of such a chamber. In many houses the treasury or spendiment contained two classes of books—one for the monks generally, others more closely guarded. A press near the infirmary contained books used by the reader in the refectory. By the end of the 15th century the larger monasteries became possessed of many volumes and found themselves obliged to store the books, hitherto placed in various parts of the building, in a separate apartment. We now find libraries being specially built at Canterbury, Durham, Citeaux, Clairvaux and elsewhere, and with this specialization there grew up increased liberality in the use of books and learned strangers were admitted. Even at an early date students were permitted to borrow from the Benedictines at St Germain-des-Prés at Paris, of which a later foundation owned in 1513 a noble library erected over the south wall of the cloister, and enlarged and made very accessible to the outer world in the 17th and 18th centuries. The methods and fittings of college libraries of early foundation closely resembled those of the monastic libraries. There was in both the annual giving out and inspection of what we would now call the lending department for students; while the books, fastened by chains—a kind of reference department kept in the library chamber for the common use of the fellows—followed a similar system in monastic institutions. By the 15th century collegiate and monastic libraries were on the same plan, with the separate room containing books placed on their sides on desks or lecterns, to which they were attached by chains to a horizontal bar. As the books increased the accommodation was augmented by one or two shelves erected above the desks. The library at Cesena in North Italy may still be seen in its original condition. The Laurentian library at Florence was designed by Michelangelo on the monastic model. Another good example of the old form may be seen, in the library of Merton College at Oxford, a long narrow room with bookcases standing between the windows at right angles to the walls. In the chaining system one end was attached to the wooden cover of the book while the other ran freely on a bar fixed by a method of double locks to the front of the shelf or desk on which the book rested. The fore edges of the volumes faced the reader. The seat and shelf were sometimes combined. Low cases were subsequently introduced between the higher cases, and the seat replaced by a step. Shelf lists were placed at the end of each case. There were no chains in the library of the Escorial, erected in 1584, which showed for the first time bookcases placed against the walls. Although chains were no longer part of the appliances in the newly erected libraries they continued to be used and were ordered in bequests in England down to the early part of the 18th century. Triple desks and revolving lecterns, raised by a wooden screw, formed part of the library furniture. The English cathedral libraries were fashioned after the same principle. The old methods were fully reproduced in the fittings at Westminster, erected at a late date. Here we may see books on shelves against the walls as well as in cases at right angles to the walls; the desk-like shelves for the chained volumes (no longer in existence) have a slot in which the chains could be suspended, and are hinged to allow access to shelves below. An ornamental wooden tablet at the end of each case is a survival of the old shelf list. By the end of the 17th century the type of the public library developed from collegiate and monastic prototypes, became fixed as it were throughout Europe (H. R. Tedder, "Evolution of the Public Library," in *Trans. of 2nd Int. Library Conference*, 1897, 1898).

The first conquests of the Arabians, as we have already seen, threatened hostility to literature. But, as soon as their conquests were secured, the caliphs became the patrons of learning and science. Greek manuscripts were eagerly sought for and translated into Arabic, and colleges and libraries everywhere arose. Baghdad in the east and Cordova in the west became the seats of a rich development of letters and science during the age when the civilization of Europe was most obscured. Cairo and Tripoli were also distinguished for their libraries. The royal library of the Fatimites in Africa is said to have numbered 100,000 manuscripts, while that collected by the Omayyads of Spain is reported to have contained six times as many. It is said that there were no less than seventy libraries opened in the cities of Andalusia. Whether these figures be exaggerated or not—and they are much below those given by some Arabian writers, which are undoubtedly so—it is certain that the libraries of the Arabians and the Moors of Spain offer a very remarkable contrast to those of the Christian nations during the same period.<sup>10</sup>

The literary and scientific activity of the Arabians appears to have been the cause of a revival of letters amongst the Greeks of the Byzantine empire in the 9th century. Under Leo the Philosopher and Constantine Porphyrogenitus the libraries of Constantinople awoke into renewed life. The compilations of such writers as Stobaeus, Photius and Suidas, as well as the labours of innumerable critics and

**The development of library arrangements.**

**Arabians.**

**Renaissance.**

commentators, bear witness to the activity, if not to the lofty character of the pursuits, of the Byzantine scholars. The labours of transcription were industriously pursued in the libraries and in the monasteries of Mount Athos and the Aegean, and it was from these quarters that the restorers of learning brought into Italy so many Greek manuscripts. In this way many of the treasures of ancient literature had been already conveyed to the West before the fate which overtook the libraries of Constantinople on the fall of the city in 1453.

Meanwhile in the West, with the reviving interest in literature which already marks the 14th century, we find arising outside the monasteries a taste for collecting books. St Louis of France and his successors had formed small collections, none of which survived its possessor. It was reserved for Charles V. to form a considerable library which he intended to be permanent. In 1373 he had amassed 910 volumes, and had a catalogue of them prepared, from which we see that it included a good deal of the new sort of literature. In England Guy, earl of Warwick, formed a curious collection of French romances, which he bequeathed to Bordesley Abbey on his death in 1315. Richard d'Aungervyle of Bury, the author of the *Philobiblon*, amassed a noble collection of books, and had special opportunities of doing so as Edward III.'s chancellor and ambassador. He founded Durham College at Oxford, and equipped it with a library a hundred years before Humphrey, duke of Gloucester, made his benefaction of books to the university. The taste for secular literature, and the enthusiasm for the ancient classics, gave a fresh direction to the researches of collectors. A disposition to encourage literature began to show itself amongst the great. This was most notable amongst the Italian princes. Cosimo de' Medici formed a library at Venice while living there in exile in 1433, and on his return to Florence laid the foundation of the great Medicean library. The honour of establishing the first modern public library in Italy had been already secured by Niccolò Niccoli, who left his library of over 800 volumes for the use of the public on his death in 1436. Frederick, duke of Urbino, collected all the writings in Greek and Latin which he could procure, and we have an interesting account of his collection written by his first librarian, Vespasiano. The ardour for classical studies led to those active researches for the Latin writers who were buried in the monastic libraries which are especially identified with the name of Poggio. For some time before the fall of Constantinople, the perilous state of the Eastern empire had driven many Greek scholars from that capital into western Europe, where they had directed the studies and formed the taste of the zealous students of the Greek language and literature. The enthusiasm of the Italian princes extended itself beyond the Alps. Matthias Corvinus, king of Hungary, amassed a collection of splendidly executed and magnificently bound manuscripts, which at his death are said to have reached the almost incredible number of 50,000 vols. The library was not destined long to survive its founder. There is reason to believe that it had been very seriously despoiled even before it perished at the hands of the Turks on the fall of Buda in 1527. A few of its treasures are still preserved in some of the libraries of Europe. While these munificent patrons of learning were thus taking pains to recover and multiply the treasures of ancient literature by the patient labour of transcribers and calligraphers, an art was being elaborated which was destined to revolutionize the whole condition of literature and libraries. With the invention of printing, so happily coinciding with the revival of true learning and sound science, the modern history of libraries may be said to begin.

#### MODERN LIBRARIES

In most of the European countries and in the United States libraries of all kinds have during the last twenty years been undergoing a process of development and improvement which has greatly altered their policy and methods. At one time libraries were regarded almost entirely as repositories for the storage of books to be used by the learned alone, but now they are coming to be regarded more and more as workshops or as places for intellectual recreation adapted for every department of life. This is particularly to be found as the ideal in the public libraries of the Anglo-Saxon races throughout the world.

The following details comprise the chief points in the history, equipment and methods of the various libraries and systems noticed.

#### *The United Kingdom.*

*State Libraries.*—The British Museum ranks in importance before all the great libraries of the world, and excels in the arrangement and accessibility of its contents. The library consists of over 2,000,000 printed volumes and 56,000 manuscripts, but this large total does not include pamphlets and other small publications which are usually counted in other libraries. Adding these together it is probable that over 5,000,000 items are comprised in the collections. This extraordinary opulence is principally due to the enlightened energy of Sir Anthony Panizzi (*q.v.*). The number of volumes in the printed book department, when he took the keepership in 1837, was only 240,000; and during the nineteen years he held that office about 400,000 were added, mostly by purchase, under his advice and direction. It was Panizzi likewise who first seriously set to work to see that the national library reaped all the benefits bestowed upon it by the Copyright Act.

The foundation of the British Museum dates from 1753, when effect was given to the bequest (in exchange for £20,000 to be paid to his executors) by Sir Hans Sloane, of his books, manuscripts, curiosities, &c., to be held by trustees for the use of the nation. A bill was passed through parliament for the purchase of the Sloane collections and of the Harleian MSS., costing £10,000. To these, with the Cottonian MSS., acquired by the country in 1700, was added by George II., in 1757, the royal library of the former kings of England, coupled with the privilege, which that library had for many years enjoyed, of obtaining a copy of every publication entered at Stationers' Hall. This addition was of the highest importance, as it enriched the museum with the old collections of Archbishop Cranmer, Henry prince of Wales, and other patrons of literature, while the transfer of the privilege with regard to the acquisition of new books, a right which has been maintained by successive Copyright Acts, secured a large and continuous augmentation. A lottery having been authorized to defray the expenses of purchases, as well as for providing suitable accommodation, the museum and library were established in Montague House, and opened to the public 15th January 1759. In 1763 George III. presented the well-known Thomason collection (in 220 volumes) of books and pamphlets issued in England between 1640 and 1662, embracing all the controversial literature which appeared during that period. The Rev. C. M. Cracherode, one of the trustees, bequeathed his collection of choice books in 1799; and in 1820 Sir Joseph Banks left to the nation his important library of 16,000 vols. Many other libraries have since then been incorporated in the

museum, the most valuable being George III.'s royal collection (15,000 vols. of tracts, and 65,259 vols. of printed books, including many of the utmost rarity, which had cost the king about £130,000), which was presented (for a pecuniary consideration, it has been said) by George IV. in 1823, and that of the Right Honourable Thomas Grenville (20,240 vols. of rare books, all in fine condition and binding), which was acquired under bequest in 1846. The Cracherode, Banksian, King's and Grenville libraries are still preserved as separate collections. Other libraries of minor note have also been absorbed in a similar way, while, at least since the time of Panizzi, no opportunity has been neglected of making useful purchases at all the British and Continental book auctions.

The collection of English books is far from approaching completeness, but, apart from the enormous number of volumes, the library contains an extraordinary quantity of rarities. Few libraries in the United States equal either in number or value the American books in the museum. The collection of Slavonic literature, due to the initiative of Thomas Watts, is also a remarkable feature. Indeed, in cosmopolitan interest the museum is without a rival in the world, possessing as it does the best library in any European language out of the territory in which the language is vernacular. The Hebrew, the Chinese, and printed books in other Oriental languages are important and represented in large numbers. Periodical literature has not been forgotten, and the series of newspapers is of great extent and interest. Great pains are taken by the authorities to obtain the copies of the newspapers published in the United Kingdom to which they are entitled by the provisions of the Copyright Act, and upwards of 3400 are annually collected, filed and bound.

552

The department of MSS. is almost equal in importance to that of the printed books. The collection of MSS. in European languages ranges from the 3rd century before Christ down to our own times, and includes the *Codex Alexandrinus* of the Bible. The old historical chronicles of England, the charters of the Anglo-Saxon kings, and the celebrated series of Arthurian romances are well represented; and care has been taken to acquire on every available opportunity the imprinted works of English writers. The famous collections of MSS. made by Sir Robert Cotton and Robert Harley, earl of Oxford, have already been mentioned, and from these and other sources the museum has become rich in early Anglo-Saxon and Latin codices, some of them being marvels of skill in calligraphy and ornamentation, such as the charters of King Edgar and Henry I. to Hyde Abbey, which are written in gold letters; or the Lindisfarne gospels (A.D. 700) containing the earliest extant Anglo-Saxon version of the Latin gospels. The Burney collection of classical MSS. furnished important additions, so that from this source and from the collection of Arundel MSS. (transferred from the Royal Society in 1831), the museum can boast of an early copy of the *Iliad*, and one of the earliest known codices of the *Odyssey*. Among the unrivalled collection of Greek papyri are the unique MSS. of several works of ancient literature. Irish, French and Italian MSS. are well represented. Special reference may be made to the celebrated Bedford Hours, illuminated for the duke of Bedford, regent of France, to the Sforza Book of Hours and to Queen Mary's Psalter. The Oriental collection is also extremely valuable, including the library formed by Mr Rich (consul at Baghdad in the early part of the 19th century), and a vast quantity of Arabic, Persian and Turkish MSS.; the Chambers collection of Sanskrit MSS.; several other collections of Indian MSS.; and a copious library of Hebrew MSS. (including that of the great scholar Michaelis, and codices of great age, recently brought from Yemen). The collection of Syriac MSS., embracing the relics of the famous library of the convent of St Mary Deipara in the Nitrian desert, formed by the abbot Moses of Nisibis, in the 10th century, is the most important in existence; of the large store of Abyssinian volumes many were amassed after the campaign against King Theodore. The number of genealogical rolls and documents relating to the local and family history of Great Britain is very large. Altogether there are now more than 56,000 MSS. (of which over 9000 are Oriental), besides more than 75,000 charters and rolls. There is a very large and valuable collection of printed and manuscript music of all kinds, and it is probable that of separate pieces there are nearly 200,000. The catalogue of music is partly in manuscript and partly printed, and a separate printed catalogue of the MS. music has been published. The number of maps is also very large, and a printed catalogue has been issued.

The general catalogue of the printed books was at one time kept in MS. in large volumes, but since 1880 the entries have gradually been superseded by the printed titles forming part of the large alphabetical catalogue which was completed in 1900. This important work is arranged in the order of authors' names, with occasional special entries at words like Bible, periodicals and biographical names. It is being constantly supplemented and forms an invaluable bibliographical work of reference.

The other printed catalogues of books commence with one published in 2 vols. folio (1787), followed by that of 1813-1819 in 7 vols. 8vo; the next is that of the library of George III. (1820-1829, 5 vols. folio, with 2 vols. 8vo, 1834), describing the geographical and topographical collections; and then the *Bibliotheca Grenvilliana* (1842-1872, 4 vols. 8vo). The first vol. (letter A) of a general catalogue appeared in 1841 in a folio volume which has never been added to. The octavo catalogue of the Hebrew books came out in 1867; that of the Sanskrit and Pali literature is in 4to (1876); and the Chinese catalogue is also in 4to (1877). There is a printed list of the books of reference (1910) in the reading-room.

The printed catalogues of the MSS. are—that of the old Royal Library (1734, 4to), which in 1910 was shortly to be superseded by a new one; the Sloane and others hitherto undescribed (1782, 2 vols. 4to); the Cottonian (1802, folio); the Harleian (1808, 4 vols. folio); the Hargrave (1818, 4to); the Lansdowne (1819, folio); the Arundel (1840, folio); the Burney (1840, folio); the Stowe (1895-1896, 4to); the Additional, in periodical volumes since 1836; the Greek Papyri (1893-1910); the Oriental (Arabic and Ethiopic, 5 pts., folio (1838-1871); the Syriac (1870-1873, 3 pts., 4to); the Ethiopic (1877, 4to); the Persian (1879-1896, 4 vols. 4to); and the Spanish (1875-1893, 4 vols. 8vo); Turkish (1888); Hebrew and Samaritan (1900-1909, 3 vols.); Sanskrit (1903); Hindi, &c. (1899); Sinhalese (1900). There are also catalogues of the Greek and Egyptian papyri (1839-1846, 5 pts., folio). Many other special catalogues have been issued, including one of the Thomason Collection of Civil War pamphlets, Incunabula (vol. i.), Romances (MSS.), Music, Seals and Arabic, Hebrew and other Oriental books, maps, prints and drawings. Perhaps the most useful catalogue of all is the *Subject-index to Modern Works* issued in 1881-1905 (4 vols.) and compiled by Mr G. K. Fortescue.

The *Rules for compiling catalogues in the department of printed books* were revised and published in 1906.

The building in which the library is housed forms part of the fine group situated in Great Russell Street in central London, and is distinguished by a stately circular reading-room designed by Sydney Smirke from suggestions and sketches supplied by Sir A. Panizzi. This was begun in 1855 and opened in 1857. The room is surrounded by book stores placed in galleries with iron floors, in which, owing to congestion of stock, various devices have been introduced, particularly a hanging and rolling form of auxiliary bookcase. The presses inside the reading-room, arranged in three tiers, contain upwards of 60,000 vols., those on the ground floor (20,000)

being books of reference to which readers have unlimited access. The accommodation for readers is comfortable and roomy, each person having a portion of table fitted with various conveniences. Perhaps not the least convenient arrangement here is the presence of the staff in the centre of the room, at the service of readers who require aid.

In order to enjoy the privilege of reading at the British Museum, the applicant (who must be over twenty-one years of age) must obtain a renewable ticket of admission through a recommendation from a householder addressed to the principal librarian.

The pressure upon the space at the command of the library has been so great that additional land at the rear and sides of the existing buildings was purchased by the government for the further extension of the Museum. One very important wing facing Torrington Square was nearly completed in 1910. The Natural History Museum, South Kensington, a department of the British Museum under separate management, has a library of books on the natural sciences numbering nearly 100,000 vols.

Next in importance to the British Museum, and superior to it in accessibility, is the Library of the Patent Office in Southampton Buildings, London. This is a department of the Board of Trade, and though primarily intended for office use and patentees, it is really a public library freely open to anyone. The only formality required from readers is a signature in a book kept in the entrance hall. After this readers have complete access to the shelves. The library contains considerably over 110,000 vols., and possesses complete sets of the patents specifications of all countries, and a remarkable collection of the technical and scientific periodicals of all countries. The library was first opened in 1855, in somewhat unsuitable premises, and in 1897 it was transferred to a handsome new building.

**Patent Office.**

The reading-room is provided with two galleries and the majority of the books are open to public inspection without the need for application forms. A printed catalogue in author-alphabetical form has been published with supplement, and in addition, separate subject catalogues are issued. This is one of the most complete libraries of technology in existence, and its collection of scientific transactions and periodicals is celebrated.

Another excellent special library is the National Art Library, founded in 1841 and transferred to South Kensington in 1856. It contains about half a million books, prints, drawings and photographs, and is used mostly by the students attending the art schools, though the general public can obtain admission on payment of sixpence per week.

**Other state libraries.**

A somewhat similar library on the science side is the Science Library of the Victoria and Albert Museum, South Kensington, which was founded in 1857. It is a general science collection and incorporates most of the books which at one time were in the Museum of Practical Geology.

The only other state library which is open to the public is that of the Board of Education in Whitehall, which was opened in a new building in 1908. It contains a large collection of works on educational subjects for which a special classification has been devised and printed.

The other state libraries in London may be briefly noted as follows: Admiralty (1700), 40,000 vols.; College of Arms, or Heralds College, 15,000 vols.; Colonial Office, c. 15,000 vols.; Foreign Office, c. 80,000 vols.; Home Office (1800) c. 10,000 vols.; House of Commons (1818), c. 50,000 vols.; House of Lords (1834), 50,000 vols.; India Office (1800), c. 86,000 vols.; Kew, Royal Botanic Gardens (1853), 22,000 vols.; and Royal Observatory (Greenwich), c. 20,000 vols.

Outside London the most important state library is the National Library of Ireland, Dublin, founded in 1877 and incorporating the library of the Royal Dublin Society. It is housed in a handsome building (1890) and contains about 200,000 vols., classified on the Decimal system, and catalogued in various forms. The library of the Museum of Science and Art at Edinburgh, containing over 20,000 vols., was opened to the public in 1890. Practically every department of the state has a reference library of some kind for the use of the staff, and provision is also made for lending libraries and reading-rooms in connexion with garrisons, naval depots and other services of the army and navy.

No professional qualifications are required for positions in British state libraries, most of the assistants being merely second-division clerks who have passed the Civil Service examinations. It would be an advantage from an administrative point of view if the professional certificates of the Library Association were adopted by the Civil Service Commissioners as compulsory requirements in addition to their own examination. The official recognition of a grade of properly trained librarians would tend to improve the methods and efficiency of the state libraries, which are generally behind the municipal libraries in organization and administration.

*University and Collegiate Libraries.*—The Bodleian Library, Oxford, though it had been preceded by various efforts towards a university library, owed its origin to Sir Thomas Bodley (*q.v.*). Contributing largely himself, and procuring contributions from others, he opened the library with upwards of 2000 vols. in 1602.

**Oxford.** In 1610 he obtained a grant from the Stationers' Company of a copy of every work printed in the country, a privilege still enjoyed under the provisions of the various copyright acts. The additions made to the library soon surpassed the capacity of the room, and the founder proceeded to enlarge it. By his will he left considerable property to the university for the maintenance and increase of the library. The example set by Bodley found many noble imitators. Amongst the chief benefactors have been Archbishop Laud, the executors of Sir Kenelm Digby, John Selden, Sir Thomas (Lord) Fairfax, Richard Gough, Francis Douce, Richard Rawlinson, and the Rev. Robert Mason. The library now contains almost 800,000 printed vols., and about 41,000 manuscripts. But the number of volumes, as bound up, conveys a very inadequate idea of the size or value of the collection. In the department of Oriental manuscripts it is perhaps superior to any other European library; and it is exceedingly rich in other manuscript treasures. It possesses a splendid series of Greek and Latin *editiones principes* and of the earliest productions of English presses. Its historical manuscripts contain most valuable materials for the general and literary history of the country.

The last general catalogue of the printed books was printed in 4 vols. folio (1843-1851). In 1859 it was decided to prepare a new manuscript catalogue on the plan of that then in use at the British Museum, and this has been completed in duplicate. In 1910 it was being amended with a view to printing. It is an alphabetical author-catalogue; and the Bodleian, like the British Museum, has no complete subject-index. A slip-catalogue on subjects was, however, in course of preparation in 1910, and there are classified hand-lists of accessions since 1883. There are also printed catalogues of the books belonging to several of the separate collections. The MSS.

are in general catalogued according to the collections to which they belong, and they are all indexed. A number of the catalogues of manuscripts have been printed.

In 1860 the beautiful Oxford building known as the "Radcliffe Library," now called the "Radcliffe Camera," was offered to the curators of the Bodleian by the Radcliffe trustees. The Radcliffe Library was founded by the famous physician Dr John Radcliffe, who died in 1714, and bequeathed, besides a permanent endowment of £350 a year, the sum of £40,000 for a building. The library was opened in 1749. Many years ago the trustees resolved to confine their purchases of books to works on medicine and natural science. When the university museum and laboratories were built in 1860, the trustees allowed the books to be transferred to the museum. It is used as a storehouse for the more modern books, and it also serves as a reading-room. It is the only room open after the hour when the older building is closed owing to the rule as to the exclusion of artificial light. In 1889 the gallery of the Radcliffe Camera was opened as an addition to the reading-room.

A *Staff Kalendar* has been issued since 1902, which with a *Supplement* contains a complete list of cataloguing rules, routine work of the libraries and staff, and useful information of many kinds concerning the library methods.

The Bodleian Library is open by right to all graduate members of the university, and to others upon producing a satisfactory recommendation. No books are allowed to be sent out of the library except by special leave of the curators and convocation of the university. The administration and control of the library are committed to a librarian and board of thirteen curators. The permanent endowment is comparatively small; the ordinary expenditure, chiefly defrayed from the university chest, is about £10,000. Within recent years the use of wheeling metal bookcases has been greatly extended, and a large repository has been arranged for economical book storage underground.

The Taylor Institution is due to the benefaction of Sir Robert Taylor, an architect, who died in 1788, leaving his property to found an establishment for the teaching of modern languages. The library was established in 1848, and is devoted to the literature of the modern European languages. It contains a fair collection of works on European philology, with a special Dante collection, about 1000 Mazarinades and 400 Luther pamphlets. The Finch collection, left to the university in 1830, is also kept with the Taylor Library. Books are lent out to members of the university and to others on a proper introduction. The endowment affords an income of £800 to £1000 for library purposes.

The libraries of the several colleges vary considerably in extent and character, although, owing chiefly to limited funds, the changes and growth of all are insignificant. That of All Souls was established in 1443 by Archbishop Chichele, and enlarged in 1710 by the munificent bequest of Christopher Codrington. It devotes special attention to jurisprudence, of which it has a large collection. It possesses 40,000 printed volumes and 300 MSS., and fills a splendid hall 200 ft. long. The library of Brasenose College has a special endowment fund, so that it has, for a college library, the unusually large income of £200. The library of Christ Church is rich in divinity and topography. It embraces the valuable library bequeathed by Charles Boyle, 4th earl of Orrery, amounting to 10,000 volumes, the books and MSS. of Archbishop Wake, and the Morris collection of Oriental books. The building was finished in 1761, and closely resembles the basilica of Antoninus at Rome, now the Dogana. Corpus possesses a fine collection of Aldines, many of them presented by its founder, Bishop Fox, and a collection of 17th-century tracts catalogued by Mr Edwards, with about 400 MSS. Exeter College Library has 25,000 volumes, with special collections of classical dissertations and English theological and political tracts. The library of Jesus College has few books of later date than the early part of the last century. Many of them are from the bequest of Sir Leoline Jenkins, who built the existing library. There are also some valuable Welsh MSS. The library of Keble College consists largely of theology, including the MSS. of many of Keble's works. The library of Magdalen College has about 22,500 volumes (including many volumes of pamphlets) and 250 MSS. It has scientific and topographical collections. The library of Merton College has of late devoted itself to foreign modern history. New College Library has about 17,000 printed volumes and about 350 MSS., several of which were presented by its founder, William of Wykeham. Oriel College Library, besides its other possessions, has a special collection of books on comparative philology and mythology, with a printed catalogue. The fine library of Queen's College is strong in theology, in English and modern European history, and in English county histories. St John's College Library is largely composed of the literature of theology and jurisprudence before 1750, and possesses a collection of medical books of the 16th and 17th centuries. The newer half of the library building was erected by Inigo Jones at the expense of Laud, who also gave many printed and manuscript books. The room used as a library at Trinity College formed part of Durham College, the library of which was established by Richard of Bury. Wadham College Library includes a collection of botanical books bequeathed by Richard Warner in 1775 and a collection of books, relating chiefly to the Spanish Reformers, presented by the executors of Benjamin Wiffen. Worcester College Library has of late specially devoted itself to classical archaeology. It is also rich in old plays.

554

The college libraries as a rule have not been used to the extent they deserve, and a good deal must be done before they can be said to be as useful and efficient as they might be.

The history of the University Library at Cambridge dates from the earlier part of the 15th century. Two early lists of its contents are preserved, the first embracing 52 vols. dating from about 1425, the second a shelf-list, apparently of 330 vols., drawn up by the outgoing proctors in 1473. Its first great benefactor was Thomas Scott of Rotherham, archbishop of York, who erected in 1475 the building in which the library continued until 1755. He also gave more than 200 books and manuscripts to the library, some of which still remain. The library received other benefactions, but nevertheless appeared "but mean" to John Evelyn when he visited Cambridge in 1654. In 1666 Tobias Rustat presented a sum of money to be invested to buy the choicest and most useful books. In 1715 George I. presented the library of Bishop Moore, which was very rich in early English printed books, forming over 30,000 vols. of printed books and manuscripts. The funds bequeathed by William Worts and John Manistre, together with that of Rustat, produce at present about £1500 a year. The share of university dues appropriated to library purposes amounts to £3000 a year. In addition the library is entitled to new books under the Copyright Acts. The number of printed volumes in the library cannot be exactly stated, as no recent calculation on the subject exists. It has been estimated at half a million. It includes a fine series of *editiones principes* of the classics and of the early productions of the English press. The MSS. number over 6000, in which are included a considerable number of adversaria or printed books with MS. notes, which form a leading feature in the collection. The most famous of the MSS. is the celebrated copy of the four gospels and the Acts of the Apostles, which is known as *Codex Bezae*, and which was presented to the university by that Reformer.



A catalogue of the MSS. has been published in 4 vols. (1856-1861), and this has been followed up by the publication of a number of separate catalogues of Persian, Syriac, Hebrew, Chinese, &c., MSS. There is no published catalogue of the books, although the catalogue is in print, the accessions being printed and cut up and arranged in volumes. A catalogue of English books before 1640 is in course of publication. The regulations of the library with regard to the lending of books are very liberal, as many as ten volumes being allowed out to one borrower at the same time. The annual income is about £7000.

There is a library attached to the Fitzwilliam Museum, bequeathed to the university in 1816. It consists of the entire library of Lord Fitzwilliam, with the addition of an archaeological library bought from the executors of Colonel Leake, and a small number of works, chiefly on the history of art, since added by purchase or bequest. It contains a collection of engravings of old masters, a collection of music, printed and MS., and a collection of illuminated MSS., chiefly French and Flemish, of the 14th to 16th centuries. The books are not allowed to be taken out. Catalogues and reprints of some of the music and other collections have been published.

The library of Trinity College, which is contained in a magnificent hall built by Sir Christopher Wren, has about 90,000 printed and 1918 MS. vols., and is especially strong in theology, classics and bibliography. It owes to numerous gifts and bequests the possession of a great number of rare books and manuscripts. Amongst these special collections are the Capell collection of early dramatic and especially Shakespearian literature, the collection of German theology and philosophy bequeathed by Archdeacon Hare, and the Grylls bequest in 1863 of 9600 vols., including many early printed books. There are printed catalogues of the Sanskrit and other Oriental MSS. by Dr Aufrecht and Professor Palmer, and of the incunabula by the late librarian, Mr Sinker. The library is open to all members of the college, and the privilege of using it is liberally extended to properly accredited students. One of the most interesting libraries is that of Trinity Hall, in which the original bookcases and benches are preserved, and many books are seen chained to the cases, as used formerly to be the practice.

None of the other college libraries rivals Trinity in the number of books. The library of Christ's College received its first books from the foundress. Clare College Library includes a number of Italian and Spanish plays of the end of the 16th century left by George Ruggle. The library of Corpus Christi College first became notable through the bequest of books and MSS. made by Archbishop Parker in 1575. The printed books are less than 5000 in number, and the additions now made are chiefly in such branches as throw light on the extremely valuable collection of ancient MSS., which attracts scholars from all parts of Europe. There is a printed catalogue of these MSS. Gonville and Caius College Library is of early foundation. A catalogue of the MSS. was printed in 1849, with pictorial illustrations, and a list of the incunabula in 1850. The printed books of King's College includes the fine collection bequeathed by Jacob Bryant in 1804. The MSS. are almost wholly Oriental, chiefly Persian and Arabic, and a catalogue of them has been printed. Magdalene College possesses the curious library formed by Pepys and bequeathed by him to the college, together with his collections of prints and drawings and of rare British portraits. It is remarkable for its treasures of popular literature and English ballads, as well as for the Scottish manuscript poetry collected by Sir Richard Maitland. The books are kept in Pepys's own cases, and remain just as he arranged them himself. The library of Peterhouse is the oldest library in Cambridge, and possesses a catalogue of some 600 or 700 books dating from 1418, in which year it was completed. It is chiefly theological, though it possesses a valuable collection of modern works on geology and natural science, and a unique collection of MS. music. Queen's College Library contains about 30,000 vols. mainly in theology, classics and Semitic literature, and has a printed class-catalogue. The library of St John's College is rich in early printed books, and possesses a large collection of English historical tracts. Of the MSS. and rare books there is a printed catalogue.

The library of the university of London, founded in 1837, has over 60,000 vols, and includes the Goldsmith Library of economic literature, numbering 30,000 vols. Other collections are De Morgan's collection of mathematical books, Grote's classical library, &c. There is a printed catalogue of 1897, with **London.** supplements. Since its removal to South Kensington, this library has been greatly improved and extended. University College Library, Gower Street, established in 1829, has close upon 120,000 vols. made up chiefly of separate collections which have been acquired from time to time. Many of these collections overlap, and much duplicating results, leading to congestion. These collections include Jeremy Bentham's library, Morrison's Chinese library, Barlow's Dante library, collections of law, mathematical, Icelandic, theological, art, oriental and other books, some of them of great value.

King's College Library, founded in 1828, has over 30,000 vols. chiefly of a scientific character. In close association with the university of London is the London School of Economics and Political Science in Clare Market, in which is housed the British Library of Political Science with 50,000 vols. and a large number of official reports and pamphlets.

The collegiate library at Dulwich dates from 1619, and a list of its earliest accessions, in the handwriting of the founder, may still be seen. There are now about 17,000 vols. of miscellaneous works of the 17th and 18th centuries, with a few rare books. A catalogue of them was printed in 1880; and one describing the MSS. (567) and the muniments (606) was issued during the succeeding year. The last two classes are very important, and include the well-known "Alleyn Papers" and the theatrical diary of Philip Henslow. Sion College is a guild of the parochial clergy of the city and suburbs of London, and the library was founded in 1629 for their use; laymen may also read (but not borrow) the books when recommended by some beneficed metropolitan clergyman. The library is especially rich in liturgies, Port-Royal authors, pamphlets, &c., and contains about 100,000 vols. classified on a modification of the Decimal system. The copyright privilege was commuted in 1835 for an annual sum of £363, 15s. 2d. The present building was opened in 1886 and is one of the striking buildings of the Victoria Embankment.

Most of the London collegiate or teaching institutions have libraries attached to them, and it will only be necessary to mention a few of the more important to get an idea of their variety: Baptist College (1810), 13,000 vols.; Bedford College (for women), 17,000 vols.; Birkbeck College (1823), 12,000 vols.; Congregational Library (1832-1893), 14,000 vols.; the Royal College of Music, containing the library of the defunct Sacred Harmonic Society; Royal Naval College (Greenwich, 1873), 7000 vols.; St Bartholomew's Hospital (1422), 15,000 vols.; St Paul's School (1509), 10,000 vols.; the Working Men's College (1854), 5000 vols.; and all the Polytechnic schools in the Metropolitan area.

The university library of Durham (1832) contains about 35,000 vols., and all the modern English universities—Birmingham, Mason University College (1880), 27,000 vols.; Leeds, Liverpool (1882), 56,000 vols.; Manchester, Victoria University, which absorbed Owens College (1851), 115,000 vols.; Newcastle-upon-Tyne; Sheffield

**English provinces.** (1907), &c.—have collections of books. The libraries in connexion with theological colleges and public schools throughout England are often quite extensive, and reference may be made to Eton College (1441), 25,000 vols.; Haileybury (1862), 12,000 vols.; Harrow (Vaughan Library), 12,000 vols.; Mill Hill; Oscott College, Erdington (1838), 36,000 vols.; Rugby (1878), 8000 vols.; Stonyhurst College (1794), *c.* 40,000 vols., &c. The new building for the university of Wales at Bangor has ample accommodation for an adequate library, and the University College at Aberystwith is also equipped with a library.

The origin of the University Library of Edinburgh is to be found in a bequest of his books of theology and law made to the town in 1580 by Clement Little, advocate. This was two years before the foundation of the university, and in 1584 the town council caused the collection to be removed to the college, of which they were the patrons. As it was the only library in the town, it continued to grow and received many benefactions, so that in 1615 it became necessary to erect a library building. Stimulated perhaps by the example of Bodley at Oxford, Drummond of Hawthornden made a large donation of books, of which he printed a catalogue in 1627, and circulated an appeal for assistance from others. In 1678 the library received a bequest of 2000 vols. from the Rev. James Nairne. In 1709 the library became entitled to the copy privilege, which has since been commuted for a payment of £575 per annum. In 1831 the books were removed to the present library buildings, for which a parliamentary grant had been obtained. The main library hall (190 ft. in length) is one of the most splendid apartments in Scotland. One of the rooms is set apart as a memorial to General Reid, by whose benefaction the library has greatly benefited. Amongst the more recent accessions have been the Halliwell-Phillips Shakespeare collection, the Laing collection of Scottish MSS., the Baillie collection of Oriental MSS. (some of which are of great value), and the Hodgson collection of works on political economy. The library now consists of about 210,000 vols. of printed books with over 2000 MSS. Recently it has been found necessary to make considerable additions to the shelving. The library of the university of Glasgow dates from the 15th century, and numbers George Buchanan and many other distinguished men amongst its early benefactors. A classified subject-catalogue has been printed, and there is also a printed dictionary catalogue. The annual accessions are about 1500, and the commutation-grant £707. Connected with the university, which is trustee for the public, is the library of the Hunterian Museum, formed by the eminent anatomist Dr William Hunter. It is a collection of great bibliographical interest, as it is rich in MSS. and in fine specimens of early printing, especially in Greek and Latin classics. There are about 200,000 vols. in the library.

The first mention of a library at St Andrews is as early as 1456. The three colleges were provided with libraries of their own about the time of their foundation—St Salvador's 1455, St Leonard's 1512, St Mary's 1537. The University Library was established about 1610 by King James VI., and in the course of the 18th century the college libraries were merged in it. The copyright privilege was commuted in 1837. The collection numbers 120,000 vols. exclusive of pamphlets, with about 200 MSS., chiefly of local interest. A library is supposed to have existed at Aberdeen since the foundation of King's College by Bishop Elphinstone in 1494. The present collection combines the libraries of King's College and Marischal College, now incorporated in the university. The latter had its origin in a collection of books formed by the town authorities at the time of the Reformation, and for some time kept in one of the churches. The library has benefited by the Melvin bequest, chiefly of classical books, and those of Henderson and Wilson, and contains some very valuable books. The general library is located in Old Aberdeen in a room of imposing design, while the medical and law books are in the New Town in Marischal College. The library has a grant, in lieu of the copyright privilege, of £320. The annual income of the library is £2500, and it contains over 180,000 vols. The books are classified on a modification of the decimal system, and there are printed author and MS. subject-catalogues. By arrangement with the municipal library authority, books are lent to non-students. All the technical schools, public schools, and theological and other colleges in Scotland are well equipped with libraries as the following list will show:—Aberdeen: Free Church College, 17,000 vols. Edinburgh: Fettes College, *c.* 5000 vols.; Heriot's Hospital (1762), *c.* 5000 vols.; New College (1843), 50,000 vols. Glasgow: Anderson's College (containing the valuable Euing music library), 16,000 vols.; United Free Church Theological College, 33,000 vols. Trinity College, Glenalmond, 5000 vols.

The establishment of the library of Trinity College, Dublin, is contemporaneous with that of the Bodleian at Oxford, and it is an interesting circumstance that, when Challoner and Ussher (afterwards the archbishop) were in London purchasing books to form the library, they met Bodley there, and entered into friendly intercourse and co-operation with him to procure the choicest and best books. The commission was given to Ussher and Challoner as trustees of the singular donation which laid the foundation of the library. In the year 1601 the English army determined to commemorate their victory over the Spanish troops at Kinsale by some permanent monument. Accordingly they subscribed the sum of £1800 to establish a library in the university of Dublin. For Ussher's own collection, consisting of 10,000 vols. and many valuable MSS., the college was also indebted to military generosity. On his death in 1655 the officers and soldiers of the English army then in Ireland purchased the whole collection for £22,000 with the design of presenting it to the college. Cromwell, however, interfered, alleging that he proposed to found a new college, where the books might more conveniently be preserved. They were deposited therefore in Dublin Castle, and the college only obtained them after the Restoration. In 1674 Sir Jerome Alexander left his law books with some valuable MSS. to the college. In 1726 Dr Palliser, archbishop of Cashel, bequeathed over 4000 vols. to the library; and ten years later Dr Gilbert gave the library nearly 13,000 vols. which he had himself collected and arranged. In 1745 the library received a valuable collection of MSS. as a bequest from Dr Stearne. In 1802 the collection formed by the pensionary Fagel, which had been removed to England on the French invasion of Holland, was acquired for £10,000. It consisted of over 20,000 vols. In 1805 Mr Quin bequeathed a choice collection of classical and Italian books. There have been many other smaller donations, in addition to which the library is continually increased by the books received under the Copyright Act. The library now contains 300,000 vols. and over 2000 MSS. There is no permanent endowment, and purchases are made by grants from the board. The whole collections are contained in one building, erected in 1732, consisting of eight rooms. The great library hall is a magnificent apartment over 200 ft. long. A new reading-room was opened in 1848. A catalogue of the books acquired before 1872 has been printed (1887). There is a printed catalogue of the MSS. and Incunabula (1890). Graduates of Dublin, Oxford, and Cambridge are admitted to read permanently, and temporary admission is granted by the board to any fit person who makes application.

The library of Queen's College, Belfast (1849), contains about 60,000 vols., while Queen's College, Cork (1849), has over 32,000 vols. St Patrick's College, Maynooth (1795), has about 60,000, and other collegiate

libraries are well supplied with books.

With one or two exceptions, libraries are attached to the cathedrals of England and Wales. Though they are of course intended for the use of the cathedral or diocesan clergy, they are in most cases open to any respectable person who may be properly introduced. They seldom contain very much modern literature, chiefly consisting of older theology, with more or less addition of classical and historical literature. They vary in extent from a few volumes, as at Llandaff or St David's, to 20,000 vols., as at Durham. Together they possess nearly 150,000 printed and manuscript vols. As a rule, very little is spent upon them, and they are very little used. The chamber in the old cloisters, in which the library of the dean and chapter of Westminster is preserved, is well known from the charming description by Washington Irving in his *Sketch Book*. There are about 14,000 vols., mostly of old theology and history, including many rare Bibles and other valuable books. The library of the dean and chapter of St Paul's Cathedral was founded in very early times, and now numbers some 22,000 vols. and pamphlets, mainly theological, with a good collection of early Bibles and Testaments, Paul's Cross Sermons, and works connected with the cathedral.

**Cathedral and church libraries.**

556

Perhaps the best library of Catholic theology in London is that of the Oratory at South Kensington, established in 1849, and now containing nearly 35,000 vols. The Catholic Cathedral of Westminster, of recent foundation, contains about 22,000 vols. The archiepiscopal library at Lambeth was founded in 1610 by Archbishop Bancroft, and has been enriched by the gifts of Laud, Tenison, Manners Sutton, and others of his successors; it is now lodged in the noble hall built by Juxon. The treasures consist of the illuminated MSS., and a rich store of early printed books; of the latter two catalogues have been issued by Samuel Roffey Maitland (1792-1866). The MSS. are described in H. J. Todd's catalogue, 1812. The total number of printed books and manuscripts is nearly 45,000.

The library of Christ Church, Oxford, belongs alike to the college and the cathedral, but will be more properly described as a college library. The cathedral library of Durham dates from monastic times, and possesses many of the books which belonged to the monastery. These were added to by Dean Sudbury, the second founder of the library, and Bishop Cosin. The collection has been considerably increased in more modern times, and now contains 15,000 vols. It is especially rich in MSS., some of which are of great beauty and value; a catalogue of them was printed in 1825. The library has good topographical and entomological collections. The chapter spend £370 per annum in salaries and in books. The library at York numbers about 11,000 vols., and has been very liberally thrown open to the public. It is kept in the former chapel of the archbishop's palace, and has many valuable MSS. and early printed books. The foundation of the library at Canterbury dates probably from the Roman mission to England, A.D. 596, although the library does not retain any of the books then brought over, or even of the books said to have been sent by Pope Gregory to the first archbishop in 601. It is recorded that among Lanfranc's buildings was a new library, and Becket is said to have collected books abroad to present to the library. The collection now numbers about 9900 printed books, with about 110 MS. vols., and between 6000 and 7000 documents. A catalogue was printed in 1802. The present building was erected in 1867 on part of the site of the monastic dormitory. The library at Lincoln contains 7400 vols., of which a catalogue was printed in 1859. It possesses a fine collection of political tracts of the age of Elizabeth, James and Charles I. The present collection at Chichester dates from the Restoration only; that at Ely is rich in books and tracts relating to the non-jurors. The library at Exeter possesses many Saxon MSS. of extreme interest, one of them being the gift of Leofric, the first bishop. The treasures of Lichfield were destroyed by the Puritans during the civil war, and the existing library is of later formation. Frances, duchess of Somerset, bequeathed to it nearly 1000 vols., including the famous Evangelary of St Chad. The collection at Norwich is chiefly modern, and was presented by Dr Sayers. The earlier library at Peterborough having almost wholly perished in the civil war, Bishop White Kennett became the virtual founder of the present collection. Salisbury is rich in incunabula, and a catalogue has recently been printed. Winchester Cathedral Library is mainly the bequest of Bishop Morley in the 17th century. The library at Bristol, then numbering 6000 or 7000 vols., was burnt and pillaged by the mob in the riots of 1831. Only about 1000 vols. were saved, many of which were recovered, but few additions have been made to them. At Chester in 1691 Dean Arderne bequeathed his books and part of his estate "as the beginning of a public library for the clergy and city." The library of Hereford is a good specimen of an old monastic library; the books are placed in the Lady Chapel, and about 230 choice MSS. are chained to oaken desks. The books are ranged with the edges outwards upon open shelves, to which they are attached by chains and bars. Another most interesting "chained" library is that at Wimborne Minster, Dorset, which contains about 280 books in their original condition. The four Welsh cathedrals were supplied with libraries by a deed of settlement in 1709. The largest of them, that of St Asaph, has about 1750 vols. The Bibliotheca Leightoniana, or Leightonian Library, founded by Archbishop Leighton in 1684 in Dunblane Cathedral, Scotland, contains about 2000 vols., and is the only cathedral library in Scotland of any historic interest. The library of St Benedict's Abbey, Fort Augustus (1878) with 20,000 vols. is an example of a recent foundation. The public library in St Patrick's Cathedral, Dublin, sometimes called Marsh's Library after its founder, was established about 1694 by Archbishop Marsh, was incorporated by act of parliament in 1707, and endowed by its founder at his death in 1713. The building was erected by the founder, and the original oak fittings still remain. There is no room for additions, and a large collection of modern books was refused a few years ago on that account. The endowment is too small to allow of purchases from the funds of the library, so that it still retains the character of a 17th-century library. The books are chiefly theological, and in the learned languages; they include the libraries of Bishop Stillingfleet and of Elias Bouhereau, a French refugee, who was the first librarian.

Endowed libraries may be defined as those which have been directly established by the bequests of individuals or corporate bodies, excluding those which have been assisted by donors or are merely named after them. As compared with the United States, the endowed libraries of Britain are few in number, although several are of great importance. London possesses very few libraries which have been endowed by individual donors. The principal are the Bishopsgate Institute (1891), which was founded out of sundry City of London charities, and now contains about 44,000 vols., and is celebrated for a fine collection of local prints, drawings and maps. It is open free to persons in the east part of the City. The Cripplegate Institute (1896) in Golden Lane, also founded out of charity moneys, has three branches—St Bride's Foundation Institute (18,000 vols.), jointly; Queen Street, Cheapside, Branch (8000 vols.); and St Luke's Institute (5000 vols.)—and contains 28,000 vols. Lectures and other entertainments are features of both these libraries. Dr Williams' library was founded by the will of an eminent Presbyterian divine of that name; it was opened in 1729. The books (50,000) are housed in a new building in Gordon Square, completed in 1873. Theology of all schools of opinion is represented, and there are special collections of theosophical books and MSS., the works of

**Endowed libraries.**

Boehme, Law, and other mystical writers. The MSS. include the original minutes of the Westminster Assembly, letters and treatises of Richard Baxter, &c. The St Bride Foundation Technical Reference Library (1895) is a very complete collection of books and specimens of printing and the allied arts, including the libraries of William Blades and Talbot Baines Reed, and a number of more modern books presented by Mr Passmore Edwards. It contains about 18,000 vols., and is open to all persons interested in printing, lithography, &c., and also to the general public.

The most notable of the English provincial endowed libraries are those established in Manchester. The fine old library established by Humphrey Chetham in 1653 is still housed in the old collegiate buildings where Sir Walter Raleigh was once entertained by Dr Dee. The collection consists largely of older literature, and numbers about 60,000 volumes and MSS. It is freely open to the public, and may be said to have been the first free library in England. Catalogues in broad classified form were issued in 1791-1863, and there have been supplements since. A remarkable instance of a great library established by private munificence is that of the John Rylands Library at Manchester, which was founded, erected and endowed by Mrs E. A. Rylands in memory of her husband, and is contained in a magnificent building designed by Basil Champneys and opened in 1899. The collection was formed largely on the famous Althorp Library, made by Earl Spencer (40,000 vols.), one of the most remarkable collections of early printed books and rare Bibles ever brought together. The present number of volumes is about 115,000, of which over 2500 are incunabula. A short-title catalogue, 3 vols. 4to., and one of English books, have been published, and a manuscript dictionary catalogue has been provided. Several valuable special catalogues and descriptive lists have been issued, one of the latest being a special catalogue of the architectural works contained in all the Manchester libraries.

The William Salt Library, a special Staffordshire library with numerous MSS. and other collections, formed to bring together materials for a history of Staffordshire, was opened to the public in 1874 in the town of Stafford. It contains nearly 20,000 books, prints and other items.

Other endowed libraries in the English provinces which deserve mention are the Bingham Public Library (1905) at Cirencester; the Guille-Allès Library (1856), Guernsey; St Deiniol's Library (1894), Hawarden, founded by William Ewart Gladstone, the great statesman; and the Shakespeare Memorial Library and theatre (1879) at Stratford-upon-Avon.

The most important endowed library in Scotland is the Mitchell Library in Glasgow, founded by Stephen Mitchell, tobacco-manufacturer (1874), who left £70,000 for the purpose. It was opened in 1877 in temporary premises, and after various changes will soon be transferred to a very fine new building specially erected. It contains some very valuable special collections, among which may be mentioned Scottish poetry, Burns' works, Glasgow books and printing, and a choice collection of fine books on art and other subjects given by Robert Jeffrey. It contains nearly 200,000 vols. and is the reference library for the Glasgow public library system. Another older Glasgow public library, also founded by a tobacco merchant, is Stirling's and Glasgow Public Library (1791), which was endowed by Walter Stirling, and amalgamated with an existing subscription library. It contains 60,000 vols. and is free to reference readers, but a subscription is charged for borrowing privileges. Still another Glasgow institution is Baillie's Institution Free Reference Library, established under the bequest of George Baillie (1863), but not opened till 1887. It contains over 24,000 vols. Other Scottish endowed libraries are the Anderson Library, Woodside, Aberdeen (1883); the Taylor Free Library, Crieff (1890); the Elder Free Library, Govan (1900); and the Chambers Institution, Peebles (1859), founded by William Chambers, the well-known publisher. The public library of Armagh, Ireland, was founded by Lord Primate Robinson in 1770, who gave a considerable number of books and an endowment. The books are freely available, either on the spot, or by loan on deposit of double the value of the work applied for.

557

There are many libraries belonging to societies devoted to the study of every kind of subject, and it is only necessary to mention a few of the principal. Full particulars of most of them will be found in Reginald A. Rye's *Libraries of London: a Guide for Students* (1910), a work of accuracy and value.

**Libraries of societies and learned bodies.**

Of the law libraries, that at Lincoln's Inn, London, is the oldest and the largest. It dates from 1497, when John Nethersale, a member of the society, made a bequest of forty marks, part of which was to be devoted to the building of a library for the benefit of the students of the laws of England. A catalogue of the printed books was published in 1859 and since supplemented, and the MSS. were catalogued by the Rev. Joseph Hunter in 1837. There are about 72,000 vols. The library of the Inner Temple is known to have existed in 1540. In the middle of the 17th century it received a considerable benefaction from William Petyt, the well-known keeper of the Tower records. There are now about 60,000 vols., including the pamphlets collected by John Adolphus for his *History of England*, books on crime and prisons brought together by Mr Crawford, and a selection of works on jurisprudence made by John Austin. A library in connexion with the Middle Temple was in existence during the reign of Henry VIII., but the date usually assigned to its foundation is 1641, when Robert Ashley left his books to the inn of which he had been a member. There are now about 50,000 vols. Gray's Inn Library (21,000 vols.) was perhaps established before 1555. In 1669 was made the first catalogue of the books, and the next, still extant, in 1689. The Law Society (1828) has a good law and general library (50,000 vols.), including the best collection of private acts of parliament in England. The library of the Royal Society (1667), now housed in Burlington House, contains over 80,000 vols., of which many are the transactions and other publications of scientific bodies. The Royal Institution of Great Britain (1803) possesses a reference library of 60,000 vols. Some of its early catalogues were in classified form. The London Institution (1805), in the City, is a general library of reference and lending books open to members only. There are about 150,000 vols., and lectures are given in connexion with the institution. The Royal Society of Arts has a library numbering about 11,000 vols., chiefly the publications of other learned bodies.

The best library of archaeology and kindred subjects is that of the Society of Antiquaries, Burlington House, consisting of nearly 40,000 printed vols. and many MSS. It is rich in early printed books, topography, heraldry and numismatics, and includes a curious collection of books on pageants presented by Mr Fairholt, and the remarkable assemblage of lexicographical works formerly belonging to Albert Way.

Of libraries devoted to the natural sciences may be mentioned those of the Geological Society of London (1807), with over 30,000 vols. and maps; the Linnean Society (1788), 35,000 vols.; the Zoological Society (1829), about 31,000 vols. Of libraries associated with medicine there are those of the Royal Society of Medicine (1907), incorporating a number of medical societies, over 95,000 vols., about to be housed in a new building; the Royal College of Physicians (1525), 26,000 vols.; the British Medical Association, 20,000 vols.; the Royal College of Surgeons of England (1800), 60,000 vols., with a MS. catalogue on cards; the Chemical Society (1841), over

25,000 vols.; and the Pharmaceutical Society of Great Britain (1841), about 15,000 vols. Other important London society libraries are—the Royal Geographical Society (1830), 50,000 vols., and numerous maps in a special room, open to the public for reference; the Royal Colonial Institute (1868), 70,000 vols. of British colonial literature; the Royal United Service Institution, Whitehall (1831), has 32,000 works on military and naval subjects and a museum. Large and interesting collections of books are owned by the British and Foreign Bible Society, the Institution of Civil Engineers, the Institution of Electrical Engineers (containing the Ronalds Library), the Royal Academy, the Royal Institute of British Architects, and practically every other working society in London.

The English provincial libraries connected with societies or learned bodies are mostly attached to those concerned with law, medicine, and various antiquarian, literary and scientific subjects. The headquarters of most national societies being in London to some extent accounts for the comparatively small number of these special libraries in the provinces.

The most important libraries of this description outside London are situated in Scotland and Ireland, and one at least is practically a national collection.

The principal library in Scotland is that of the Faculty of Advocates at Edinburgh, who in 1680 appointed a committee of their number, which reported that "it was fitt that, seeing if the recusants could be made pay their entire money, there wold be betwixt three thousand and four thousand pounds in cash; that the same be employed on the best and fynest lawers and other law bookes, conforme to a catalogue to be condescended upon by the Facultie, that the samen may be a fonde for ane Bibliothecque whereto many lawers and others may leave their books." In 1682 the active carrying out of the scheme was committed to the Dean of Faculty, Sir George Mackenzie of Rosehaugh, who may be regarded as the founder of the library. In 1684 the first librarian was appointed, and the library appears to have made rapid progress, since it appears from the treasurer's accounts that in 1686 the books and furniture were valued at upwards of £11,000 Scots, exclusive of donations. In the year 1700, the rooms in the Exchange Stairs, Parliament Close, in which the library was kept, being nearly destroyed by fire the collection was removed to the ground floor of the Parliament House, where it has ever since remained. The library retains the copyright privilege conferred upon it in 1709. Of the special collections the most important are the Astorga collection of old Spanish books, purchased by the faculty in 1824 for £4000; the Thorkelin collection, consisting of about 1200 vols., relating chiefly to the history and antiquities of the northern nations, and including some rare books on old Scottish poetry; the Dietrich collection of over 100,000 German pamphlets and dissertations, including many of the writings of Luther and Melancthon, purchased for the small sum of £80; and the Combe collection.

The faculty appear early to have turned their attention to the collection of MSS., and this department of the library now numbers about 3000 vols. Many of them are of great interest and value, especially for the civil and ecclesiastical history of Scotland before and after the Reformation. There are thirteen monastic chartularies which escaped the destruction of the religious houses to which they belonged. The MSS. relating to Scottish church history include the collections of Spottiswoode, Wodrow and Calderwood. The Wodrow collection consists of 154 vols., and includes his correspondence, extending from 1694 to 1726. Sir James Balfour's collection and the Balcarres papers consist largely of original state papers, and include many interesting royal letters of the times of James V., Queen Mary and James VI. The Sibbald papers, numbering over 30 vols., are largely topographical. The Riddel notebooks, numbering 156 vols., contain collections to illustrate the genealogy of Scottish families. There are about one hundred volumes of Icelandic MSS., purchased in 1825 from Professor Finn Magnusson, and some Persian and Sanskrit, with a few classical, manuscripts. The department has some interesting treasures of old poetry, extending to 73 vols. The most important are the Bannatyne MS., in 2 vols. folio, written by George Bannatyne in 1568, and the Auchinleck MS., a collection of ancient English poetry, named after Alexander Boswell of Auchinleck, who presented it in 1774.

The first catalogue of the printed books was compiled in 1692, and contains a preface by Sir George Mackenzie. Another was prepared under the care of Ruddiman in 1742. In 1853 the late Mr Halkett commenced a catalogue, which has been printed in 6 vols. 4to, with a supplement, and includes all the printed books in the library at the end of 1871, containing about 260,000 entries. The library, managed by a keeper and staff, under a board of six curators, is easily accessible to all persons engaged in literary work, and now contains about 500,000 vols.

The library of the Writers to the Signet was established by the Society at Edinburgh in 1755. At first it consisted of law books exclusively, but in 1788 they began to collect the best editions of works in other departments of literature. During the librarianship of Macvey Napier (1805-1837) the number of volumes was more than sextupled, and in 1812 the library was removed to the new hall adjoining the Parliament House. In 1834 the upper hall was devoted to the collection. This is a magnificent apartment 142 ft. long, with a beautiful cupola painted by Stothard. The library now contains over 110,000 vols. and includes some fine specimens of early printing, as well as many other rare and costly works. It is especially rich in county histories and British topography and antiquities. A catalogue of the law books was printed in 1856. The late David Laing, who became librarian in 1837, published the first volume of a new catalogue in 1871, and in 1891 this was completed with a subject index. The books are lent out to the writers and even to strangers recommended by them.

The library of the Royal Irish Academy at Dublin was established on the formation of the Academy in 1785 for the purpose of promoting the study of science, literature and antiquities in Ireland. The library possesses about 80,000 printed vols. and MSS. There is a large collection of MSS. and books relating to the history, ancient language, and antiquities of Ireland. They include the Betham collection, acquired partly by public subscription in 1851. The library is partly supported by a government grant and is freely open on a proper introduction. The publication of Irish MSS. in the library was begun in 1870, and has since continued; the general catalogue is in manuscript form.

The library of King's Inns was founded, pursuant to a bequest of books and legal MSS. under the will of Mr Justice Robinson in 1787, to form the nucleus of a library for law students. It is partly supported from the funds of the benchers, but partly also by a treasury grant in lieu of the copyright privilege.

It is needless to describe the other society libraries, as most of them are described in annuals like the *Literary Year-book* and similar publications, with statistics of stock, issues, &c., brought up to date.

Proprietary and subscription libraries were at one time more common than now, as, owing to the steady advance of the municipal library, the minor subscription libraries have been gradually extinguished. A striking example of this is furnished by the mechanics' institutes which used to flourish all over the country. In most cases these have been handed over to the local authorities by the owners to

**and  
subscription  
libraries.**

form the nucleus of the public rate-supported library, and in this way the older libraries have been preserved and valuable aid has been given to the popular library movement. Somewhat akin to the mechanics' institutes are the libraries established in connexion with various co-operative societies in the north of England. Together with working men's club libraries, there must be nearly 100 libraries of the class just mentioned, ranging in size from a few hundred vols. to 30,000 or 40,000 vols. The affiliated clubs of the Working Men's Club and Institute Union possess among them over 100,000 vols.

Among subscription libraries, the London Library stands first in order of importance. It was founded in 1841 as a lending library for the use of scholars, and Dean Milman, Sir G. C. Lewis, W. E. Gladstone, Thomas Carlyle, Henry Hallam and other eminent men took part in its formation. By means of a moderate subscription, funds were raised for the purchase of books on general subjects, which now amount to about 250,000 vols. Of these elaborate and excellent author and subject catalogues have been printed. The last is valuable as a classified guide to the contents of the library.

Some mention should be made also of the more important subscription or proprietary libraries, which were formed for the most part in the latter half of the 18th century. The earliest circulating library in the metropolis was established about the middle of the 18th century. The first in Birmingham was opened by Hutton in 1757. The idea of a proprietary library appears to have been first carried out at Liverpool in 1758. The library then formed still flourishes at the Lyceum, and possesses a collection of 55,000 vols. and an income of £1000 a year. In 1760 a library was formed at Warrington which has been merged in the Warrington Museum. The Leeds library was established in 1768, and now has 64,000 vols. In 1772 the Bristol museum and library was formed, and numbered Coleridge, Southey and Landor among its earlier members. It has now been merged in the reference collection of the Bristol public libraries. The Birmingham (old) library was formed in 1779, and its rules were drawn up by Dr Priestley. The library has now about 80,000 vols.

Other English proprietary libraries have been established at Leicester, Liverpool (Athenaeum, 1798), Manchester, Nottingham and elsewhere. In Scotland the first subscription library was started by Allan Ramsay, the poet, at Edinburgh in 1725, and since that time commercial subscription libraries have increased greatly in number and size, Mudie's and *The Times* Book Club being typical modern examples.

Many of the principal clubs possess libraries; that of the Athenaeum (London) is by far the most important. It now numbers about 75,000 vols. of books in all departments of literature, and is especially rich in well-bound and fine copies of works on the fine arts, archaeology, topography and history. The pamphlets, of which there is a complete printed catalogue, as well as of the books, form a remarkable series, including those collected by Gibbon and Mackintosh. Next comes the Reform Club, with about 60,000 vols., chiefly in belles-lettres, with a fair proportion of parliamentary and historical works. The National Liberal Club, containing the Gladstone Library, has about 45,000 vols., and may be used occasionally by non-members. The Oxford and Cambridge Club has 30,000 vols. in general and classical literature. At the Garrick there is a small dramatic collection; and the (Senior) United Service Club, besides a number of books on professional subjects, possesses the fine library which formerly belonged to Dugald Stewart.

**Club  
libraries.**

Other London clubs which possess libraries are the Carlton with 25,000 vols.; the Constitutional with 12,000 vols.; Grand Lodge of Freemasons, 10,000 vols.; Alpine, 5000 vols.; Travellers, 8000 vols.; and Junior Carlton, 6000 vols. In the provinces and in Scotland and Ireland every club of a social character has a reading-room, and in most cases a library is attached.

The first act of parliament authorizing the establishment of public libraries in England was obtained by William Ewart, M.P. for the Dumfries Burghs, in 1850. This arose out of the report of a special parliamentary committee appointed to enquire into the management of the British Museum in 1835, and a more general report on libraries in 1849, at which much evidence was submitted to prove the necessity for providing public libraries. Ewart obtained both committees and also, in 1845, procured an act for "encouraging the establishment of museums in large towns." Neither the 1845 nor 1850 acts proved effective, owing chiefly to the limitation of the library rate to ½d. in the £ of rental, which produced in most cases an insufficient revenue. In 1853 the Library Act of 1850 was extended to Ireland and Scotland, and in 1854 Scotland obtained an act increasing the rate limit from ½d. to 1d. in the £. In 1855 Ireland also obtained a penny rate, and later in the same year England obtained the same power by an act which remained the principal library act, with some intermediate amendments, till 1892, when a Public Library Consolidation Act was passed. In the following year, 1893, the power of adopting the acts, or putting them in operation, was transferred from the ratepayers to the local authority, save in the case of rural parishes and the metropolitan vestries. By the London Government Act of 1899, however, the metropolitan boroughs were given the power of adopting the acts of 1892-1893 without consulting the ratepayers, so that as the law at present stands, any urban district can put the public libraries acts in force without reference to the voters. Rural parishes are still required by the provisions of the Local Government Act 1894 to adopt the 1892 Libraries Act by means of a parish meeting, or if a poll is demanded, by means of a poll of the voters.

**Municipal  
libraries.**

The main points in British library legislation are as follows:—

(a) The acts are permissive in character and not compulsory, and can only be put in force by a vote of a majority of members in an urban district or city, or of a majority of voters in rural districts.

(b) The amount of rate which can be collected is limited to one penny in the pound of the rateable value of the district, though in some towns power has been obtained by special legislation for local purposes to increase the amount to 2d. In a few cases, as at Birmingham, no limit is fixed. The incomes produced by the penny in the pound range from less than £10 in a rural district to over £25,000 in a large city.

(c) Municipal libraries are managed by committees appointed by the local authorities, who may, if so disposed, delegate to them all their powers and duties under section 15 of the act of 1892. The local authorities in England have also power to appoint persons on such committees who are not members of the council. By the Scottish principal act of 1887 committees are to consist of one-half councillors and one-half non-councillors, not to exceed a total of 20, and these committees become independent bodies not subject to the councils. Glasgow has contracted out of this arrangement by means of a special act. In Ireland, committees are appointed much on the same system as in England.

(d) Power is given to provide libraries, museums, schools for science, art galleries, and schools for art.

Needless to say it is impossible to carry on so many departments with the strictly limited means provided by the acts, although some towns have attempted to do so. The Museums and Gymnasiums Act of 1891 enables an additional rate of ½d. to be raised for either purpose, and many places which have established museums or art galleries under the provisions of the Libraries Acts have also adopted the Museums Act in order to increase their revenues.

(e) The regulation and management of public libraries are entrusted to the library authority, which may either be the local authority, or a committee with a full or partial delegation of powers. The library authority can buy books, periodicals, specimens of art and science, and make all necessary rules for the proper working of the libraries. A staff can be appointed, and arrangements may be made with adjoining local authorities for the joint use of one or more libraries. Buildings may also be erected, and money borrowed for the purpose on the security of the local rates. These are the main provisions of the library legislation of the United Kingdom as at present existing. Revision and amendment are wanted as regards the abolition or raising of the rate limitation, and some clearer definitions as to powers which can be exercised, as, for example, the right to spend money on lectures. The rate limitation is the most serious obstacle to progress, and it affects the smaller towns to a much greater degree than large cities or areas.

Between 1850 and 1910 about 630 local government areas of all kinds adopted the Public Libraries Acts. Of these a considerable number had in 1910 not yet put the acts in operation, whilst the London Government Act 1899, by joining various previously independent vestries or boards, extinguished about 23 library areas. The Metropolitan County of London in 1910 comprised 25 library areas, or counting also the City, 26, and only Marylebone, Bethnal Green and parts of Finsbury and Paddington remained unprovided. Practically every large city or district council has adopted the Public Libraries Acts or obtained special legislation, and the only important places, in addition to Marylebone and Bethnal Green, unprovided in 1910 were Bacup, Crewe, Dover, Jarrow, Scarborough, Swindon, Weymouth, Llandudno, Govan, Leith, Pollokshaws and Wishaw. In all, 556 places had library systems in operation, and among them they possessed about 925 buildings.

The progress of the public library movement was very slow up to 1887, the year of Queen Victoria's jubilee. From 1887, however, when many districts established libraries as memorials to Queen Victoria, the progress has been much more rapid. An immense stimulus to the movement was given from about 1900, when Mr Andrew Carnegie (*q.v.*) began to present library buildings to towns in England as well as to Scotland and the United States. The result of this action was to increase the number of municipal libraries from 146 in 1886 to 556 in 1910; and in the 10 years up to 1910 during which Mr Carnegie's gifts had been offered, no fewer than 163 places had put the acts in operation, a yearly average of over 16 adoptions.

There is one municipal library whose importance demands special mention, although it is not rate-supported under the provisions of the Public Libraries Acts. This is the Guildhall library of the Corporation of the City of London, which is a free public reference library with a periodicals reading-room, and a lending department for officials and members of the corporation. A library was established for London by Sir Richard Whittington between 1421-1426, and several notices in the civic records show how well in those times the citizens cared for their books. But it did not remain without accident; in 1522 the Lord Protector Somerset carried off three cart-loads of books, and during the great fire of 1666 the remainder was destroyed together with the library buildings. Nothing was done to repair the loss until 1824, when a committee was appointed, and rooms set apart for library purposes. In 1840 a catalogue of 10,000 vols. was printed, and in 1859 a second was prepared of 40,000 vols. In consequence of the large and increasing number of the readers, the present fine building was commenced about ten years later, and, after having cost £90,000, was opened in 1873 as a free public library.

There are now upwards of 136,000 printed vols. and 5900 MSS. in the Guildhall library. The contents are of a general character, and include a special collection of books about London, the Solomons Hebrew and rabbinical library, and the libraries of the Clockmakers Company and the old Dutch church in Austin Friars. Recently the fine collection of books by and about Charles Dickens, called the National Dickens Library, was added, and other special libraries of a valuable nature, as well as an extensive and well-cared-for collection of London prints, and drawings.

There is such a variety of library buildings in the United Kingdom that it is not possible to single out examples for special description, but a brief statement of their work and methods will help to give some idea of the extent of their activities.

#### **British library**

#### **administration.**

The total number of borrowers enrolled in 1910 was<sup>11</sup> about 2,200,000, 59% males and 41% females, 48% under 20 years of age and 52% over 20. Industrial and commercial occupations were followed by 49% of the borrowers, the balance of 51% being domestic, professional, unstated, and including 20% of students and scholars. To these borrowers 60,000,000 vols. are circulated every year for home-reading, and of this large number 54% represented fiction, including juvenile literature. The Reference libraries issued over 11,000,000 vols., exclusive of books consulted at open shelves, and to the Reading-rooms, Magazines, Newspapers, Directories, Time-tables, &c., allowing only one consultation for each visit, 85,000,000 visits are made per annum. Allowing 5% for the reading of fiction in current magazines, it appears that the percentage of fiction read in British municipal libraries, taking into account the work of every issuing or consulting department, is only about 24%. This fact should be carefully recorded, as in the past municipal libraries have suffered in the esteem of all sections of the public, by being erroneously described as mere centres for the distribution of common novels. The quality of the fiction selected is the best obtainable, and, as shown above, it is not read to an unreasonable or unnecessary extent.

The changes in character, policy and methods which have marked library administration in the United Kingdom, have affected libraries of all kinds, but on the whole the municipal libraries have been most active in the promotion of improvements. It is evident, moreover, even to the most casual observer, that a complete revolution in library practice has been effected since 1882, not only in the details of administration, but in the initiation of ideas and experiments. One of the most notable changes has been the gradual disappearance of the unclassified library. Previous to 1882 very little had been accomplished in the way of scientific classification schemes equipped with suitable notations, although the Decimal method of Mr Melvil Dewey had been applied in the United States. After that date this system began to be adopted for reference departments in British municipal libraries, till in 1910 at least 120 places had been classified by means of the scheme. An English scheme, called the "Adjustable," with a notation, but not fully expanded, has been adopted in 53 places, and a very complete and minute scheme called the "Subject," also English, has been used in nearly 40 libraries,

although it only dates from 1906. That much remains to be accomplished in this direction is indicated by the fact that over 340 municipal libraries were in 1910 not closely classified, but only arranged in broad numerical or alphabetical divisions. The adoption of exact schemes of classification for books in libraries may be said to double their utility almost mechanically, and in course of time an unclassified municipal library will be unknown. The other kinds of library—state, subscription, university, &c.—are very often not classified, but some use the Decimal system, while others, like the Patent Office, have systems peculiar to themselves.

The catalogue, as a means of making known the contents of books, has also undergone a succession of changes, both in policy and mechanical construction. At one period, before access to the shelves and other methods of making known the contents of libraries had become general, the printed catalogue was relied upon as practically the sole guide to the books. Many excellent examples of such catalogues exist, in author, subject and classified form, and some of them are admirable contributions to bibliography. Within recent years, however, doubts have arisen in many quarters, both in Europe and America, as to the wisdom of printing the catalogues of general popular libraries which possess comparatively few rare or extraordinary books. A complete catalogue of such a library is out of date the moment it is printed, and in many cases the cost is very great, while only a small number is sold. For these and other reasons, modern libraries have begun to compile complete catalogues only in MS. form, and to issue comparatively cheap class-lists at intervals, supplemented by monthly or quarterly bulletins or lists of recent accessions, which in combination will answer most of the questions likely to be put to a catalogue. Various improvements in the mechanical construction of manuscript catalogues have contributed to popularize them, and many libraries use the card, sheaf and other systems which allow constant and infinite intercalation coupled with economy and ease in making additions.

560

The idea of using separate slips or cards for cataloguing books, in order to obtain complete powers of arrangement and revision is not new, having been applied during the French revolutionary period to the cataloguing of libraries. More recently the system has been applied to various commercial purposes, such as book-keeping by what is known as the "loose-leaf ledger," and in this way greater public attention has been directed to the possibilities of adjustable methods both in libraries and for business. The card system is perhaps the most generally used at present, but many improvements in the adjustable binders, called by librarians the "sheaf system," will probably result in this latter form becoming a serious rival. The card method consists of a series of cards in alphabetical or other order kept on edge in trays or drawers, to which projecting guides are added in order to facilitate reference. Entries are usually made on one side of the card, and one card serves for a single entry. The sheaf method provides for slips of an uniform size being kept in book form in volumes capable of being opened by means of a screw or other fastening, for the purpose of adding or withdrawing slips. In addition to the advantage of being in book-form the sheaf system allows both sides of a slip to be used, while in many cases from two to twelve entries may be made on one slip. This is a great economy and leads to considerable saving of space. A great advantage resulting from the use of an adjustable manuscript catalogue, in whatever form adopted, is the simplicity with which it can be kept up-to-date. This is an advantage which in the view of many librarians outweighs the undoubted valuable qualities of comparative safety and multiplication of copies possessed by the printed form. There are many different forms of both card and sheaf systems, and practically every library now uses one or other of them for cataloguing or indexing purposes.

One other modification in connexion with the complete printed catalogue has been tried with success, and seems worthy of brief mention. After a complete manuscript catalogue has been provided in sheaf form, a select or eclectic catalogue is printed, comprising all the most important books in the library and those that represent special subjects. This, when supplemented by a printed list or bulletin of additions, seems to supply every need.

The most striking tendency of the modern library movement is the great increase in the freedom allowed to readers both in reference and lending departments. Although access to the shelves was quite a common feature in the older subscription libraries, and in state libraries like the British Museum and Patent Office, it is only within comparatively recent years that lending library borrowers were granted a similar privilege. Most municipal reference libraries grant access to a large or small collection of books, and at Cambridge, Birmingham and elsewhere in the United Kingdom, the practice is of long standing. So also in the United States, practically every library has its open shelf collection. On the continent of Europe, however, this method is not at all general, and books are guarded with a jealousy which in many cases must militate against their utility. The first "safe-guarded" open access municipal lending library was opened at Clerkenwell (now Finsbury), London, in 1893, and since then over one hundred cities and districts of all sizes in Britain have adopted the system. The British municipal libraries differ considerably from those of the United States in the safeguards against abuse which are employed, and the result is that their losses are insignificant, whilst in America they are sometimes enormous. Pawtucket and Cleveland in America were pioneers to some extent of the open shelf system for lending libraries, but the methods employed had little resemblance to the safe-guarded system of British libraries. The main features of the British plan are: exact classification; class, shelf and book guiding; the provision of automatic locking wickets to regulate the entrance and exit of borrowers, and the rule that borrowers must be registered before they can obtain admission. This last rule is not always current in America, and in consequence abuses are liable to take place. The great majority of British and American libraries, whether allowing open access or not, use cards for charging or registering books loaned to borrowers. In the United Kingdom a considerable number of places still use indicators for this purpose, although this mechanical method is gradually being restricted to fiction, save in very small places.

Other activities of modern libraries which are common to both Britain and America are courses of lectures, book exhibitions, work with children, provision of books for the blind and for foreign residents, travelling libraries and the education of library assistants. In many of the recent buildings, especially in those erected from the gifts of Mr Andrew Carnegie, special rooms for lectures and exhibitions and children are provided. Courses of lectures in connexion with the Liverpool and Manchester public libraries date from 1860, but during the years 1900-1910 there was a very great extension of this work. As a rule these courses are intended to direct attention to the literature of the subjects treated, as represented in the libraries, and in this way a certain amount of mutual advantage is secured. In some districts the libraries work in association with the education authorities, and thus it is rendered possible to keep schools supplied with books, over which the teachers are able to exercise supervision. This connexion between libraries and schools is much less common in the United Kingdom than in the British colonies and the United States, where the libraries are regarded as part of the national system of education. Excellent work has been accomplished within recent years by the Library Association in the training of librarians, and it is usual for about 300 candidates to come forward annually for examination in literary



history, bibliography, classification, cataloguing, library history and library routine for which subjects certificates and diplomas are awarded. The profession of municipal librarian is not by any means remunerative as compared with employment in teaching or in the Civil Service, and until the library rate is increased there is little hope of improvement.

The usefulness of public libraries has been greatly increased by the work of the Library Association, founded in 1877, during the first International Library Conference held in London in October 1877. A charter of incorporation was granted to the association in 1898. It holds monthly and annual meetings, publishes a journal, conducts examinations, issues certificates, holds classes for instruction, and has greatly helped to improve the public library law. The Library Assistants Association (1895) publishes a journal. A second International Library Conference was held at London in 1897, and a third at Brussels in 1910. Library associations have been started in most of the countries of Europe, and the American Library Association, the largest and most important in existence, was established in 1876. These associations are giving substantial aid in the development and improvement of library methods and the status of librarians, and it is certain that their influence will in time produce a more scientific and valuable type of library than at present generally exists.

#### *British Colonies and India.*

The majority of the British Colonies and Dependencies have permissive library laws on lines very similar to those in force in the mother country. There are, however, several points of difference which are worth mention. The rate limit is not so strict in every case, and an effort is made to bring the libraries into closer relations with the educational machinery of each colony. There is, for example, no rate limit in Tasmania; and South Australia may raise a library rate equivalent to 3d. in the £, although, in both cases, owing to the absence of large towns, the legislation existing has not been adopted. In Africa, Australia and Canada the governments make grants to public libraries up to a certain amount, on condition that the reading-rooms are open to the public, and some of the legislatures are even in closer touch with the libraries. The Canadian and Australian libraries are administered more or less on American lines, whilst those of South Africa, India, &c., are managed on the plan followed in England.

#### *Africa.*

There are several important libraries in South Africa, and many small town libraries which used to receive a government grant equal to the subscriptions of the members, but in no case did such grants exceed £150 for any one library in one year. These grants fluctuate considerably owing to the changes and temper of successive governments, and since the last war they have been considerably reduced everywhere. One of the oldest libraries is the South African Public Library at Cape Town established in 1818, which enjoys the copyright-privilege of receiving a free copy of every publication issued in Cape Colony. This library contains the great collection of colonial books bequeathed by Sir George Grey. The libraries of the various legislatures are perhaps the best supported and most important, but mention should be made of the public libraries of Port Elizabeth, Cape Colony, which published an excellent catalogue, and the public libraries at Kimberley; Durban, Natal; Bloemfontein, Orange River Colony; Bulawayo, Rhodesia; Johannesburg, Transvaal; and the public and university libraries at Pretoria. None of the libraries of North Africa are specially notable, although there are considerable collections at Cairo and Algiers.

561

#### *Australasia.*

All the public libraries, mechanics' institutes, schools of arts and similar institutes receive aid from the government, either in the form of grants of money or boxes of books sent from some centre. The public library of New South Wales, Sydney (1869), which includes the Mitchell Library of over 50,000 vols., now possesses a total of nearly 250,000 vols., and circulates books to country libraries, lighthouses and teachers' associations to the number of about 20,000 vols. per annum. The public library of Victoria, Melbourne (1853), with about 220,000 vols., also sends books to 443 country libraries of various kinds, which among them possess 750,000 vols., and circulate annually considerably over 2½ million vols. The university library at Melbourne (1855) has over 20,000 vols., and the libraries connected with the parliament and various learned societies are important. The public library of South Australia, Adelaide, has about 75,000 vols., and is the centre for the distribution of books to the institutes throughout the colony. These institutes possess over 325,000 vols. There is a good public library at Brisbane, Queensland, and there are a number of state-aided schools of arts with libraries attached. The Library of Parliament in Brisbane possesses over 40,000, and the Rockhampton School of Arts has 10,000 vols. Western Australia has a public library at Perth, which was established in 1887, and the small town institutes are assisted as in the other colonies.

Tasmania has several good libraries in the larger towns, but none of them had in 1910 taken advantage of the act passed in 1867 which gives municipalities practically unlimited powers and means as far as the establishment and maintenance of public libraries are concerned. At Hobart the Tasmanian Public Library (1849) is one of the most important, with 25,000 vols.

New Zealand is well equipped with public libraries established under acts dating from 1869 to 1877, as well as subscription, college and government libraries. At Auckland the Free Public Library (1880) has 50,000 vols., including Sir George Grey's Australasian collection; the Canterbury Public Library, Christchurch (1874), has 40,000 vols.; the University of Otago Library, Dunedin (1872), 10,000 vols.; and the public library at Wellington (1893) contains 20,000 vols.

#### *India and the East.*

Apart from government and royal libraries, there are many college, society, subscription and others, both English and oriental. It is impossible to do more than name a few of the most notable. Lists of many of the libraries in private hands including descriptions of their MS. contents have been issued by the Indian government. At Calcutta the Sanskrit college has 1652 printed Sanskrit volumes and 2769 Sanskrit MSS., some as old as the 14th century; there is also a large collection of Jain MSS. The Arabic library attached to the Arabic department of the Madrasa was founded about 1781, and now includes 731 printed volumes, 143 original MSS. and 151 copies; the English library of the Anglo-Persian department dates from 1854, and extends to 3254 vols.

The library of the Asiatic Society of Bengal was founded in 1784, and now contains 15,000 printed vols., chiefly on eastern and philological subjects, with a valuable collection of 9500 Arabic and Persian MSS.

At Bombay the library of the Bombay branch of the Royal Asiatic Society, established in 1804 as the Literary Society of Bengal, is now an excellent general and oriental collection of 75,000 printed vols. and MSS., described in printed catalogues. The Moolla Feroze Library was bequeathed for public use by Moolla Feroze, head priest of the Parsis of the Kudmi sect in 1831, and consisted chiefly of MSS., in Arabic and Persian on history, philosophy and astronomy; some additions of English and Gujarati works have been made, as well as of European books on Zoroastrianism. The Native General Library (1845) has 11,000 vols., and there are libraries attached to Elphinstone College and the university of Bombay.

The library of Tippoo Sahib, consisting of 2000 MSS., fell into the hands of the British, and a descriptive catalogue of them by Charles Stewart was published at Cambridge in 1809, 4to. A few were presented to public libraries in England, but the majority were placed in the college of Fort William, then recently established. The first volume, containing Persian and Hindustani poetry, of the *Catalogue of the Libraries of the King of Oudh*, by A. Sprenger, was published at Calcutta in 1854. The compiler shortly afterwards left the Indian service, and no measures were taken to complete the work. On the annexation of the kingdom in 1856 the ex-king is believed to have taken some of the most valuable MSS. to Calcutta, but the largest portion was left behind at Lucknow. During the siege the books were used to block up windows, &c., and those which were not destroyed were abandoned and plundered by the soldiers. Many were burnt for fuel; a few, however, were rescued and sold by auction, and of these some were purchased for the Asiatic Society of Bengal.

Perhaps the most remarkable library in India is that of the rājā of Tanjore, which dates from the end of the 16th or beginning of the 17th century, when Tanjore was under the rule of the Telugu Nāiks, who collected Sanskrit MSS. written in the Telugu character. In the 18th century the Mahrattas conquered the country, and since that date the library increased but slowly. By far the greater portion of the store was acquired by Sharabhojī Rājā during a visit to Benares in 1820-1830; his successor Sivaḷī added a few, but of inferior value. There are now about 18,000 MSS. written in Devanāgarī, Nandināgarī, Telugu, Kannada, Granthī, Malayālam, Bengālī, Panjābī or Kashmirī, and Uriya; 8000 are on palm leaves. Dr Burnell's printed catalogue describes 12,375 articles.

The Royal Asiatic Society has branches with libraries attached in many of the large cities of India, the Straits Settlements, Ceylon, China, Japan, &c. At Rangoon in Burma there are several good libraries. The Raffles Library at Singapore was established as a proprietary institution in 1844, taken over by the government in 1874, and given legal status by an ordinance passed in 1878. It now contains about 35,000 vols. in general literature, but books relating to the Malayan peninsula and archipelago have been made a special feature, and since the acquisition of the collection of J. R. Logan in 1879 the library has become remarkably rich in this department. In Ceylon there is the Museum Library at Colombo (1877), which is maintained by the government, and there are many subscription and a few oriental libraries.

#### Canada.

The public libraries of the various provinces of Canada have grown rapidly in importance and activity, and, assisted as they are by government and municipal grants, they promise to rival those of the United States in generous equipment. Most of the library work in Canada is on the same lines as that of the United States, and there are no special points of difference worth mention. The library laws of the Dominion are embodied in a series of acts dating from 1854, by which much the same powers are conferred on local authorities as by the legislation of Britain and the United States. An important feature of the Canadian library law is the close association maintained between schools and libraries, and in some provinces the school libraries are established by the school and not the library laws. There is also an important extension of libraries to the rural districts, so that in every direction full provision is being made for the after-school education and recreation of the people.

The province of Ontario has a very large and widespread library system of which full particulars are given in the annual reports of the minister of education. The library portion has been printed separately, and with its illustrations and special articles forms quite a handbook of Canadian library practice. There are now 413 public libraries described as free and not free, and of these 131 free and 234 not free reported in 1909. The free libraries possessed 775,976 vols. and issued 2,421,049 vols. The not free libraries, most of which receive legislative or municipal grants, possessed 502,879 vols. and issued 650,826 vols. This makes a grand total of 1,278,855 vols. in municipal and assisted subscription libraries without counting the university and other libraries in the province. The most important other libraries in Ontario are—Queen's University, Kingston (1841), 40,000 vols.; Library of Parliament, Ottawa, about 250,000 vols.; university of Ottawa, 35,000 vols.; Legislative Library of Ontario, Toronto, about 100,000 vols.; university of Toronto (1856), 50,000 vols. The Public (municipal) Library of Toronto has now over 152,000 vols.

562

In the province of Quebec, in addition to the state-aided libraries there are several large and important libraries, among which may be mentioned the Fraser Institute, Montreal, 40,000 vols.; McGill University, Montreal (1855), 125,000 vols., comprising many important collections; the Seminary of St Sulpice, Montreal, about 80,000 vols.; Laval University, Quebec, 125,000 vols.; and the library of the Legislature (1792), about 100,000 vols. In the western provinces several large public, government and college libraries have been formed, but none of them are as old and important as those in the eastern provinces.

In Nova Scotia there are now 279 cases of books circulating among the school libraries, containing about 40,000 vols., and in addition 2800 vols. were stocked for the use of rural school libraries. The rural school libraries of Nova Scotia are regulated by a special law, and a little handbook has been printed, somewhat similar to that published by the French educational authorities for the communale libraries. The Legislative Library at Halifax contains nearly 35,000 vols., and the Dalhousie University (1868), in the same town, contains about 20,000 vols. The Legislative Library of Prince Edward Island, Charlottetown, containing the Dodd Library, issues books for home use. The school law of New Brunswick provides for grants being made in aid of school libraries by the Board of Education equal to one half the amount raised by a district, and a series of rules has been published. The only other British libraries in America of much consequence are those in the West Indian Islands. The Institute of Jamaica, Kingston (1879) has about 15,000 vols.; the Trinidad Public Library (1841), recently revised and catalogued, 23,000 vols.; and there are a few small legislative and college libraries in addition.

(Albany, N.Y., 1900); J. D. Brown, *Guide to Librarianship* (1909); G. F. Chambers and H. W. Fovargue, *The Law relating to Public Libraries* (4th ed., 1899); J. W. Clark, *The Care of Books* (1909); E. Edwards, *Memoirs of Libraries* (1859); T. Greenwood, *Edward Edwards* (1901) and *Public Libraries* (4th ed., revised, 1891); J. J. Ogle, *The Free Library* (1897); Maurice Pellisson, *Les Bibliothèques populaires à l'étranger et en France* (Paris, 1906); R. A. Rye, *The Libraries of London* (1910); E. A. Savage, *The Story of Libraries and Book-Collectors* (1909).

For library economy consult J. D. Brown, *Manual of Library Economy* (1907); F. J. Burgoyne, *Library Construction, &c.* (1897); A. L. Champneys, *Public Libraries: a Treatise on their Design* (1907); J. C. Dana, *A Library Primer* (Chicago, 1910); Arnim Graesel, *Handbuch der Bibliothekslehre* (Leipzig, 1902); Albert Maire, *Manuel pratique du bibliothécaire* (Paris, 1896). On the subject of classification consult J. D. Brown, *Manual of Library Classification* (1898) and *Subject Classification* (1906); C. A. Cutter, *Expansive Classification* (1891-1893) (not yet completed); M. Dewey, *Decimal Classification* (6th ed., 1899), and *Institut International de Bibliographie: Classification bibliographique décimale* (Brussels, 1905); E. C. Richardson, *Classification: Theoretical and Practical* (1901).

Various methods of cataloguing books are treated in *Cataloguing Rules, author and title entries, compiled by the Committees of the American Library Association and the Library Association* (1908); C. A. Cutter, *Rules for a Printed Dictionary Catalogue* (Washington, 1904); M. Dewey, *Rules for Author and Classed Catalogues* (1892); T. Hitchler, *Cataloguing for Small Libraries* (Boston, 1905); K. A. Linderfelt, *Eclectic Card Catalog Rules* (Boston, 1890); J. H. Quinn, *Manual of Library Cataloguing* (1899); E. A. Savage, *Manual of Descriptive Annotation* (1906); J. D. Stewart, *The Sheaf Catalogue* (1909); H. B. Wheatley, *How to Catalogue a Library* (1889).

#### United States of America.

The libraries of the United States are remarkable for their number, size, variety, liberal endowment and good administration. The total number of libraries with over 1000 vols. was 5383 in 1900, including those attached to schools and institutions, and in 1910 there were probably at least 10,000 libraries having 1000 vols. and over. It is impossible to do more than glance at the principal libraries and activities, where the field is so immense, and a brief sketch of some of the chief federal, state, university, endowed and municipal libraries will therefore be presented.

The Library of Congress was first established in 1800 at Washington, and was burned together with the Capitol by the British army in 1814. President Jefferson's books were purchased to form the foundation of a new library, which continued to increase slowly until 1851, when all but 20,000 vols. were destroyed by fire. From this time the collection has grown rapidly, and now consists of about 1,800,000 vols. In 1866 the library of the Smithsonian Institution, consisting of 40,000 vols., chiefly in natural science, was transferred to the Library of Congress. The library is specially well provided in history, jurisprudence, the political sciences and Americana. Since 1832 the law collections have been constituted into a special department. This is the national library. In 1870 the registry of copyrights was transferred to it under the charge of the librarian of Congress, and two copies of every publication which claims copyright are required to be deposited. Cards for these are now printed and copies are sold to other libraries for an annual subscription fixed according to the number taken. The building in which the library is now housed was opened in 1897. It covers 3½ acres of ground, contains 10,000,000 cub. ft. of space, and has possible accommodation for over 4 million vols. Its cost was \$6,500,000, or including the land, \$7,000,000. It is the largest, most ornate and most costly building in the world yet erected for library purposes. Within recent years the appropriation has been largely increased, and the bibliographical department has been able to publish many valuable books on special subjects. The *A.L.A. Catalog* (1904) and *A.L.A. Portrait Index* (1906), may be mentioned as of especial value. The classification of the library is being gradually completed, and in every respect this is the most active government library in existence.

Other important federal libraries are those attached to the following departments at Washington: Bureau of Education (1868); Geological Survey (1882); House of Representatives; Patent Office (1836); Senate (1868); Surgeon General's Office (1870), with an elaborate analytical printed catalogue of world-wide fame.

Although the state libraries of Pennsylvania and New Hampshire are known to have been established as early as 1777, it was not until some time after the revolution that any general tendency was shown to form official libraries in connexion with the state system. It is especially within the last thirty years that the number of these libraries has so increased that now every state and territory possesses a collection of books and documents for official and public purposes. These collections depend for their increase upon annual appropriations by the several states, and upon a systematic exchange of the official publications of the general government and of the several states and territories. The largest is that of the state of New York at Albany, which contains nearly 500,000 vols., and is composed of a general and a law library. Printed and MS. card catalogues have been issued. The state libraries are libraries of reference, and only members of the official classes are allowed to borrow books, although any well-behaved person is admitted to read in the libraries.

The earliest libraries formed were in connexion with educational institutions, and the oldest is that of Harvard (1638). It was destroyed by fire in 1764, but active steps were at once taken for its restoration. From that time to the present, private donations have been the great resource of the library. In 1840 the collection was removed to Gore Hall, erected for the purpose with a noble bequest from Christopher Gore (1758-1829), formerly governor of Massachusetts. There are also ten special libraries connected with the different departments of the university. The total numbers of vols. in all these collections is over 800,000. There is a MS. card-catalogue in two parts, by authors and subjects, which is accessible to the readers. The only condition of admission to use the books in Gore Hall is respectability; but only members of the university and privileged persons may borrow books. The library of Yale College, New Haven, was founded in 1701, but grew so slowly that, even with the 1000 vols. received from Bishop Berkeley in 1733, it had only increased to 4000 vols. in 1766, and some of these were lost in the revolutionary war. During the 19th century the collection grew more speedily, and now the library numbers over 550,000 vols.

Other important university and college libraries are Amherst College, Mass. (1821), 93,000 vols.; Brown University, R.I. (1767), 156,000 vols.; Columbia University, N.Y. (1763), 430,000 vols.; Cornell University, N.Y. (1868), 355,000 vols.; Dartmouth College, N.H. (1769), 106,000 vols.; Johns Hopkins University, Baltimore

(1876), 220,000 vols.; Lehigh University, Pa. (1877), 150,000 vols.; Leland Stanford University, Cal. (1891), 113,000 vols.; Princeton University, N.J. (1746), 260,000 vols.; University of California (1868), 240,000 vols.; University of Chicago, Ill. (1892), 480,000 vols.; University of Michigan (1837), 252,000 vols.; University of Pennsylvania (1749), 285,000 vols. There are numerous other college libraries, several of them even larger than some of those named above.

The establishment of proprietary or subscription libraries runs back into the first half of the 18th century, and is connected with the name of Benjamin Franklin. It was at Philadelphia, in the year 1731, that he set on foot what he called "his first project of a public nature, that for a subscription library.... The institution soon manifested its ability, was imitated by other towns and in other provinces." The Library Company of Philadelphia was soon regularly incorporated, and gradually drew to itself other collections of books, including the Loganian Library, which was vested in the company by the state legislature in 1792 in trust for public use. Hence the collection combines the character of a public and of a proprietary library, being freely open for reference purposes, while the books circulate only among the subscribing members. It numbers at present 226,000 vols., of which 11,000 belong to the Loganian Library, and may be freely lent. In 1869 Dr James Rush left a bequest of over one million dollars for the purpose of erecting a building to be called the Ridgeway branch of the library. The building is very handsome, and has been very highly spoken of as a library structure. Philadelphia has another large proprietary library—that of the Mercantile Library Company, which was established in 1821. It possesses 200,000 vols., and its members have always enjoyed direct access to the shelves. The library of the Boston Athenaeum was established in 1807, and numbers 235,000 vols. It has published an admirable dictionary-catalogue. The collection is especially rich in art and in history, and possesses a part of the library of George Washington. The Mercantile Library Association of New York, which was founded in 1820, has over 240,000 vols. New York possesses two other large proprietary libraries, one of which claims to have been formed as early as 1700 as the "public" library of New York. It was organized as the New York Society Library in 1754, and has been especially the library of the old Knickerbocker families and their descendants, its contents bearing witness to its history. It contains about 100,000 vols. The Apprentices' Library (1820) has about 100,000 vols., and makes a special feature of works on trades and useful arts.

The Astor Library in New York was founded by a bequest of John Jacob Astor, whose example was followed successively by his son and grandson. The library was opened to the public in 1854, and consists of a careful selection of the most valuable books upon all subjects. It is a library of reference, for which purpose it is freely open, and books are not lent out. It is "a working library for studious persons." The Lenox Library was established by James Lenox in 1870, when a body of trustees was incorporated by an act of the legislature. In addition to the funds intended for the library building and endowment, amounting to \$1,247,000, the private collection of books which Mr Lenox had long been accumulating is extremely valuable. Though it does not rank high in point of mere numbers, it is exceedingly rich in early books on America, in Bibles, in Shakesperiana and in Elizabethan poetry. Both those libraries are now merged in the New York Public Library. The Peabody Institute at Baltimore was established by George Peabody in 1857, and contains a reference library open to all comers. The institute has an endowment of \$1,000,000, which, however, has to support, besides the library, a conservatoire of music, an art gallery, and courses of popular lectures. It has a very fine printed dictionary catalogue and now contains nearly 200,000 vols. In the same city is the Enoch Pratt Free Library (1882) with 257,000 vols. In the city of Chicago are two very important endowed libraries, the Newberry Library (1887) with over 200,000 vols., and the John Crerar Library (1894), with 235,000 vols. Both of these are reference libraries of great value, and the John Crerar Library specializes in science, for which purpose its founder left \$3,000,000.

It will be sufficient to name a few of the other endowed libraries to give an idea of the large number of donors who have given money to libraries. Silas Bronson (Waterbury), Annie T. Howard (New Orleans), Joshua Bates (Boston), Charles E. Forbes (Northampton, Mass.), Mortimer F. Reynolds (Rochester, N.Y.), Leonard Case (Cleveland), I. Osterhout (Wilkes-Barré, Pa.), and above all Andrew Carnegie, whose library benefactions exceed \$53,000,000.

It remains to mention another group of proprietary and society libraries.

Since the organization of the government in 1789, no less than one hundred and sixty historical societies have been formed in the United States, most of which still continue to exist. Many of them have formed considerable libraries, and possess extensive and valuable manuscript collections. The oldest of them is the Massachusetts Historical Society, which dates from 1791.

The earliest of the scientific societies, the American Philosophical Society (1743), has 73,000 vols. The most extensive collection is that of the Academy of Natural Sciences of Philadelphia, which consists of 80,000 vols. and pamphlets. For information as to the numerous professional libraries of the United States—theological, legal and medical—the reader may be referred to the authorities quoted below.

In no country has the movement for the development of municipal libraries made such progress as in the United States; these institutions called free or public as the case may be are distinguished for their work, enterprise and the liberality with which they are supported. They are established under laws passed by the different states, the first to pass such an enactment being Massachusetts, which in 1848 empowered the city of Boston to establish a free public library. This was subsequently extended to the whole state in 1851. Other states followed, all with more or less variation in the provisions, till practically every state in the Union now has a body of library laws. In general the American library law is much on the same lines as the English. In most states the acts are permissive. In New Hampshire aid is granted by the state to any library for which a township contracts to make a definite annual appropriation. A limit is imposed in most states on the library tax which may be levied, although there are some, like Massachusetts and New Hampshire, which fix no limit. In every American town the amount derived from the library tax usually exceeds by double or more the same rate raised in Britain in towns of similar size. For example, East Orange, N.J., with a population of 35,000, expends £2400, while Dumfries in Scotland, with 23,000 pop. expends £500. Cincinnati, 345,000 pop., expenditure £26,000; Islington (London), 350,000 pop., expenditure £8200, is another example. In the smaller towns the difference is not so marked, but generally the average American municipal library income is considerably in excess of the British one. Many American municipal libraries have also endowments which add to their incomes.

In one respect the American libraries differ from those of the United Kingdom. They are usually managed by a

small committee or body of trustees, about five or more in number, who administer the library independent of the city council. This is akin to the practice in Scotland, although there, the committees are larger. In addition to the legislation authorizing town libraries to be established, thirty-two states have formed state library commissions. These are small bodies of three or five trained persons appointed by the different states which, acting on behalf of the state, encourage the formation of local libraries, particularly in towns and villages, and in many cases have authority to aid their establishment by the grant out of the state funds of a certain sum (usually \$100) towards the purchase of books, upon the appropriation of a similar sum by the local authorities. These commissions are prepared to aid further with select lists of desirable books, and with suggestions or advice in the problems of construction and maintenance. Such commissions are in existence in Alabama, California, Colorado, Connecticut, Delaware, Georgia, Idaho, Illinois, Indiana, Iowa, Kansas, Maine, Maryland, Massachusetts, Michigan, Minnesota, Missouri, Nebraska, New Hampshire, New Jersey, New York, North Carolina, North Dakota, Ohio, Oregon, Pennsylvania, Tennessee, Texas, Utah, Vermont, Washington and Wisconsin.

The reports and other documents issued by some of these commissioners are very interesting and valuable, especially as regards the light they throw on the working of the travelling libraries in country districts. These to some extent are a revival of the "itinerating" library idea of Samuel Brown of Haddington in Scotland, who from 1817 to 1836 carried on a system of travelling subscription libraries in that country. At the time of his death there were 3850 vols. in 47 libraries. The American travelling libraries, often under state supervision, are well organized and numerous, and the books are circulated free. New York was the pioneer in this movement which now extends to most of the states which have established library commissions. There are also town travelling libraries and deposit stations in addition to branches, so that every effort is made to bring people in outlying districts into touch with books.

The municipal libraries of the United States work in conjunction with the schools, and it is generally considered that they are part of the educational machinery of the country. In the case of New York the state libraries have been put under the control of the university of the state of New York, which also inaugurated the travelling libraries. Work with the schools and children generally is more cultivated in the libraries of the United States than elsewhere. In some cases the libraries send collections of books to the schools; in others provision is made for children's reading-rooms and lending departments at the library buildings. At Cleveland (Ohio), Pittsburg (Pa.), New York and many other places, elaborate arrangements are in force for the convenience and amusement of children. There is a special school, the Carnegie Library training school for children's librarians, at Pittsburg, and within recent years the instruction has included the art of telling stories to children at the libraries. This "story-hour" idea has been the cause of considerable discussion in the United States, librarians and teachers being divided in opinion as to the value of the service. The chief factors in children's work in American libraries, often overlooked by critics, are the number of non-English reading adults and the large number of children of foreign origin. The adults do not use the libraries to any large extent, but the children, who learn English at the schools, are brought into close touch with the juvenile departments of the libraries. In this way many libraries are obliged to undertake special work for children, and as a rule it is performed in a sane, practical and economical manner. The preponderance of women librarians and their natural sentimental regard for children has tended to make this work loom rather largely in some quarters, but with these exceptions the activity on behalf of children is justified on many grounds. But above all, it is manifest that a rapidly growing nation, finding homes for thousands of foreigners and their children annually, must use every means of rapidly educating their new citizens, and the public library is one of the most efficient and ready ways of accomplishing this great national object.

With regard to methods, the American libraries are working on much the same plan as those of the United Kingdom. They allow access to the shelves more universally, and there is much more standardization in classification and other internal matters. The provision of books is more profuse, although there is, on the whole, more reading done in the United Kingdom. The largest municipal library system in America, and also in the world, is that of New York City, which, after struggling with a series of Free Circulating Libraries, blossomed out in 1895 into the series of combinations which resulted in the present great establishment. In that year, the Astor and Lenox libraries (see above) were taken over by the city, and in addition, \$2,000,000 was given by one of the heirs of Mr S. J. Tilden, who had bequeathed about \$4,000,000 for library purposes in New York but whose will had been upset in the law courts. In 1901 Mr Andrew Carnegie gave about £1,500,000 for the purpose of providing 65 branches, and these are now nearly all erected. A very fine central library building has been erected, and when the organization is completed there will be no system of municipal libraries to equal that of New York. It possesses about 1,400,000 vols. in the consolidated libraries. Brooklyn, although forming part of Greater New York, has an independent library system, and possesses about 560,000 vols. distributed among 26 branches and including the old Brooklyn Library which has been absorbed in the municipal library system. At Boston (Mass.) is one of the most renowned public libraries in the United States, and also the oldest established by act of legislature. It was first opened to the public in 1854, and is now housed in a very magnificently decorated building which was completed in 1895. The central library contains many fine special collections, and there are 28 branch and numerous school libraries in connexion. It possesses about 1,000,000 vols. altogether, its annual circulation is about 1,500,000 vols., and its annual expenditure is nearly £70,000.

Other notable municipal libraries are those of Philadelphia (1891), Chicago (1872), Los Angeles (Cal.), 1872, Indianapolis (1868), Detroit (1865), Minneapolis (1885), St Louis (1865), Newark, N.J. (1889), Cincinnati (1856), Cleveland (1869), Allegheny (1890), Pittsburg (1895), Providence, R.I. (1878), Milwaukee (1875), Washington, D.C. (1898), Worcester, Mass. (1859), Buffalo (1837).

AUTHORITIES.—*The Annual Library Index* (New York, 1908)—contains a select list of libraries in the United States; Arthur E. Bostwick, *The American Public Library*, illust. (New York, 1910)—the most comprehensive general book; Bureau of Education, *Statistics of Public Libraries in the United States and Canada* (1893)—this has been succeeded by a list of "Public, Society and School Libraries," reprinted at irregular intervals from the Report of the Commissioner of Education and giving a list of libraries containing over 5000 vols. with various other particulars; Clegg, *International Directory of Booksellers* (1910) and earlier issues—contains a list of American libraries with brief particulars; John C. Dana, *A Library Primer* (Chicago, 1910)—the standard manual of American library practice; *Directory of Libraries in the United States and Canada* (6th ed.; Minneapolis, 1908)—a brief list of 4500 libraries, with indication of the annual income of each; Wm. I. Fletcher, *Public Libraries in America* (2nd ed., Boston, 1899), illust.; T. W. Koch, *Portfolio of Carnegie Libraries* (1908); Cornelia Marvin,

France.

French libraries (other than those in private hands) belong either to the state, to the departments, to the communes, or to learned societies, educational establishments and other public institutions; the libraries of judicial or administrative bodies are not considered to be owned by them, but to be state property. Besides the unrivalled library accommodation of the capital, France possesses a remarkable assemblage of provincial libraries. The communal and school libraries also form striking features of the French free library system. Taking as a basis for comparison the *Tableau statistique des bibliothèques publiques* (1857), there were at that date 340 departmental libraries with a total of 3,734,260 vols., and 44,436 MSS. In 1908 the number of volumes in all the public libraries; communal, university, learned societies, educational and departmental, was more than 20,060,148 vols., 93,986 MSS. and 15,530 incunabula. Paris alone now possesses over 10,570,000 printed vols., 147,543 MSS., 5000 incunabula, 609,439 maps and plans, 2,000,000 prints (designs and reproductions).

The Bibliothèque Nationale (one of the most extensive libraries in the world) has had an advantage over others in the length of time during which its contents have been accumulating, and in the great zeal shown for it by several kings and other eminent men. Enthusiastic writers find the original of this library in the

565

**Paris.** MS. collections of Charlemagne and Charles the Bald, but these were dispersed in course of time, and the few precious relics of them which the national library now possesses have been acquired at a much later date. Of the library which St Louis formed in the 13th century (in imitation of what he had seen in the East) nothing has fallen into the possession of the Bibliothèque Nationale, but much has remained of the royal collections made by kings of the later dynasties. The real foundation of the institution (formerly known as the Bibliothèque du Roi) may be said to date from the reign of King John, the Black Prince's captive, who had a considerable taste for books, and bequeathed his "royal library" of MSS. to his successor Charles V. Charles V. organized his library in a very effective manner, removing it from the Palais de la Cité to the Louvre, where it was arranged on desks in a large hall of three storeys, and placed under the management of the first librarian and cataloguer, Claude Mallet, the king's valet-de-chambre. His catalogue was a mere shelf-list, entitled *Inventaire des Livres du Roy nostre Seigneur estans au chastel du Louvre*; it is still extant, as well as the further inventories made by Jean Blanchet in 1380, and by Jean le Bègue in 1411 and 1424. Charles V. was very liberal in his patronage of literature, and many of the early monuments of the French language are due to his having employed Nicholas Oresme, Raoul de Presle and other scholars to make translations from ancient texts. Charles VI. added some hundreds of MSS. to the royal library, which, however, was sold to the regent, duke of Bedford, after a valuation had been established by the inventory of 1424. The regent transferred it to England, and it was finally dispersed at his death in 1435. Charles VII. and Louis XI. did little to repair the loss of the precious Louvre library, but the news of the invention of printing served as a stimulus to the creation of another one, of which the first librarian was Laurent Paulmier. The famous miniaturist, Jean Foucquet of Tours, was named the king's *enlumineur*; and although Louis XI. neglected to avail himself of many precious opportunities that occurred in his reign, still the new library developed gradually with the help of confiscation. Charles VIII. enriched it with many fine MSS. executed by his order, and also with most of the books that had formed the library of the kings of Aragon, seized by him at Naples. Louis XII., on coming to the throne, incorporated the Bibliothèque du Roi with the fine Orleans library at Blois, which he had inherited. The Blois library, thus augmented, and further enriched by plunder from the palaces of Pavia, and by the purchase of the famous Gruthuyse collection, was described at the time as one of the four marvels of France. Francis I. removed it to Fontainebleau in 1534, enlarged by the addition of his private library. He was the first to set the fashion of fine artistic bindings, which was still more cultivated by Henry II., and which has never died out in France. During the librarianship of Amyot (the translator of Plutarch) the library was transferred from Fontainebleau to Paris, not without the loss of several books coveted by powerful thieves. Henry IV. removed it to the Collège de Clermont, but in 1604 another change was made, and in 1622 it was installed in the Rue de la Harpe. Under the librarianship of J. A. de Thou it acquired the library of Catherine de' Medici, and the glorious Bible of Charles the Bald. In 1617 a decree was passed that two copies of every new publication should be deposited in the library, but this was not rigidly enforced till Louis XIV.'s time. The first catalogue worthy of the name was finished in 1622, and contains a description of some 6000 vols., chiefly MSS. Many additions were made during Louis XIII.'s reign, notably that of the Dupuy collection, but a new era dawned for the Bibliothèque du Roi under the patronage of Louis XIV. The enlightened activity of Colbert, one of the greatest of collectors, so enriched the library that it became necessary for want of space to make another removal. It was therefore in 1666 installed in the Rue Vivien (now Vivienne) not far from its present habitat. The departments of engravings and medals were now created, and before long rose to nearly equal importance with that of books. Marolles's prints, Foucquet's books, and many from the Mazarin library were added to the collection, and, in short, the Bibliothèque du Roi had its future pre-eminence undoubtedly secured. Nic. Clément made a catalogue in 1684 according to an arrangement which has been followed ever since (that is, in twenty-three classes, each one designated by a letter of the alphabet), with an alphabetical index to it. After Colbert's death Louvois emulated his predecessor's labours, and employed Mabillon, Thevenot and others to procure fresh accessions from all parts of the world. A new catalogue was compiled in 1688 in 8 vols, by several distinguished scholars. The Abbé Louvois, the minister's son, became head of the library in 1691, and opened it to all students—a privilege which although soon withdrawn was afterwards restored. Towards the end of Louis XIV.'s reign it contained over 70,000 vols. Under the management of the Abbé Bignon numerous additions were made in all departments, and the library was removed to its present home in the Rue Richelieu. Among the more important acquisitions were 6000 MSS. from the private library of the Colbert family, Bishop Huet's forfeited collection, and a large number of Oriental books imported by missionaries from the farther East, and by special agents from the Levant. Between 1739 and 1753 a catalogue in 11 vols, was printed, which enabled the administration to discover and to sell its duplicates. In Louis XVI.'s reign the sale of the La Vallière library furnished a valuable increase both in MSS. and printed books. A few years before the Revolution broke out the latter department contained over 300,000 vols, and opuscles. The Revolution was serviceable to the library, now called the Bibliothèque Nationale, by increasing it with the forfeited collections of the *émigrés*, as well as of the suppressed religious communities. In the midst of the difficulties of placing and cataloguing these numerous acquisitions, the name of Van Praet appears as an administrator of the first order. Napoleon increased the amount of the government grant; and by the strict enforcement of the law concerning new publications, as well as by the acquisition of several special collections,

the Bibliothèque made considerable progress during his reign towards realizing his idea that it should be universal in character. At the beginning of last century the recorded numbers were 250,000 printed vols., 83,000 MSS., and 1,500,000 engravings. After Napoleon's downfall the MSS. which he had transferred from Berlin, Hanover, Florence, Venice, Rome, the Hague and other places had to be returned to their proper owners. The MacCarthy sale in 1817 brought a rich store of MSS. and incunabula. From that time onwards to the present, under the enlightened administration of MM. Taschereau and Delisle and Marcel, the accessions have been very extensive.

According to the statistics for 1908 the riches of the Bibliothèque Nationale may be enumerated as follows: (1) Département des Imprimés: more than 3,000,000 vols.; Maps and plans, 500,000 in 28,000 vols. (2) Département des Manuscrits: 110,000 MSS. thus divided: Greek 4960, Latin 21,544, French 44,913, Oriental and miscellaneous 38,583. (3) Département des Estampes: 1,000,000 pieces. (4) Département des Médailles: 207,096 pieces.

Admittance to the "salle de travail" is obtained through a card procured from the secretarial office; the "salle publique" contains 344 places for readers, who are able to consult more than 50,000 vols. of books of reference. Great improvements have lately been introduced into the service. A "salle de lecture publique" is free to all readers and is much used. New buildings are in process of construction. The slip catalogue bound in volumes dates from 1882 and gives a list of all accessions since that date; it is divided into two parts, one for the names of authors and the other for subjects. There is not yet, as at the British Museum, an alphabetical catalogue of all the printed works and kept up by periodical supplements, but since 1897 a *Catalogue général des livres imprimés* has been begun. In 1909 the 38th vol. containing letters A to Delp had appeared. Some volumes are published each year, but the earlier volumes only contain a selection of the books; this inconvenience has now been remedied. Among the other catalogues published by the Printed Book Department, the following may be mentioned: *Répertoire alphabétique des livres mis à la disposition des lecteurs dans la salle de travail* (1896, 8vo), *Liste des périodiques français et étrangers mis à la disposition des lecteurs* (1907, 4to, autogr.), *Liste des périodiques étrangers* (new ed., 1896, 8vo) and *Supplément* (1902, 8vo), *Bulletin des récentes publications françaises* (from 1882, 8vo), *Catalogue des dissertations et écrits académiques provenant des échanges avec les universités étrangères* (from 1882, 8vo). The other extensive catalogues apart from those of the 18th century are: *Catalogue de l'histoire de France* (1885-1889, 4to, 11 vols.); *Table des auteurs*, par P. Marchal (1895, 4to), with the following autographed supplements: *Histoire locale* (1880); *Histoire généalogique et biographies* (1884); *Mœurs et coutumes, archéologie* (1885); *Histoire maritime et militaire* (1894); *Histoire constitutionnelle* (1895); *Sciences médicales* (1857-1889, 3 vols., 4to); *Histoire de la Grande-Bretagne* (1875-1878, autogr.); *Histoire de l'Espagne et du Portugal* (1883, autogr.); *Histoire de l'Asie* (1894); *Histoire de l'Afrique* (1895, autogr.); *Histoire de l'Amérique*, par G. Barringer (1903-1908, autogr.); *Factums et autres documents judiciaires antérieurs à 1790*, par Corda et A. Trudon des Ormes (1890-1907, 8 vols., 8vo); *Catalogue général des incunables des bibliothèques publiques de France*, par M. Pellechet et L. Polain, t. i.-iii. (1897-1909, 8vo); *Livres d'heures imprimés au XV<sup>e</sup> siècle conservés dans les bibliothèques publiques de Paris*, par P. Lacombe (1907, 8vo), &c. In the Geographical section there is L. Vallée's *Catalogue des cartes et plans relatifs à Paris et aux environs de Paris* (1908, 8vo). The following should be mentioned: *Bibliographie générale des travaux historiques et archéologiques publiés par les sociétés savantes de la France*, par R. de Lasteyrie avec la collaboration d'E. Lefèvre-Pontalis, S. Bougenot, A. Vidier, t. i.-vi. (1885-1908, 4to). The scientific division of this work (in two parts) is by Deniker. The printed catalogues and the autographed and manuscript lists of the Département des Manuscrits are very numerous and greatly facilitate research. For the French there are: H. Omont, *Catalogue général des manuscrits français* (1895-1897, 9 vols. 8vo); H. Omont, *Nouvelles acquisitions* (continuation of the same catalogue, 1899-1900, 3 vols. 8vo); H. Omont, *Anciens Inventaires de la Bibliothèque Nationale* (1908-1909, 2 vols. 8vo); E. Coyecque, *Inventaire de la Collection Anisson sur l'histoire de l'imprimerie et de la librairie* (1900, 2 vols. 8vo). Without repeating the catalogues mentioned in the tenth edition of the *Encyclopaedia Britannica*, it is yet necessary to mention the following: *Catalogue de la collection Baluze; Inventaire des sceaux de la collection Clairambault; Catalogue de la collection des cinq-cents et des mélanges Colbert; Catalogue des collections Duchesne et de Bréquigny*; those of the Dupuy, Joly de Fleury, and Moreau collections, and that of provincial history, &c. For the Greek collection the most important catalogues have been made by H. Omont, the present Keeper of the Manuscripts, and these are: *Inventaire sommaire des MSS. grecs* (1886-1898, 4 vols. 8vo); *Catalogus codicum hagiographicorum graecorum* (1896, 8vo); *Facsimilés des plus anciens MSS. grecs en onciale et en minuscule du IX<sup>e</sup> au XIV<sup>e</sup> siècle* (1891, fol.); as well as *Description des peintures et autres ornements contenus dans les MSS. latins*, par H. Bordier (1883, 4to). The lists of the Latin MSS. are: *Inventaire des manuscrits latins et nouvelles acquisitions jusqu'en 1874* (1863-1874, 7 pts. 8vo) and *Manuscrits latins et français ajoutés aux fonds des nouvelles acquisitions 1875-1881* (1891, 2 vols. 8vo), by M. Delisle; M. Omont published *Nouvelles Acquisitions du département des manuscrits* (1892-1907, 8 pts. 8vo), and B. Haureau, *Notices et extraits de quelques manuscrits latins* (1890-1893, 6 vols. 8vo). The principal modern catalogues of the oriental collection are: B. de Slane, *Catalogue des MSS. arabes, avec supplément* (1883-1895, 4to); E. Blochet, *Catalogue des MSS. arabes, persans, et turcs de la collection Schefer* (1900); E. Blochet, *Inventaire des MSS. arabes de la collection Decourtemanche* (1906); F. Macler, *Catalogue des MSS. arméniens et géorgiens* (1908). For other oriental languages the following catalogues have been compiled: *MSS. birmans et cambodgiens* (1879); *MSS. chinois, coréens et japonais* (1900-1907); *MSS. coptes* (1906); *MSS. éthiopiens* (1859-1877); *MSS. hébreux et samaritains* (1867-1903); *MSS. indo-chinois* (in the press); *MSS. malayo-polynésiens* (in the press); *MSS. mazdéens* (1900); *MSS. mexicains* (1899); *MSS. persans*, t. i. (1905); *MSS. sanscrits et pâlis* (1899, 1907-1908); *MSS. siamois* (1887); *MSS. syriaques et sabéens* (1874-1896); *MSS. thibétains* (in the press), &c. The catalogues of manuscripts in modern languages are nearly all completed. The Départements des Médailles et des Estampes possess excellent catalogues, and the following should be mentioned: E. Babelon, *Catalogue des monnaies grecques* (1890-1893); E. Babelon, *Inventaire sommaire de la collection Waddington* (1898); *Médailles fausses recueillies*, par Hoffmann (1902); Muret et Chabouillet, *Catalogue des monnaies gauloises* (1889-1892); Prou, *Catalogue des monnaies françaises* (1892-1896); H. de la Tour, *Catalogue de la collection Rouyer, 1<sup>re</sup> partie* (1899); *Catalogues des monnaies et médailles d'Alsace* (1902); *Cat. des monnaies de l'Amérique du Nord* (1861); *Cat. des monnaies musulmanes* (1887-1891); *Cat. des plombs* (1900); *Cat. des bronzes antiques* (1889); *Cat. des camées antiques et modernes* (1897-1899); *Cat. des vases peints* (1902-1904, 2 vols.). In the Département des Estampes the following should be mentioned: F. Courboin, *Catalogue sommaire des gravures et lithographies de la Réserve* (1900-1901); Duplessis, *Cat. des portraits français et étrangers* (1896-1907, 6 vols.); H. Bouchot, *Les Portraits au crayon des XVI<sup>e</sup> et XVII<sup>e</sup> siècles* (1884); *Cat. des dessins relatifs à l'histoire du théâtre* (1896); F. Courboin, *Inventaire des dessins, photographies et gravures relatives à l'histoire générale de l'art* (1895, 2 vols.), &c.

The Bibliothèque de l'Arsenal was founded by the marquis de Paulmy (Antoine-René d'Argenson) in the 18th

century; it received in 1786 80,000 vols. from the duc de La Vallière. Before its confiscation as national property it had belonged to the comte d'Artois, who had bought it from the marquis de Paulmy in his lifetime. It contains at the present time about 600,000 vols., 10,000 manuscripts, 120,000 prints and the Bastille collection (2500 portfolios) of which the inventory is complete; it is the richest library for the literary history of France and has more than 30,000 theatrical pieces.

*L'Inventaire des manuscrits* was made by H. Martin (1885-1899, t. i.-viii.); the other catalogues and lists are: *Extrait du catalogue des journaux conservés à la Bibliothèque de l' Arsenal* ("Bulletin des biblioth. et des archives" t. i.); *Archives de la Bastille*, par F. Funck-Brentano (1892-1894, 3 vols. 8vo); *Notice sur les dépôts littéraires* par J. B. Labiche (1880, 8vo); *Catalogue des estampes, dessins et cartes composant le cabinet des estampes de la bibliothèque de l' Arsenal*, par G. Schefer (1894-1905, 8 pts. 8vo).

The Bibliothèque Mazarine owes its origin to the great cardinal, who confided the direction to Gabriel Naudé; it was open to the public in 1642, and was transferred to Rue de Richelieu in 1648. Dispersed during the Fronde in the lifetime of Mazarin, it was reconstituted after the death of the cardinal in 1661, when it contained 40,000 vols. which were left to the Collège des Quatre-Nations, which in 1691 made it again public. It now has 250,000 vols.; with excellent manuscript catalogues.

The catalogues of incunabula and manuscripts are printed: P. Marais et A. Dufresne de Saint-Léon, *Catalogue des incunables de la bibliothèque Mazarine* (1893, 8vo); *Supplément, additions et corrections* (1898, 4 vols. 8vo); *Catalogue des MSS.*, par A. Molinier (1885-1892, 4 vols. 8vo); *Inventaire sommaire des MSS. grecs*, par H. Omont.

The first library of the Genévains had nearly disappeared owing to bad administration when Cardinal François de la Rochefoucauld, who had charge of the reformation of that religious order, constituted in 1642 a new library with his own books. The Bibliothèque Ste-Geneviève in 1716 possessed 45,000 vols.; important gifts were made by Letellier in 1791, and the duc d'Orléans increased it still more. It became national property in 1791, and was called the Bibliothèque du Panthéon and added to the Lycée Henri IV. under the empire. In 1908 the library contained 350,000 printed vols., 1225 incunabula, 3510 manuscripts, 10,000 prints (including 7357 portraits and 3000 maps and plans).

The printed catalogues at present comprise: Poirée et Lamoureux, *Catalogue abrégé de la bibliothèque Ste-Geneviève* (1891, 8vo); 3 supplements (1890-1896, 1897-1899, 1900-1902); *Catalogue des incunables de la bibliothèque Ste-Geneviève, rédigé par Daunou*, publié par M. Pellechet (1892, 8vo); *Catalogue général des MSS.*, par Ch. Kohler (1894-1896, 2 vols. 8vo); *Inventaire sommaire des MSS. grecs*, par H. Omont; *Notices sur quelques MSS. normands*, par E. Deville (1904-1906, 10 pts. 8vo), &c.

The Bibliothèque des Archives nationales, founded in 1808 by Daunou, contains 30,000 vols. on sciences auxiliary to history. It is only accessible to the officials.

It would be impossible to describe all the official, municipal and academic libraries of Paris more or less open to the public, which are about 200 in number, and in the following survey we deal only with those having 10,000 vols. and over.

The Bibliothèque du Ministère des affaires étrangères was founded by the marquis de Torcy, minister for foreign affairs under Louis XIV.; it contains 80,000 vols. and is for official use only. The Bibliothèque du Ministère de l'Agriculture dates from 1882 and has only 4000 vols. At the Ministry for the Colonies the library (of 10,000 vols.) dates from 1897; the catalogue was published in 1905; the library of the Colonial office is attached to this ministry; suppressed in 1896, it was re-established in 1899, and now contains 6000 vols., 7400 periodicals and 5000 photographs; it is open to the public. There are 30,000 vols. in the Bibliothèque du Ministère du commerce et de l'industrie; the Bibliothèque du Ministère des finances was burnt at the Commune, but has been reconstituted and now contains 35,000 vols.; connected with it are the libraries of the following offices: Contributions directes, Contributions indirectes, Enregistrement et inspection des finances; the contents of these four libraries make a total of 13,500 vols. The Bibliothèque du Ministère de la Guerre was formed by Louvois and possesses 130,000 vols. and 800 MSS. and an income of 20,000 francs; the catalogues are *Bibliothèque du dépôt de la guerre: Catalogue* (1883-1890); *Suppléments* (1893-1896); *Catalogue des MSS.*, par J. Lemoine (1910). The following libraries are connected with this department: Comité de santé (10,000 vols.), École supérieure de guerre (70,000 vols.), Comité technique de l'artillerie (24,000 vols.). The Bibliothèque du Ministère de l'Intérieur was founded in 1793 and has 80,000 vols. The Bibliothèque du Ministère de la Justice possesses 10,000 vols., and L'Imprimerie Nationale which is connected with it has a further 19,000 vols. There are also the following law libraries: Cour d'appel (12,000 vols.); Ordre des avocats, dating from 1871 (56,000 vols., with a catalogue printed in 1880-1882); the Bibliothèque des avocats de la cour de Cassation (20,000 vols.); that of the Cour de Cassation (40,000 vols.). The Bibliothèque du Ministère de la Marine is of old formation (catalogue 1838-1843); it contains 100,000 vols, and 356 MSS.; the catalogue of manuscripts was compiled in 1907. The Bibliothèque du service hydrographique de la Marine has 65,000 vols, and 250 MSS. The Ministère des Travaux publics possesses 12,000 vols., and the Sous-Secrétariat des postes et télégraphes a further 30,000 vols. The Bibliothèque de la Chambre des députés (1796) possesses 250,000 printed books and 1546 MSS. (*Catalogue des manuscrits*, by E. Coyecque et H. Debray, 1907; *Catalogue des livres de jurisprudence, d'économie politique, de finances, et d'administration*, 1883). The Bibliothèque du Sénat (1818) contains 150,000 vols, and 1343 MSS. The Bibliothèque du Conseil d'État has 30,000 vols. All these libraries are only accessible to officials except by special permission.

The Bibliothèque Historique de la ville de Paris was destroyed in 1871, but Jules Cousin reconstituted it in 1872; it possesses 400,000 vols., 3500 MSS. and 14,000 prints; the principal printed catalogues are *Catalogue des imprimés de la Réserve* by M. Poète (1910), *Catalogue des manuscrits*, by F. Bournon (1893); a *Bulletin* has been issued periodically since 1906. The Bibliothèque administrative de la préfecture de la Seine is divided into two sections: French (40,000 vols.) and foreign (22,000 vols.); it is only accessible to officials and to persons having a card of introduction; the catalogues are printed.

The other libraries connected with the city of Paris are that of the Conseil municipal (20,000 vols.), the Bibliothèques Municipales Populaires, 82 in number with a total of 590,000 books; those of the 22 Hospitals (92,887 vols.), the Préfecture de police (10,000 vols.), the Bibliothèque Forney (10,000 vols. and 80,000 prints), the five Écoles municipales supérieures (19,700 vols.), the six professional schools (14,200 vols.).

The libraries of the university and the institutions dealing with higher education in Paris are well organized and their catalogues generally printed.



The Bibliothèque de l'Université, although at present grouped as a system in four sections in different places, historically considered is the library of the Sorbonne. This was founded in 1762 by Montempuis and only included the faculties of Arts and Theology. It changed its name several times; in 1800 it was the Bibliothèque du Prytanée, in 1808 Bibliothèque des Quatre Lycées and in 1812 Bibliothèque de l'Université de France. The sections into which the Bibliothèque de l'Université is now divided are: (1) Facultés de Sciences et des Lettres à la Sorbonne, (2) Faculté de Médecine, (3) Faculté de droit, (4) École supérieure de pharmacie. Before the separation of Church and State there was a fifth section, that of Protestant theology. After the Bibliothèque nationale it is the richest in special collections, and above all as regards classical philology, archaeology, French and foreign literature and literary criticism, just as the library of the Faculté des Sciences et des Lettres is notable for philosophy, mathematics and chemico-physical sciences. The great development which has taken place during the last thirty years, especially under the administration of M. J. de Chantepie du Désert, its installation since 1897 in the buildings of the New Sorbonne, have made it a library of the very first rank. The reading-room only seats about 300 persons. The average attendance per day is 1200, the number of books consulted varies from 1500 to 3000 vols. a day, and the loans amount to 14,000 vols. per year. The store-rooms, although they contain more than 1200 mètres of shelves and comprise two buildings of five storeys each, are insufficient for the annual accessions, which reach nearly 10,000 vols. by purchase and presentation. Amongst the latter the most important are the bequests of Leclerc, Peccot, Lavis, Derembourg and Beljame; the last-named bequeathed more than 3000 vols., including an important Shakespearean library. The first section contains more than 550,000 vols., 2800 periodicals which include over 70,000 vols., 320 incunabula, 2106 MSS., more than 2000 maps and plans and some prints. The alphabetical catalogues are kept up day by day on slips. The classified catalogues were in 1910 almost ready for printing, and some had already been published: *Périodiques* (1905); *Cartulaires* (1907); *Mélanges jubilaires et publications commémoratives* (1908); *Inventaires des MSS.*, by E. Chatelain (1892); *Incunables*, by E. Chatelain (1902); and *Supplément, Réserve de la bibliothèque 1401-1540*, by Ch. Beauhieux (1909); *Nouvelles acquisitions* (1905-1908); *Catalogue des livres de G. Duplessis donnés à l'Université de Paris* (1907), *Catalogue collectif des bibliothèques universitaires* by Fécamp (1898-1901). For French thèses, of which the library possesses a rich collection, the catalogues are as follows: Mourier et Deltour, *Catalogue des thèses de lettres* (1809, &c.); A. Maire, *Répertoire des thèses de lettres* (1809-1900); A. Maire, *Catalogue des thèses de sciences* (1809-1890) with *Supplément* to 1900 by Estanave; *Catalogue des thèses publié par le Ministère de l'Instruction publique* (1882, &c.).

At the Sorbonne are also to be found the libraries of A. Dumont and V. Cousin (15,000 vols.), and those of the laboratories, of which the richest is the geological (30,000 specimens and books). The section relating to medicine, housed since 1891 in the new buildings of the Faculté de Médecine, includes 180,000 vols, and 88 MSS. (catalogue 1910). The Bibliothèque de la faculté de droit dates from 1772 and contains 80,000 vols., 239 MSS. The fourth section, l'École supérieure de pharmacie, greatly developed since 1882, now contains 50,000 vols.

The other libraries connected with higher education include that of the École des Beaux-Arts (40,000 vols., 100,000 reproductions, 14,000 drawings). The library of the École normale supérieure (1794), established in the Rue d'Ulm in 1846, has received legacies from Verdet (1867), Caboche (1887), Lerambert-Whitcomb (1890), and a portion of Cuvier's library; the system of classification in use is practically the same as that of the Sorbonne, being devised by Philippe Lebas (librarian of the Sorbonne) about 1845; there are 200,000 vols. The library of the Muséum d'histoire naturelle dates from the 18th century, and contains 220,000 vols., 2000 MSS., 8000 original drawings on vellum beginning in 1631. The Bibliothèque de l'Office et Musée de l'Instruction publique (formerly Musée pédagogique), founded only in 1880, has 75,000 vols. In 1760 was founded the Bibliothèque de l'Institut de France, which is very rich; its acquisitions come particularly from gifts and exchanges (400,000 vols., numerous and scarce; valuable MSS., especially modern ones).

The following may be briefly mentioned: Conservatoire national de musique (1775), which receives everything published in France relating to music (200,000 vols.); the Bibliothèque du théâtre de l'Opéra (25,000 vols., 5000 songs, 20,000 romances, and a dramatic library of 12,000 vols. and 20,000 prints); the Théâtre français (40,000 vols.); the Académie de médecine (15,000 vols., 10,000 vols. of periodicals, 5000 portraits), l'Observatoire (18,400 vols.); the Bureau des Longitudes (15,000 vols. and 850 MSS.). The scholastic libraries are: L'École centrale des arts et manufactures (16,000 vols.); l'École coloniale (11,000 vols.); 1, l'École d'application du service de santé militaire (23,000 vols.); l'École d'application du génie maritime (14,000 vols.); l'École libre des sciences politiques (25,000 vols., 250 periodicals); l'École normale d'instituteurs de la Seine (10,000 vols.); l'École normale israélite (30,000 vols., 250 MSS.); l'École nationale des ponts-et-chaussées (9000 vols., 5000 MSS., 5000 photographs); Bibliothèque de l'Institut catholique (160,000 vols.); l'Institut national agronomique (25,000 vols.); Faculté libre de théologie protestante (36,000 vols.); Conservatoire des arts et métiers (46,000 vols., 2500 maps and plans); Bibliothèque polonaise, administered by the Académie des Sciences de Cracovie (80,000 vols., 30,000 prints); Séminaire des Missions étrangères (25,000 vols.); l'Association Valentin Haüy, established 1885 (2000 vols. printed in relief) which lends out 40,000 books per annum; l'Association générale des Étudiants (22,000 vols.), which lends and allows reference on the premises to books by students; Bibliothèque de la Chambre de Commerce (40,000 vols.), the catalogues of which were printed in 1879, 1889 and 1902; the Société nationale d'agriculture (20,000 vols.); the Société d'anthropologie (23,000 vols.); the Société asiatique (12,000 vols., 200 MSS.); the Société chimique de France (10,000 vols.), the catalogue of which was published in 1907; the Société de chirurgie, dating from 1843 (20,000 vols.); the Société entomologique (30,000 vols.); the Société de géographie founded 1821 (60,000 vols., 6000 maps, 22,000 photographs, 2200 portraits, 80 MSS. of which the catalogue was printed in 1901); the Société géologique de France (15,000 vols., 30,000 specimens, 800 periodicals); the Société de l'histoire du protestantisme français, founded in 1852 (50,000 vols., 1000 MSS.; income 25,000 frs.); the Société d'encouragement pour l'industrie nationale (50,000 vols., income 8000 frs.); the Société des Ingénieurs civils (47,000 vols.; catalogue made in 1894); the Société de législation comparée (15,000 vols., 4500 pamphlets); and lastly the Bibliothèque de la Société de Statistique de Paris, founded in 1860 (60,000 vols., with a printed catalogue).

Before the Revolution there were in Paris alone 1100 libraries containing altogether 2,000,000 vols. After the suppression of the religious orders the libraries were confiscated, and in 1791 more than 800,000 vols, were seized in 162 religious houses and transferred to eight literary foundations in accordance with a decree of November 14, 1789. In the provinces 6,000,000 vols. were seized and transferred to local depositories. The organization of the central libraries under the decree of 3 Brumaire An IV. (October 25, 1795) came to nothing, but the consular edict of January 28, 1803 gave definitive organization to the books in the local depositories. From that time the library system was reconstituted, alike in Paris and the provinces. Unfortunately many precious books and MSS. were burnt, since by the decree of 4 Brumaire An II. (October 25, 1793) the Committee

of Instruction ordered, on the proposition of its president the deputy Romme, the destruction or modification of books and objects of art, under the pretext that they recalled the outward signs of feudalism.

The books in the provincial libraries, not including those in private hands or belonging to societies, number over 9,200,000 vols., 15,540 incunabula and 93,986 MSS. The number in the colonies and protected states outside France is uncertain, but it extends to more than 200,000 vols.; to this number must be added the 2,428,954 vols. contained in the university libraries. There are over 300 departmental libraries, and as many belong to learned societies. The increase in the provincial libraries is slower than that of the Parisian collections. With the exception of 26 libraries connected specially with the state, the others are municipal and are administered under state control by municipal librarians. The original foundation of most of the libraries dates but a short time before the Revolution, but there are a few exceptions. Thus the Bibliothèque d'Angers owes its first collection to Alain de la Rue about 1376; it now contains 72,485 vols., 134 incunabula and 2039 MSS. That of Bourges dates from 1466 (36,856 vols., 325 incunabula, 741 MSS.). The library of Carpentras was established by Michel Anglici between 1452 and 1474 (50,000 vols., 2154 MSS.). Mathieu de la Porte is said to be the founder of the library at Clermont-Ferrand at the end of the 15th century; it contained rather more than 49,000 vols. at the time of its union with the Bibliothèque Universitaire.

### **Libraries of the Departments.**

Amongst the libraries which date from the 16th century must be mentioned that at Lyons founded by François I. in 1527; it possesses 113,168 vols., 870 incunabula and 5243 MSS. That of the Palais des Arts has 82,079 vols., 64 incunabula and 311 MSS.

In the 17th century were established the following libraries: Abbeville, by Charles Sanson in 1685 (46,929 vols., 42 incunabula, 342 MSS.); Besançon by Abbé Boisot in 1696 (93,580 vols., 1000 incunabula, 2247 MSS.). In 1604 the Consistoire réformé de la Rochelle established a library which possesses to-day 58,900 vols., 14 incunabula, 1715 MSS. St Étienne, founded by Cardinal de Villeroy, has 50,000 vols., 8 incunabula, 343 MSS.

The principal libraries founded during the 18th century are the following: Aix-en-Provence, established by Tournon and Méjane in 1705 (160,000 vols., 300 incunabula, 1351 MSS.); Bordeaux, 1738 (200,000 vols., 3491 MSS.); Chambéry, 1736 (64,200 vols., 47 incunabula, 155 MSS.); Dijon, 1701, founded by P. Fevret (125,000 vols., 211 incunabula, 1669 MSS.); Grenoble, 1772 (260,772 vols., 635 incunabula, 2485 MSS.); Marseilles, 1799 (111,672 vols., 143 incunabula, 1691 MSS.); Nancy, founded in 1750 by Stanislas (126,149 vols., 205 incunabula, 1695 MSS.); Nantes, 1753 (103,328 vols., 140 incunabula, 2750 MSS.); Nice, founded in 1786 by Abbé Massa (55,000 vols., 300 incunabula, 150 MSS.); Nîmes, founded by J. T. de Séguier in 1778 (80,000 vols., 61 incunabula, 675 MSS.); Niort, by Jean de Dieu and R. Bion in 1771 (49,413 vols., 67 incunabula, 189 MSS.); Perpignan, by Maréchal de Mailly in 1759 (27,200 vols., 80 incunabula, 127 MSS.); Rennes, 1733 (110,000 vols., 116 incunabula, 602 MSS., income 8950 frs.); Toulouse, by archbishop of Brienne in 1782 (213,000 vols., 859 incunabula, 1020 MSS.).

Nearly all the other municipal libraries date from the Revolution, or rather from the period of the redistribution of the books in 1803. The following municipal libraries possess more than 100,000 vols.: Avignon (135,000 vols., 698 incunabula, 4152 MSS.), of which the first collection was the legacy of Calvet in 1810; Caen (122,000 vols., 109 incunabula, 665 MSS.); Montpellier (130,300 vols., 40 incunabula, 251 MSS.); Rouen (140,000 vols., 400 incunabula, 4000 MSS.); Tours (123,000 vols., 451 incunabula, 1999 MSS.); Versailles (161,000 vols., 436 incunabula, 1213 MSS.).

The following towns have libraries with more than 50,000 volumes: Amiens, Auxerre, Beaune, Brest, Douai, le Havre, Lille, le Mans, Orléans, Pau, Poitiers, Toulon and Verdun.

The catalogues of the greater part of the municipal libraries are printed. Especially valuable is the *Catalogues des MSS. des bibliothèques de Paris et des Départements*, which began to appear in 1885; the MSS. of Paris fill 18 octavo volumes, and those of the provinces 50.

The libraries of the provincial universities, thanks to their reorganization in 1882 and to the care exhibited by the general inspectors, are greatly augmented. Aix has 74,658 vols.; Alger 160,489; Besançon 24,275; Bordeaux 216,278; Caen 127,542; Clermont 173,000; Dijon 117,524; Grenoble 127,400; Lille 215,427; Lyons 425,624; Marseilles 53,763; Montpellier 210,938; Nancy 139,036; Poitiers 180,000; Rennes 166,427; Toulouse 232,000.

Since 1882 the educational libraries have largely developed; in 1877 they were 17,764 in number; in 1907 they were 44,021, containing 7,757,917 vols. The purely scholastic libraries have decreased; in 1902 there were 2674 libraries with 1,034,132 vols., whilst after the reorganization (Circulaire of March 14, 1904) there were only 1131 with 573,279 vols. The Société Franklin pour la propagation des bibliothèques populaires et militaires distributed among the libraries which it controls 55,185 vols., between the years 1900 and 1909.

AUTHORITIES.—Information has been given for this account by M. Albert Maire, librarian at the Sorbonne. See also the following works:—*Bibliothèque Nationale: I. Bâtiments, collections, organisation, département des estampes, département des médailles et antiques*, par Henri Marcel, Henri Bouchot et Ernest Babelon. II. *Le Département des imprimés et la section de géographie. Le Département des manuscrits*, par Paul Marchal et Camille Couderc (Paris, 1907, 2 vols); Félix Chambon, *Notes sur la bibliothèque de l'Université de Paris de 1763 à 1905* (Ganat, 1905); Fosseyeux, *La Bibliothèque des hôpitaux de Paris* (Revue des bibliothèques, t. 18, 1908); Alfred Franklin, *Guide des savants, des littérateurs et des artistes dans les bibliothèques de Paris* (Paris, 1908); *Instruction du 7 Mars 1899 sur l'organisation des bibliothèques militaires* (Paris, 1899); Henri Jadart, *Les Anciennes bibliothèques de Reims, leur sort en 1790-1791 et la formation de la bibliothèque publique* (Reims, 1891); Henry Marcel, *Rapport adressé au Ministre de l'Instruction Publique, sur l'ensemble des services de la bibliothèque nationale en 1905* (Journal Officiel, 1906); Henry Martin, *Histoire de la bibliothèque de l'Arsenal* (Paris, 1899); E. Morel, *Le Développement des bibliothèques publiques* (Paris, 1909); Théod. Mortreuil, *La Bibliothèque nationale, son origine et ses accroissements; notice historique* (Paris, 1878); Abbé L. V. Pécheur, *Histoire des bibliothèques publiques du département de l'Aisne existant à Soissons, Laon et Saint-Quentin* (Soissons, 1884); M. Poète, E. Beaurepaire and E. Clouzot, *Une visite à la bibliothèque de la ville de Paris* (Paris, 1907); E. de Saint-Albin, *Les Bibliothèques municipales de la ville de Paris* (Paris, 1896); B. Subercaze, *Les Bibliothèques populaires, scolaires et pédagogiques* (Paris, 1892).

### *Germany (with Austria-Hungary and Switzerland).*

Germany is emphatically the home of large libraries; her former want of political unity and consequent multiplicity of capitals have had the effect of giving her many large state libraries, and the number of her

**Germany.** universities has tended to multiply considerable collections; 1617 libraries were registered by P. Schwenke in 1891. As to the conditions, hours of opening, &c., of 200 of the most important of them, there is a yearly statement in the *Jahrbuch der deutschen Bibliotheken*, published by the Verein deutscher Bibliothekare.

The public libraries of the German empire are of four distinct types: state libraries, university libraries, town libraries and popular libraries. The administration and financial affairs of the state and university libraries are under state control. The earlier distinction between these two classes has become less and less marked. Thus the university libraries are no longer restricted to professors and students, but they are widely used by scientific workers, and books are borrowed extensively, especially in Prussia. In Prussia, as a link between the state and the libraries, there has been since 1907 a special office which deals with library matters at the Ministry of Public Instruction. Generally the state does not concern itself with the town libraries and the popular libraries, but there is much in common between these two classes. Sometimes popular libraries are under the supervision of a scientifically administered town library as in Berlin, Dantzig, &c.; elsewhere, as at Magdeburg, we see an ancient foundation take up the obligations of a public library. Only in Prussia and Bavaria are regulations in force as to the professional education of librarians. Since 1904 the librarians of the Prussian state libraries have been obliged to complete their university courses and take up their doctorate, after which they have to work two years in a library as volunteers and then undergo a technical examination. The secretarial officials since 1909 have to reach a certain educational standard and must pass an examination. This regulation has been in force as regards librarians in Bavaria from 1905.

Berlin is well supplied with libraries, 268 being registered by P. Schwenke and A. Hortschansky in 1906, with about 5,000,000 printed vols. The largest of them is the Royal Library, which was founded by the "Great Elector" Frederick William, and opened as a public library in a wing of the electoral palace in 1661.

**Berlin.** From 1699 the library became entitled to a copy of every book published within the royal territories, and it has received many valuable accessions by purchase and otherwise. It now includes 1,230,000 printed vols. and over 30,000 MSS. The amount yearly expended upon binding and the acquisition of books, &c., is £11,326. The catalogues are in manuscript, and include two general alphabetical catalogues, the one in volumes, the other on slips, as well as a systematic catalogue in volumes. The following annual printed catalogues are issued: *Verzeichnis der aus der neu erschienenen Literatur von der K. Bibliothek und den Preussischen Universitäts-Bibliotheken erworbenen Druckschriften* (since 1892); *Jahresverzeichnis der an den Deutschen Universitäten erschienenen Schriften* (since 1887); *Jahresverzeichnis der an den Deutschen Schulanstalten erschienenen Abhandlungen* (since 1889). There is besides a printed *Verzeichnis der im grossen Lesesaal aufgestellten Handbibliothek* (4th ed. 1909), the alphabetical *Verzeichnis der laufenden Zeitschriften* (last ed., 1908), and the classified *Verzeichnis der laufenden Zeitschriften* (1908). The catalogue of MSS. are mostly in print, vols. 1-13, 16-23 (1853-1905). The library is specially rich in oriental MSS., chiefly due to purchases of private collections. The musical MSS. are very remarkable and form the richest collection in the world as regards autographs. The building, erected about 1780 by Frederick the Great, has long been too small, and a new one was completed in 1909. The building occupies the whole space between the four streets: Unter den Linden, Dorotheenstrasse, Universitätsstrasse and Charlottenstrasse, and besides the Royal Library, houses the University Library and the Academy of Sciences. The conditions as to the use of the collections are, as in most German libraries, very liberal. Any adult person is allowed to have books in the reading-room. Books are lent out to all higher officials, including those holding educational offices in the university, &c., and by guarantee to almost any one recommended by persons of standing; borrowing under pecuniary security is also permitted. By special leave of the librarian, books and MSS. may be sent to a scholar at a distance, or, if especially valuable, may be deposited in some public library where he can conveniently use them. In 1908-1909 264,000 vols. were used in the reading-rooms, 312,000 were lent inside Berlin, and 32,000 outside. There is a regular system of exchange between the Royal Library and a great number of Prussian libraries. It is the same in Bavaria, Württemberg and Baden; the oldest system is that between Darmstadt and Giessen (dating from 1837). There is either no charge for carriage to the borrower or the cost is very small. The reading-room and magazine hall are, with the exception of Sundays and holidays, open daily from 9 to 9, the borrowing counter from 9 to 6.

Associated with the Royal Library are the following undertakings: the *Gesamtkatalog der Preussischen wissenschaftlichen Bibliotheken* (describing the printed books in the Royal Library and the Prussian University Libraries in one general catalogue upon slips), the Auskunftsbureau der Deutschen Bibliotheken (bureau to give information where any particular book may be consulted), and the Kommission für den Gesamtkatalog der Wiegendrucke (to draw up a complete catalogue of books printed before 1500).

The University Library (1831) numbers 220,000 vols. together with 250,000 academical and school dissertations. The number of volumes lent out in 1908-1909 was 104,000. The library possesses the right to receive a copy of every work published in the province of Brandenburg.

Some of the governmental libraries are important, especially those of the Statistisches Landesamt (184,000 vols.); Reichstag (181,000 vols.); Patent-Amt (118,000 vols.); Haus der Abgeordneten (100,000 vols.); Auswärtiges-Amt (118,000 vols.).

The public library of Berlin contains 102,000 vols.; connected therewith 28 municipal Volksbibliotheken and 14 municipal reading-rooms. The 28 Volksbibliotheken contain (1908) 194,000 vols.

The Prussian university libraries outside Berlin include Bonn (332,000 printed vols., 1500 MSS.); Breslau (330,000 printed vols., 3700 MSS.); Göttingen, from its foundation in 1736/7 the best administered library of the 18th century (552,000 printed vols., 6800 MSS.); Greifswald (200,000 printed vols., 800 MSS.); Halle (261,000 printed vols., 2000 MSS.); Kiel (278,000 printed vols., 2400 MSS.); Königsberg (287,000 printed vols., 1500 MSS.); Marburg (231,000 printed vols, and about 800 MSS.); Münster (191,000 printed vols., 800 MSS.). Under provincial administration are the Königliche and Provinzialbibliothek at Hanover (203,000 printed vols., 4000 MSS.); the Landesbibliothek at Cassel (230,000 printed vols., 4400 MSS.); and the Kaiser-Wilhelm-Bibliothek at Posen (163,000 printed vols.). A number of the larger towns possess excellent municipal libraries; Aix-la-Chapelle (112,000 vols.); Breslau (164,000 vols., 4000 MSS.); Dantzig (145,600 vols., 2900 MSS.); Frankfort a/M (342,000 vols, besides MSS.); Cassel Murhardsche Bibliothek (141,000 vols., 6300 MSS.); Cologne (235,000 vols.); Treves (100,000 vols., 2260 MSS.); Wiesbaden (158,000 vols.).

The libraries of Munich, though not so numerous as those of Berlin, include two of great importance. The Royal Library, for a long time the largest collection of books in Germany, was founded by Duke Albrecht V. of Bavaria (1550-1579), who made numerous purchases from Italy, and incorporated the libraries of the Nuremberg physician and historian Schedel, of Widmannstadt, and of J. J. Fugger. The number

**Munich.**

of printed vols, is estimated at about 1,100,000 and about 50,000 MSS. The library is especially rich in incunabula, many of them being derived from the libraries of over 150 monasteries closed in 1803. The oriental MSS. are numerous and valuable, and include the library of Martin Haug. The amount annually spent upon books and binding is £5000. The catalogues of the printed books are in manuscript, and include (1) a general alphabetical catalogue, (2) an alphabetical repertorium of each of the 195 subdivisions of the library, (3) biographical and other subject catalogues. A printed catalogue of MSS. in 8 vols, was in 1910 nearly complete; the first was published in 1858. The library is open on weekdays from 8 to 1 (November to March 8.30 to 1), and on Monday to Friday (except from August 1 to September 15) also from 3 to 8. The regulations for the use of the library are very similar to those of the Royal Library at Berlin. The building was erected for this collection under King Louis I. in 1832-1843. The archives are bestowed on the ground floor, and the two upper floors are devoted to the library, which occupies seventy-seven apartments. The University Library was originally founded at Ingolstadt in 1472, and removed with the university to Munich in 1826. At present the number of vols. amounts to 550,000; the MSS. number 2000. Forty-six Munich libraries are described in Schwenke's *Adressbuch*, 15 of which possessed in 1909 about 2,000,000 printed vols. and about 60,000 MSS. After the two mentioned above the most noteworthy is the Königlich Bayrische Armee-Bibliothek (100,000 printed vols., 1000 MSS.).

The chief Bavarian libraries outside Munich are the Royal Library at Bamberg (350,000 vols., 4300 MSS.) and the University Library at Würzburg (390,000 vols., 1500 MSS.); both include rich monastic libraries. The University Library at Erlangen has 237,000 vols. The Staats-Kreis and Stadtbibliothek at Augsburg owns 200,000 vols., and 2000 MSS.; Nuremberg has two great collections, the Bibliothek des Germanischen National-museums (250,000 vols., 3550 MSS.) and the Stadtbibliothek (104,000 vols., 2500 MSS.).

In 1906 there were in Dresden 78 public libraries with about 1,495,000 vols. The Royal Public Library in the Japanese Palace was founded in the 16th century. Among its numerous acquisitions have been the library of Count Büнау in 1764, and the MSS. of Ebert. Special attention is devoted to history and literature. The library possesses more than 520,000 vols. (1909); the MSS. number 6000. Admission to the reading-room is granted to any respectable adult on giving his name, and books are lent out to persons qualified by their position or by a suitable guarantee. Here, as at other large libraries in Germany, works of belles-lettres are only supplied for a literary purpose. The number of persons using the reading-room in a year is about 14,000, and about 23,000 vols. are lent. The second largest library in Dresden, the Bibliothek des Statistischen Landes-Amtes, has 120,000 vols.

Leipzig is well equipped with libraries; that of the University has 550,000 vols. and 6500 MSS. The Bibliothek des Reichsgerichts has 151,000 vols., the Pädagogische Central-Bibliothek der Comenius-Stiftung 150,000 vols., and the Stadtbibliothek 125,000 vols., with 1500 MSS.

The Royal Public Library of Stuttgart, although only established in 1765, has grown so rapidly that it now possesses about 374,000 vols. of printed works and 5300 MSS. There is a famous collection of Bibles, containing over 7200 vols. The annual expenditure devoted to books and binding is £2475. The library also enjoys the copy-privilege in Württemberg. The annual number of borrowers is over 2600, who use nearly 29,000 vols. The number issued in the reading-room is 41,000. The number of parcels despatched from Stuttgart is nearly 23,000. Admission is also gladly granted to the Royal Private Library, founded in 1810, which contains about 137,000 vols.

Of the other libraries of Württemberg the University Library of Tübingen (500,000 vols. and 4100 MSS.) need only be noted.

The Grand-ducal Library of Darmstadt was established by the grand-duke Louis I. in 1819, on the basis of the still older library formed in the 17th century, and includes 510,000 vols. and about 3600 MSS. (1909). The number of vols. used in the course of the year is about 90,000, of which 14,000 are lent out.

Among the other libraries of the Grand Duchy of Hesse the most remarkable are the University Library at Giessen (230,000 vols., 1500 MSS.), and the Stadtbibliothek at Mainz (220,000 vols., 1200 MSS.) to which is attached the Gutenberg Museum.

In the Grand Duchy of Baden are the Hof- und Landesbibliothek at Carlsruhe (202,000 vols., 3800 MSS.), the University Library at Freiburg i/B (300,000 vols., 700 MSS.), and the University Library at Heidelberg. This, the oldest of the German University libraries, was founded in 1386. In 1623 the whole collection, described by Joseph Scaliger in 1608 as "locupletior et meliorum librorum quam Vaticana," was carried as a gift to the pope and only the German MSS. were afterwards returned. The library was re-established in 1703, and after 1800 enriched with monastic spoils; it now contains about 400,000 vols. and 3500 MSS. for the most part of great value.

Among the State or University libraries of other German states should be mentioned Detmold (110,000 vols.); Jena (264,000 vols.); Neustrelitz (130,000 vols.); Oldenburg (126,000 vols.); Rostock (275,000 vols.); Schwerin (225,000 vols.); and Weimar (270,000), all possessing rich collections of MSS.

The Ducal Library of Gotha was established by Duke Ernest the Pious in the 17th century, and contains many valuable books and MSS. from monastic collections. It numbers about 192,000 vols., with 7400 MSS. The catalogue of the oriental MSS., chiefly collected by Seetzen, and forming one-half of the collection, is one of the best in existence.

The Ducal Library at Wolfenbüttel, founded in the second half of the 16th century by Duke Julius, was made over to the university of Helmstedt in 1614, whence the most important treasures were returned to Wolfenbüttel in the 19th century; it now numbers 300,000 vols., 7400 MSS.

The chief libraries of the Hanse towns are: Bremen (Stadtbibliothek, 141,000 vols.), and Lübeck (Stadtbibliothek, 121,000 vols.); the most important being the Stadtbibliothek at Hamburg, made public since 1648 (383,000 vols., 7300 MSS., among them many Mexican). Hamburg has also in the Kommerzbibliothek (120,000 vols.) a valuable trade collection, and the largest Volksbibliothek (about 100,000 vols.) after that at Berlin. Alsace-Lorraine has the most recently formed of the great German collections—the Universitäts- und Landesbibliothek at Strassburg, which, though founded only in 1871 to replace that which had been destroyed in the siege, already ranks amongst the largest libraries of the empire. Its books amount to 922,000 vols., the number of MSS. is 5900.

**Austria.**

describes 1014 libraries in Austria, 656 in Hungary, and 23 in Bosnia and Herzegovina. Included in this list, however, are private lending libraries.

The largest library in Austria, and one of the most important collections in Europe, is the Imperial Public Library at Vienna, apparently founded by the emperor Frederick III. in 1440, although its illustrious librarian Lambecius, in the well-known inscription over the entrance to the library which summarizes its history attributes this honour to Frederick's son Maximilian. However this may be, the munificence of succeeding emperors greatly added to the wealth of the collection, including a not inconsiderable portion of the dispersed library of Corvinus. Since 1808 the library has also been entitled to the copy-privilege in respect of all books published in the empire. The sum devoted to the purchase and binding of books is £6068 annually. The number of printed vols. is 1,000,000; 8000 incunabula. The MSS. amount to 27,000, with 100,000 papyri of the collection of Archduke Rainer. The main library apartment is one of the most splendid halls in Europe. Admission to the reading-room is free to everybody, and books are also lent out under stricter limitations. The University Library of Vienna was established by Maria Theresa. The reading-room is open to all comers, and the library is open from 1st Oct. to 30th June from 9 a.m. to 8 p.m.; in the other months for shorter hours. In 1909 447,391 vols. were used in the library, 45,000 vols. lent out in Vienna, and 6519 vols. sent carriage free to borrowers outside Vienna. The number of printed vols. is 757,000. For the purchase of books and binding the Vienna University Library has annually 60,000 crowns from the state as well as 44,000 crowns from matriculation fees and contributions from the students.

The total number of libraries in Vienna enumerated by Bohatta and Holzmann is 165, and many of them are of considerable extent. One of the oldest and most important libraries of the monarchy is the University Library at Cracow, with 380,000 vols. and 8169 MSS.

The number of monastic libraries in Austria is very considerable. They possess altogether more than 2,500,000 printed vols., 25,000 incunabula and 25,000 MSS. The oldest of them, and the oldest in Austria, is that of the monastery of St Peter at Salzburg, which was established by Archbishop Arno (785-821). It includes 70,000 vols., nearly 1500 incunabula. The three next in point of antiquity are Kremsmünster (100,000), Admont (86,000) and Melk (70,000), all of them dating from the 11th century. Many of the librarians of these monastic libraries are trained in the great Vienna libraries. There is no official training as in Prussia and Bavaria.

Information about income, administration, accessions, &c., of the chief libraries in the Hungarian kingdom, are given in the Hungarian *Statistical Year Book* annually. The largest library in Hungary is the Széchenyi-Nationalbibliothek at Budapest, founded in 1802 by the gift of the library of Count Franz Széchenyi. It contains 400,000 printed vols., 16,000 MSS., and has a remarkable collection of Hungarica. The University Library of Budapest includes 273,000 printed books and more than 2000 MSS. Since 1897 there has been in Hungary a Chief Inspector of Museums and Libraries whose duty is to watch all public museums and libraries which are administered by committees, municipalities, religious bodies and societies. He also has undertaken the task of organizing a general catalogue of all the MSS. and early printed books in Hungary.

**Hungary.**

The libraries of the monasteries and other institutions of the Catholic Church are many in number but not so numerous as in Austria. The chief among them, the library of the Benedictines at St Martinsberg, is the central library of the order in Hungary and contains nearly 170,000 vols. It was reconstituted in 1802 after the re-establishment of the order. The principal treasures of this abbey (11th century) were, on the secularization of the monasteries under Joseph II., distributed among the state libraries in Budapest.

Among the Swiss libraries, which numbered 2096 in 1868, there is none of the first rank. Only three possess over 200,000 vols.—the University Library at Basle founded in 1460, the Cantonal Library at Lausanne, and the Stadtbibliothek at Berne, which since 1905 is united to the University Library of that city. One great advantage of the Swiss libraries is that they nearly all possess printed catalogues, which greatly further the plan of compiling a great general catalogue of all the libraries of the republic. A valuable co-operative work is their treatment of Helvetiana. All the literature since 1848 is collected by the Landes-Bibliothek at Berne, established in 1895 for this special object. The older literature is brought together in the Bürgerbibliothek at Lucerne, for which it has a government grant. The monastic libraries of St Gall and Einsiedeln date respectively from the years 830 and 946, and are of great historical and literary interest.

**Switzerland.**

AUTHORITIES.—Information has been supplied for this account by Professor Dr A. Hortzschansky, librarian of the Royal Library, Berlin. See also *Adressbuch der deutschen Bibliotheken* by Paul Schwenke (Leipzig, 1893); *Jahrbuch der deutschen Bibliotheken* (Leipzig, 1902-1910); *Berliner Bibliothekenführer*, by P. Schwenke and A. Hortzschansky (Berlin, 1906); A. Hortzschansky, *Die K. Bibliothek zu Berlin* (Berlin, 1908); Ed. Zarncke, *Leipziger Bibliothekenführer* (Leipzig, 1909); J. Bohatta and M. Holzmann, *Adressbuch der Bibliotheken der österreich-ungarischen Monarchie* (Vienna, 1900); Ri. Kukula, *Die österreichischen Studienbibliotheken* (1905); A. Hübl, *Die österreichischen Klosterbibliotheken in den Jahren 1848-1908* (1908); P. Gulyas, *Das ungarische Oberinspektorat der Museen und Bibliotheken* (1909); *Die über 10,000 Bände zählenden öffentlichen-Bibliotheken Ungarns, im Jahre 1908* (Budapest, 1910); H. Escher, "Bibliothekswesen" in *Handbuch der Schweizer Volkswirtschaft*, vol. i. (1903).

*Italy.*

As the former centre of civilization, Italy is, of course, the country in which the oldest existing libraries must be looked for, and in which the rarest and most valuable MSS. are preserved. The Vatican at Rome and the Laurentian Library at Florence are sufficient in themselves to entitle Italy to rank before most other states in that respect, and the venerable relics at Vercelli, Monte Cassino and La Cava bear witness to the enlightenment of the peninsula while other nations were slowly taking their places in the circle of Christian polity. The local rights and interests which so long helped to impede the unification of Italy were useful in creating and preserving at numerous minor centres many libraries which otherwise would probably have been lost during the progress of absorption that results from such centralization as exists in England. In spite of long centuries of suffering and of the aggression of foreign swords and foreign gold, Italy is still rich in books and MSS. The latest official statistics (1896) give particulars of 1831 libraries, of which 419 are provincial and communal. In 1893 there were 542 libraries of a popular character and including circulating libraries.

The governmental libraries (*biblioteche governative*) number 36 and are under the authority of the minister of public instruction. The *Regolamento* controlling them was issued in the *Bolletino Ufficiale*, 5 Dec. 1907. They consist of the national central libraries of Rome (Vittorio Emanuele) and Florence, of the national libraries of Milan (Braidense), Naples, Palermo, Turin and Venice (Marciana); the Biblioteca governativa at Cremona; the Marucelliana, the Mediceo-Laurenziana and the Riccardiana at Florence; the governativa at Lucca; the Estense at Modena; the Brancacciana and that of San Giacomo at Naples; the Palatina at Parma; the Angelica, the Casanatense, and the Lancisiana at Rome; the university libraries of Bologna, Cagliari, Catania, Genoa, Messina, Modena, Naples, Padua, Pavia, Pisa, Rome and Sassari; the Ventimiliana at Catania (joined to the university library for administrative purposes); the Vallicelliana and the musical library of the R. Accad. of St Cecilia at Rome; the musical section of the Palatine at Parma; and the Lucchesi-Palli (added to the national library at Naples). There are provisions whereby small collections can be united to larger libraries in the same place and where there are several governmental libraries in one city a kind of corporate administration can be arranged. The libraries belonging to bodies concerned with higher education, to the royal scientific and literary academies, fine art galleries, museums and scholastic institutions are ruled by special regulations. The minister of public instruction is assisted by a technical board.

The librarians and subordinates are divided into (1) librarians, or keepers of MSS.; (2) sub-librarians, or sub-keepers of MSS.; (3) attendants, or book distributors; (4) ushers, &c. Those of class 1 constitute the "board of direction," which is presided over by the librarian, and meets from time to time to consider important measures connected with the administration of the library. Each library is to possess, alike for books and MSS., a general inventory, an accessions register, an alphabetical author-catalogue and a subject-catalogue. When they are ready, catalogues of the special collections are to be compiled, and these the government intends to print. A general catalogue of the MSS. was in 1910 being issued together with catalogues of oriental codices and incunabula. Various other small registers are provided for. The sums granted by the state for library purposes must be applied to (1) salaries and the catalogues of the MSS.; (2) maintenance and other expenses; (3) purchase of books, binding and repairs, &c. Books are chosen by the librarians. In the university libraries part of the expenditure is decided by the librarians, and part by a council formed by the professors of the different faculties. The rules (*Boll. Ufficiale*, Sept. 17, 1908) for lending books and MSS. allow them to be sent to other countries under special circumstances.

The 36 *biblioteche governative* annually spend about 300,000 lire in books. From the three sources of gifts, copyright and purchases, their accessions in 1908 were 142,930, being 21,122 more than the previous year. The number of readers is increasing. In 1908 there were 1,176,934, who made use of 1,650,542 vols., showing an increase of 30,456 readers and 67,579 books as contrasted with the statistics of the previous year. Two monthly publications catalogue the accessions of these libraries, one dealing with copyright additions of Italian literature, the other with all foreign books.

The minister of public instruction has kept a watchful eye upon the literary treasures of the suppressed monastic bodies. In 1875 there were 1700 of these confiscated libraries, containing two millions and a half of volumes. About 650 of the collections were added to the contents of the public libraries already in existence; the remaining 1050 were handed over to the different local authorities, and served to form 371 new communal libraries, and in 1876 the number of new libraries so composed was 415.

The Biblioteca Vaticana stands in the very first rank among European libraries as regards antiquity and wealth of MSS. We can trace back the history of the Biblioteca Vaticana to the earliest records of the *Scrinium Sedis Apostolicae*, which was enshrined in safe custody at the Lateran, and later on partly in the **Vatican.** Turris Chartularia; but of all the things that used to be stored there, the only survival, and that is a dubious example, is the celebrated Codex Amiatinus now in the Laurentian Library at Florence. Of the new period inaugurated by Innocent III. there but remains to us the inventory made under Boniface VIII. The library shared in the removal of the Papal court to Avignon, where the collection was renewed and increased, but the Pontifical Library at Avignon has only in part, and in later times, been taken into the Library of the Vatican. This latter is a new creation of the great humanist popes of the 15th century. Eugenius IV. planted the first seed, but Nicholas V. must be looked upon as the real founder of the library, to which Sixtus IV. consecrated a definite abode, ornate and splendid, in the Court of the Pappagallo. Sixtus V. erected the present magnificent building in 1588, and greatly augmented the collection. The library increased under various popes and librarians, among the most noteworthy of whom were Marcello Cervini, the first *Cardinale Bibliotecario*, later Pone Marcel II., Sirloto and A. Carafa. In 1600 it was further enriched by the acquisition of the valuable library of Fulvio Orsini, which contained the pick of the most precious libraries. Pope Paul V. (1605-1621) separated the library from the archives, fixed the progressive numeration of the Greek and Latin MSS., and added two great halls, called the Pauline, for the new codices. Under him and under Urban VIII. a number of MSS. were purchased from the Convento of Assisi, of the Minerva at Rome, of the Capranica College, &c. Especially noteworthy are the ancient and beautiful MSS. of the monastery of Bobbio, and those which were acquired in various ways from the monastery of Rossano. Gregory XV. (1622) received from Maximilian I., duke of Bavaria, by way of compensation for the money supplied by him for the war, the valuable library of the Elector Palatine, which was seized by Count Tilly at the capture of Heidelberg. Alexander VII. (1658), having purchased the large and beautiful collection formerly belonging to the dukes of Urbino, added the MSS. of it to the Vatican library. The *Libreria della Regina*, i.e. of Christina, queen of Sweden, composed of very precious manuscripts from ancient French monasteries, from St Gall in Switzerland, and others—also of the MSS. of Alexandre Petau, of great importance for their history and French literature, was purchased and in great part presented to the Vatican library by Pope Alexander VIII. (Ottoboni) in 1689, while other MSS. came in later with the Ottoboni library. Under Clement XI. there was the noteworthy purchase of the 54 Greek MSS. which had belonged to Pius II., and also the increase of the collection of Oriental MSS. Under Benedict XIV. there came into the Vatican library, as a legacy, the library of the Marchese Capponi, very rich in rare and valuable Italian editions, besides 285 MSS.; and by a purchase, the Biblioteca Ottoboniana, which, from its wealth in Greek, Latin, and even Hebrew MSS., was, after that of the Vatican, the richest in all Rome. Clement XIII. in 1758, Clement XIV. in 1769, and Pius VI. in 1775 were also benefactors. During three centuries the vast and monumental library grew with uninterrupted prosperity, but it was to undergo a severe blow at the end of the 18th century. In 1798, as a sequel to the Treaty of Tolentino, 500 MSS. picked from the most valuable of the different collections were sent to Paris by the victorious French to enrich the Bibliothèque Nationale and other libraries. These, however, were

chiefly restored in 1815. Most of the Palatine MSS., which formed part of the plunder, found their way back to the university of Heidelberg. Pius VII. acquired for the Vatican the library of Cardinal Zelada in 1800, and among other purchases of the 19th century must be especially noted the splendid Cicognara collection of archaeology and art (1823); as well as the library in 40,000 vols. of Cardinal Angelo Mai (1856). Recent more important purchases, during the Pontificate of Leo XIII., have been the Borghese MSS., about 300 in number, representing part of the ancient library of the popes at Avignon; the entire precious library of the Barberini; the Borgia collection *De Propaganda Fide*, containing Latin and Oriental MSS., and 500 incunabula.

Few libraries are so magnificently housed as the Biblioteca Vaticana. The famous *Codici Vaticani* are placed in the *salone* or great double hall, which is decorated with frescoes depicting ancient libraries and councils of the church. At the end of the great hall an immense gallery, also richly decorated, and extending to 1200 ft., opens out from right to left. Here are preserved in different rooms the codici Palatini, Regin., Ottoboniani, Capponiani, &c. The printed books only are on open shelves, the MSS. being preserved in closed cases. The printed books that were at first stored in the Borgia Apartment, now with the library of Cardinal Mai, constitute in great part the *Nuova Sala di Consultazione*, which was opened to students under the Pontificate of Leo XIII. Other books, on the other hand, are still divided into 1<sup>a</sup> and 2<sup>da</sup> raccolta, according to the ancient denomination, and are stored in adjacent halls.

Well-reasoned calculations place the total number of printed books at 400,000 vols.; of incunabula about 4000, with many vellum copies; 500 Aldines and a great number of bibliographical rarities. The Latin manuscripts number 31,373; the Greek amount to 4148; the Oriental MSS., of which the computation is not complete, amount to about 4000. Among the Greek and Latin MSS. are some of the most valuable in the world, alike for antiquity and intrinsic importance. It is sufficient to mention the famous biblical *Codex Vaticanus* of the 4th century, the two Virgils of the 4th and 5th centuries, the Bembo Terence, the palimpsest *De Republica* of Cicero, conjectured to be of the 4th century, discovered by Cardinal Mai, and an extraordinary number of richly ornamented codices of great beauty and costliness. The archives are apart from the library, and are accessible in part to the public under conditions. Leo XIII. appointed a committee to consider what documents of general interest might expediently be published.

572

The Biblioteca Vaticana is now open from October 1st to Easter every morning between 9 and 1 o'clock, and from Easter to June 29 from 8 o'clock to 12, with the exception of Sundays, Thursdays and the principal feast days.

Catalogues of special classes of MSS. have been published. The Oriental MSS. have been described by J. S. Assemani, *Bibliotheca orientalis Clementino-Vaticana* (Rome, 1719-1728, 4 vols. folio), and *Bibl. Vat. codd. MSS. catalogus ab S. E. et J. S. Assentano redactus* (ib., 1756-1759, 3 vols. folio), and by Cardinal Mai in *Script. Vet. nova collectio*. The Coptic MSS. have been specially treated by G. Zoega (Rome, 1810, folio) and by F. G. Bonjour (Rome, 1699, 4to). There are printed catalogues of the Capponi (1747) and the Cicognara (1820) libraries. The following catalogues have lately been printed: E. Stevenson, *Codd. Palatini Graeci* (1885), *Codd. Gr. Reg. Sueciae et Pii II.* (1888); Feron-Battaglini, *Codd. Ottobon. Graeci* (1893); C. Stornaiolo, *Codd. Urbinates Gr.* (1895); E. Stevenson, *Codd. Palatini Lat.* tom. 1 (1886); G. Salvo-Cozzo, *Codici Capponiani* (1897); M. Vattasso and P. Franchi de' Cavalieri, *Codd. Lat. Vaticani*, tom. 1 (1902); C. Stornaiolo, *Codices Urbinates Latini*, tom. 1 (1902); E. Stevenson, *Inventario dei libri stampati Palatino-Vaticani* (1886-1891); and several volumes relating to Egyptian papyri by O. Marucchi. Some of the greatest treasures have been reproduced in facsimile.

The most important library in Italy for modern requirements is the Nazionale Centrale Vittorio Emanuele. From its foundation in 1875, incorporating the *biblioteca maior o secreta* of the Jesuits in the Collegio Romano, and all the cloister libraries of the Provincia Romana which had devolved to the state through the suppression of the Religious Orders, it has now, by purchases, by donations, through the operation of the law of the press increased to about 850,000 printed vols., and is continually being ameliorated. It possesses about 1600 incunabula and 6200 MSS. Noteworthy among these are the Farfensi and the Sessoriani MSS. of Santa Croce in Jerusalem, and some of these last of the 6th to the 8th centuries are real treasures. The library has been recently reorganized. It is rich in the history of the renaissance, Italian and foreign reviews, and Roman topography. A monthly *Bollettino* is issued of modern foreign literature received by the libraries of Italy.

#### **Other Roman libraries.**

The Biblioteca Casanatense, founded by Cardinal Casanate in 1698, contains about 200,000 printed vols., over 2000 incunabula, with many Roman and Venetian editions, and more than 5000 MSS., among which are examples of the 8th, 9th and 10th centuries. They are arranged in eleven large rooms, the large central hall being one of the finest in Rome. It is rich in theology, the history of the middle ages, jurisprudence and the economic, social and political sciences. An incomplete catalogue of the printed books by A. Audiffredi still remains a model of its kind (Roma, 1761-1788, 4 vols. folio, and part of vol. v.).

The Biblioteca Angelica was founded in 1605 by Monsignor Angelo Rocca, an Augustinian, and was the first library in Rome to throw open its doors to the public. It contains about 90,000 vols., of which about 1000 are incunabula; 2570 MSS., of which 120 are Greek, and 91 Oriental. It includes all the authentic acts of the Congregatio de Auxiliis and the collections of Cardinal Passionei and Lucas Holstenius.

The Biblioteca Universitaria Alessandrina was founded by Pope Alexander VII., with the greater part of the printed books belonging to the dukes of Urbino, and was opened in 1676. In 1815 Pius VII. granted to it the right to receive a copy of every printed book in the States of the Church, which grant at the present time, by virtue of the laws of Italy, is continued, but limited to the province of Rome. The library possesses 130,000 printed books, 600 incunabula, 376 MSS.

The library of the Senate was established at Turin in 1848. It contains nearly 87,000 vols. and is rich in municipal history and the statutes of Italian cities, the last collection extending to 2639 statutes or vols. for 679 municipalities. The library of the Chamber of Deputies contains 120,000 vols. and pamphlets. It is rich in modern works, and especially in jurisprudence, native and foreign history, economics and administration.

The Biblioteca Vallicelliana was founded by Achille Stazio (1581), and contains some valuable manuscripts, including a Latin Bible of the 8th century attributed to Alcuin, and some inedited writings of Baronius. It now contains 28,000 vols. and 2315 MSS. Since 1884 it has been in the custody of the R. Società Romana di Storia Patria. The Biblioteca Lancisiana, founded in 1711 by G. M. Lancisi, is valuable for its medical collections.

In 1877 Professor A. Sarti presented to the city of Rome his collection of fine-art books, 10,000 vols., which

was placed in charge of the Accademia di San Luca, which already possessed a good artistic library. The Biblioteca Centrale Militare (1893) includes 66,000 printed vols. and 72,000 maps and plans relating to military affairs; and the Biblioteca della R. Accad. di S. Cecilia (1875), a valuable musical collection of 40,000 volumes and 2300 MSS.

Among the private libraries accessible by permission, the Chigiana (1660) contains 25,000 vols. and 2877 MSS. The Corsiniana, founded by Clement XII. (Lorenzo Corsini) is rich in incunabula, and includes one of the most remarkable collections of prints, the series of Marc-Antonios being especially complete. It was added to the Accademia dei Lincei in 1884 and now extends to 43,000 vols. The library of the Collegium de Propaganda Fide was established by Urban VIII. in 1626. It owes its present richness almost entirely to testamentary gifts, among which may be mentioned those of Cardinals Borgia, Caleppi and Di Pietro. It is a private collection for the use of the congregation and of those who belong to it, but permission may be obtained from the superiors. There are at least thirty libraries in Rome which are more or less accessible to the public. At Subiaco, about 40 m. from Rome, the library of the Benedictine monastery of Santa Scolastica is not a very large one, comprising only 6000 printed vols. and 400 MSS., but the place is remarkable as having been the first seat of typography in Italy. It was in this celebrated Protocoenobium that Schweynheim and Pannartz, fresh from the dispersion of Fust and Schoeffer's workmen in 1462, established their press and produced a series of very rare and important works which are highly prized throughout Europe. The Subiaco library, although open daily to readers, is only visited by students who are curious to behold the cradle of the press in Italy, and to inspect the series of original editions preserved in their first home.

The Biblioteca Nazionale Centrale of Florence, formed from the union of Magliabechi's library with the Palatina, is the largest after the Vittorio Emanuele at Rome. The Magliabechi collection became public property in 1714, and with accessions from time to time, held an independent place until 1862, when the Palatina (formed by Ferdinand III., Grand Duke of Tuscany), was incorporated with it. An old statute by which a copy of every work printed in Tuscany was to be presented to the Magliabechi library was formerly much neglected, but has been maintained more rigorously in force since 1860. Since 1870 it receives by law a copy of every book published in the kingdom. A *Bollettino* is issued describing these accessions. There are many valuable autograph originals of famous works in this library, and the MSS. include the most important extant *codici* of Dante and later poets, as well as of the historians from Villani to Machiavelli and Guicciardini. Amongst the printed books is a very large assemblage of rare early impressions, a great number of the *Rappresentazioni* of the 16th century, at least 200 books printed on vellum, and a copious collection of municipal histories and statutes, of *testi di lingua* and of maps. The Galileo collection numbers 308 MSS. The MS. portolani, 25 in number, are for the most part of great importance; the oldest is dated 1417, and several seem to be the original charts executed for Sir Robert Dudley (duke of Northumberland) in the preparation of his *Arcano del Mare*. The library contains (1909) 571,698 printed vols., 20,222 MSS., 9037 engravings, 21,000 portraits, 3847 maps, and 3575 incunabula. In 1902 the Italian parliament voted the funds for a new building which is being erected on the Corso dei Tintori close to the Santa Croce Church.

The Biblioteca Nazionale of Milan, better known as the Braidense, founded in 1770 by Maria Theresa, consists of 243,000 printed vols. 1787 MSS. and over 3000 autographs. It comprises nearly 2300 books printed in the 15th century (including the rare *Monte Santo di Dio* of Bettini, 1477), 913 Aldine impressions, and a xylographic *Biblia Pauperum*. Amongst the MSS. are an early Dante and autograph letters of Galileo, some poems in Tasso's autograph, and a fine series of illustrated service-books, with miniatures representing the advance of Italian art from the 12th to the 16th century. One room is devoted to the works of Manzoni.

The Biblioteca Nazionale at Naples, though only opened to the public in 1804, is the largest library of that city. The nucleus from which it developed was the collection of Cardinal Seripando, which comprised many MSS. and printed books of great value. Acquisitions came in from other sources, especially when in the year 1848 many private and conventual libraries were thrown on the Neapolitan market, and still more so in 1860. The Biblical section is rich in rarities, commencing with the Mainz Bible of 1462, printed on vellum. Other special features are the collection of *testi di lingua*, that of books on volcanoes, the best collection in existence of the publications of Italian literary and scientific societies and a nearly complete set of the works issued by the Bodoni press. The MSS. include a palimpsest containing writings of the 3rd, 5th and 6th centuries under a grammatical treatise of the 8th, 2 Latin papyri of the 6th century, over 50 Latin Bibles, many illuminated books with miniatures, and the autographs of G. Leopardi. There are more than 40 books printed on vellum in the 15th and 16th centuries, including a fine first Homer; and several MS. maps and portolani, one dating from the end of the 14th century. The library contains about 389,100 printed vols., 7990 MSS. and 4217 incunabula.

The Biblioteca Nazionale of Palermo, founded from the Collegio Massimo of the Jesuits, with additions from other libraries of that suppressed order, is rich in 15th-century books, which have been elaborately described in a catalogue printed in 1875, and in Aldines and bibliographical curiosities of the 16th and following centuries, and a very complete series of the Sicilian publications of the 16th century, many being unique. The library contains 167,898 printed vols., 2550 incunabula, 1537 MSS.

The Biblioteca Nazionale Universitaria of Turin took its origin in the donation of the private library of the House of Savoy, which in 1720 was made to the University by Vittorio Amedeo II. The disastrous fire of January 1904 destroyed about 24,000 out of the 300,000 vols. which the library possessed, and of the MSS., the number of which was 4138, there survive now but 1500 in a more or less deteriorated condition. Among those that perished were the palimpsests of Cicero, Cassidorus, the Codex Theodosianus and the famous *Livre d'Heures*. What escaped the fire entirely was the valuable collection of 1095 incunabula, the most ancient of which is the *Rationale Divinorum Officiorum* of 1459. Since the fire the library has been enriched by new gifts, the most conspicuous of which is the collection of 30,000 vols. presented by Baron Alberto Lumbroso, principally relating to the French Revolution and empire. The library was in 1910 about to be transferred to the premises of the Palazzo of the Debito Pubblico. The Biblioteca Marciana, or library of St Mark at Venice, was traditionally founded in 1362 by a donation of MSS. from the famous Petrarch (all of them now lost) and instituted as a library by Cardinal Bessarione in 1468. The printed vols. number 417,314. The precious contents include 12,106 MSS. of great value, of which more than 1000 Greek codices were given by Cardinal Bessarione, important MS. collections of works on Venetian history, music and theatre, rare incunabula, and a great number of volumes, unique or exceedingly rare, on the subject of early geographical research. Amongst the MSS. is a Latin Homer, an invaluable codex of the laws of the Lombards, and the autograph MS. of Sarpi's *History of the Council of*



*Trent.* Since the fall of the republic and the suppression of the monasteries a great many private and conventual libraries have been incorporated with the Marciana, which had its first abode in the Libreria del Sansovino, from which in turn it was transferred in 1812 to the Palazzo Ducale, and from this again in 1904 to the Palazzo della Zecca (The Mint).

Among the university libraries under government control some deserve special notice. First in historical importance comes the Biblioteca della Università at Bologna, founded by the naturalist U. Aldrovandi, who bequeathed by his will in 1605 to the senate of Bologna his collection of 3800 printed books and 360 MSS. Count Luigi F. Marsili increased the library by a splendid gift in 1712 and established an Istituto delle Scienze, reconstituted as a public library by Benedict XIV. in 1756. The printed books number 255,000 vols., and the MSS. 5000. The last comprise a rich Oriental collection of 547 MSS. in Arabic, 173 in Turkish, and several in Persian, Armenian and Hebrew. Amongst the Latin codices is a Lactantius of the 6th or 7th century. The other noteworthy articles include a copy of the Armenian gospels (12th century), the Avicenna, with miniatures dated 1194, described in Montfaucon's *Diarium Italicum*, and some unpublished Greek texts. Amongst the Italian MSS. is a rich assemblage of municipal histories. Mezzofanti was for a long time the custodian here, and his own collection of books has been incorporated in the library, which is remarkable likewise for the number of early editions and Aldines which it contains. A collection of drawings by Agostino Caracci is another special feature of worth. The grand hall with its fine furniture in walnut wood merits particular attention. The Biblioteca della Università at Naples was established by Joachim Murat in 1812 in the buildings of Monte Oliveto, and has thence been sometimes called the "Biblioteca Gioacchino." Later it was transferred to the Royal University of studies, and was opened to the public in 1827. It was increased by the libraries of several monastic bodies. The most copious collections relate to the study of medicine and natural science. It possesses about 300,000 printed books, 404 incunabula, 203 Aldines, and 196 Bodoni editions, but the more important incunabula and MSS. about the middle of the 19th century went to enrich the Biblioteca Nazionale. Other important university libraries are those of Catania (1755), 130,000 vols.; Genoa (1773), 132,000 vols., 1588 MSS.; Pavia (1763), 250,000 vols., 1100 MSS.; Padua (200,000 vols., 2356 MSS.), which in 1910 was housed in a new building; Cagliari (90,000 vols.); Sassari (74,000 vols.). Messina, destroyed in the earthquake of 1908, preserved, however, beneath its ruins the more important part of its furniture and fittings, and in 1910 was already restored to active work, as regards the portion serving for the reawakened Faculty of Law in the University.

Chief among the remaining government libraries comes the world-famed Biblioteca Mediceo-Laurenziana at Florence, formed from the collections of Cosimo the Elder, Pietro de' Medici, and Lorenzo the Magnificent (which, however, passed away from the family after the expulsion of the Medici from Florence, and were repurchased in 1508 by Cardinal Giovanni, afterwards Leo X.). It was first constituted as a public library in Florence by Clement VII., who charged Michelangelo to construct a suitable edifice for its reception. It was opened to the public by Cosimo I. in 1571, and has ever since gone on increasing in value, the accessions in the 18th century alone being enough to double its former importance. The printed books it contains are probably no more than 11,000 in number, but are almost all of the highest rarity and interest, including 242 incunabula of which 151 *editiones principes*. It is, however, the precious collection of MSS., amounting to 9693 articles, which gives its chief importance to this library. They comprise more than 700 of dates earlier than the 11th century. Some of them are the most valuable codices in the world—the famous Virgil of the 4th or 5th century, Justinian's *Pandects* of the 6th, a Homer of the 10th, and several other very early Greek and Latin classical and Biblical texts, as well as copies in the handwriting of Petrarch, about 100 codices of Dante, a *Decameron* copied by a contemporary from Boccaccio's own MS., and Cellini's MS. of his autobiography. Bandini's catalogue of the MSS. occupies 13 vols. folio, printed in 1764-1778. Administratively united to the Laurentian is the Riccardiana rich in MSS. of Italian literature, especially the Florentine (33,000 vols., 3905 MSS.). At Florence the Biblioteca Marucelliana, founded in 1703, remarkable for its artistic wealth of early woodcuts and metal engravings, was opened to the public in 1753. The number of these and of original drawings by the old masters amounts to 80,000 pieces; the printed volumes number 200,000, the incunabula 620, and the MSS. 1500. At Modena is the famous Biblioteca Estense, so called from having been founded by the Este family at Ferrara in 1393; it was transferred to Modena by Cesare D'Este in 1598. Muratori, Zaccaria and Tiraboschi were librarians here, and made good use of the treasures of the library. It is particularly rich in early printed literature and valuable codices. Between 1859 and 1867 it was known as the Biblioteca Palatina. The printed vols. number 150,570, the incunabula 1600, the MSS. 3336, besides the 4958 MSS. and the 100,000 autographs of the Campori collection.

The oldest library at Naples is the Biblioteca Brancacciana, with many valuable MSS. relating to the history of Naples. Two planispheres by Coronelli are preserved here. It was founded in 1673 by Cardinal F. M. Brancaccio, and opened by his heirs in 1675; 150,000 vols. and 3000 MSS. The Regia Biblioteca di Parma, founded definitively in 1779, owes its origin to the grand-duke Philip, who employed the famous scholar Paciaudi to organize it. It is now a public library containing 308,770 vols. and 4890 MSS. Amongst its treasures is De Rossi's magnificent collection of Biblical and rabbinical MSS. Also worthy of note are the Bibl. Pubblica or government of Lucca (1600) with 214,000 vols., 725 incunabula and 3091 MSS. and that of Cremona (1774), united to that of the Museo Civico.

Among the great libraries not under government control, the most important is the famous Biblioteca Ambrosiana at Milan, founded in 1609 by Cardinal Fed. Borromeo. It contains 230,000 printed vols. and 8400 MSS. Amongst the MSS. are a Greek Pentateuch of the 5th century, the famous Peshito and Syro-Hexaplar from the Nitrian convent of St Maria Deipara, a Josephus written on papyrus, supposed to be of the 5th century, several palimpsest texts, including an early Plautus, and St Jerome's commentary on the Psalms in a volume of 7th-century execution, full of contemporary glosses in Irish, Gothic fragments of Ulfilas, and a Virgil with notes in Petrarch's handwriting. Cardinal Mai was formerly custodian here. In 1879 Professor C. Mensinger presented his "Biblioteca Europea," consisting of 2500 vols., 300 maps and 5000 pieces, all relating to the literature and linguistics of European countries. The Melzi and Trivulzio libraries should not pass without mention here, although they are private and inaccessible without special permission. The former is remarkable for its collection of early editions with engravings, including the Dante of 1481, with twenty designs by Baccio Bandinelli. The latter is rich in MSS. with miniatures of the finest and rarest kind, and in printed books of which many are unique or nearly so. It consists of 70,000 printed vols. At Genoa the Biblioteca Franzoniana, founded about 1770 for the instruction of the poorer classes, is noteworthy as being the first European library lighted up at night for the use of readers.

The foundation of the monastery of Monte Cassino is due to St Benedict, who arrived there in the year 529,

and established the prototype of all similar institutions in western Europe. The library of printed books now extends to about 20,000 vols., chiefly relating to the theological sciences, but including some rare editions. A collection of the books belonging to the monks contains about the same number of volumes. But the chief glory of Monte Cassino consists of the *archivio*, which is quite apart; and this includes more than 30,000 bulls, diplomas, charters and other documents, besides 1000 MSS. dating from the 6th century downwards. The latter comprehend some very early Bibles and important codices of patristic and other medieval writings. There are good written catalogues, and descriptions with extracts are published in the *Bibliotheca Casinensis*. The monastery was declared a national monument in 1866. At Ravenna the Biblioteca Classense has a 10th-century codex of Aristophanes and two 14th-century codices of Dante. At Vercelli the Biblioteca dell' Archivio Capitolare, the foundation of which can be assigned to no certain date, but must be referred to the early days when the barbarous conquerors of Italy had become christianized, comprises nothing but MSS., all of great antiquity and value. Amongst them is an Evangelium S. Eusebii in Latin, supposed to be of the 4th century; also the famous codex containing the Anglo-Saxon homilies which have been published by the Ælfric Society.

The Biblioteca del Monastero della S. Trinità, at La Cava dei Tirreni in the province of Salerno, is said to date from the foundation of the abbey itself (beginning of the 11th century). It contains only some 10,000 vols., but these include a number of MSS. of very great rarity and value, ranging from the 8th to the 14th century. Amongst these is the celebrated Codex Legum Longobardorum, dated 1004, besides a well-known geographical chart of the 12th century, over 100 Greek MSS., and about 1000 charters beginning with the year 840, more than 200 of which belong to the Lombard and Norman periods. The library is now national property, the abbot holding the office of Keeper of the Archives.

Not a few of the communal and municipal libraries are of great extent and interest: Bologna (1801), 191,000 vols., 5060 MSS.; Brescia, Civica Quiriniana, 125,000 vols., 1500 MSS.; Ferrara (1753), 91,000 vols., 1698 MSS., many Ferrarese rarities; Macerata, the Mozzi-Borgetti (1783-1835, united 1855), 50,000 vols.; Mantua, 70,000 vols., 1300 MSS.; Novara, Negroni e Civica (1847 and 1890), 75,000 vols.; Padua, 90,000 vols., 1600 MSS.; Palermo (1760), 216,000 vols., 3263 MSS., coins and Sicilian collection; Perugia (1852), founded by P. Podiani, 70,000 vols., 915 MSS.; Siena (1758), founded by S. Bandini, fine art collection, 83,250 vols., 5070 MSS.; Venice, Museo Civico Correr, 50,000 vols., 11,000 MSS.; Verona (1792, public since 1802), 180,000 vols., 2650 MSS.; Vicenza, Bertoliana (1708), local literature, archives of religious corporations, 175,000 vols., 6000 MSS.

Popular libraries have now been largely developed in Italy, chiefly through private or municipal enterprise; they enjoy a small state subvention of £1000. The government report for 1908 stated that 319 communes possessed *biblioteche popolari* numbering altogether 415. Of these, 313 were established by municipalities, 113 by individuals, 8 by business houses, 80 by working men's societies and 15 by ministers of religion; 225 are open to the public, 358 lend books, 221 gratuitously, and 127 on payment of a small fee. In order to establish these institutions throughout the kingdom, a *Bollettino* has been published at Milan since 1907, and a National Congress was held at Rome in December 1908.

Information has been given for this account by Dr G. Staderini of the Biblioteca Casanatense, Rome. See also F. Bluhme, *Iter Italicum* (Berlin, 1824-1836); *Notizie sulle biblioteche governative del regno d' Italia* (Roma, 1893); *Le biblioteche governative Italiane nel 1898* (Roma, 1900); *Statistica delle biblioteche* (Roma, 1893-1896, 2 pts.); *Le biblioteche popolari in Italia, relazione al Ministro della Pubbl. Istruzione* (Roma, 1898); *Bollettino delle biblioteche popolari* (Milano, 1907, in progress); E. Fabietti, *Manuale per le biblioteche popolari* (2<sup>da</sup> ediz., Milano); *Le biblioteche pop. al 1<sup>o</sup> Congresso Naz. 1908* (Milano, 1910).

#### *Latin America.*

Much interest in libraries has not been shown in south, central and other parts of Latin America. Most of the libraries which exist are national or legislative libraries.

As the libraries of the republic of Cuba are more Spanish than American in character, it will be convenient to consider them here. The chief libraries are in Havana, and the best are the Biblioteca Publica and the University Library. The Biblioteca Publica has within recent years been completely overhauled, and is now one of the most actively-managed libraries in Latin America.

Out of the twenty-nine states and territories of the Mexican republic about half have public libraries, and only a small proportion of the contents consists of modern literature. Many possess rare and valuable books, of interest to the bibliographer and historian, which have come from the libraries of the suppressed religious bodies. There is a large number of scientific and literary associations in the republic, each possessing books. The Society of Geography and Statistics, founded in 1851 in Mexico City, is the most important of them, and owns a fine museum and excellent library. After the triumph of the Liberal party the cathedral, university and conventual libraries of the city of Mexico came into the possession of the government, and steps were taken to form them into one national collection. No definite system was organized, however, until 1867, when the church of San Augustin was taken and fitted up for the purpose. In 1884 it was opened as the Biblioteca Nacional, and now possesses over 200,000 vols. Two copies of every book printed in Mexico must be presented to this library. Most of the libraries of Mexico, city or provincial, are subscription, and belong to societies and schools of various kinds.

The importance of public libraries has been fully recognized in Argentina, and more than two hundred of them are in the country. They are due to benefactions, but the government in every case adds an equal sum to any endowment. A central commission exists for the purpose of facilitating the acquisition of books and to promote a uniform excellence of administration. The most considerable is the Biblioteca Nacional at Buenos Aires, which is passably rich in MSS., some of great interest, concerning the early history of the Spanish colonies. There is also the Biblioteca Municipal with about 25,000 vols. There are libraries attached to colleges, churches and clubs, and most of the larger towns possess public libraries.

The chief library in Brazil is the Bibliotheca Publica Nacional at Rio de Janeiro (1807) now comprising over 250,000 printed vols. with many MSS. National literature and works connected with South America are special features of this collection. A handsome new building has been erected which has been fitted up in the most modern manner. Among other libraries of the capital may be mentioned those of the Faculty of Medicine, Marine Library, National Museum, Portuguese Literary Club, Bibliotheca Fluminense, Benedictine Monastery, and the Bibliotheca Municipal. There are various provincial and public libraries throughout Brazil, doing good work, and a typical example is the public library of Maranhao.

**Chile.** The Biblioteca Nacional at Santiago is the chief library in Chile. The catalogue is printed, and is kept up by annual supplements. It possesses about 100,000 vols. There is also a University Library at Santiago, and a fairly good Biblioteca Publica at Valparaiso.

The Biblioteca Nacional at Lima was founded by a decree of the liberator San Martin on the 28th of August 1821, and placed in the house of the old convent of San Pedro. The nucleus of the library consisted of those of the university of San Marcos and of several monasteries, and a large present of books was also made by San Martin. The library is chiefly interesting from containing so many MSS. and rare books relating to the history of Peru in viceregal times.

#### *Spain and Portugal.*

Most of the royal, state and university libraries of Spain and Portugal have government control and support. In Portugal the work of the universities is to a certain extent connected up, and an official bulletin is published in which the laws and accessions of the libraries are contained.

The chief library in Spain is the Biblioteca Nacional (formerly the Biblioteca Real) at Madrid. The printed volumes number 600,000 with 200,000 pamphlets. Spanish literature is of course well represented, and, in consequence of the numerous accessions from the libraries of the suppressed convents, the classes of theology, canon law, history, &c., are particularly complete. There are 30,000 MSS., including some finely illuminated codices, historical documents, and many valuable autographs. The collection of prints extends to 120,000 pieces, and was principally formed from the important series bought from Don Valentin Carderera in 1865. The printed books have one catalogue arranged under authors' names, and one under titles; the departments of music, maps and charts, and prints have subject-catalogues as well. There is a general index of the MSS., with special catalogues of the Greek and Latin codices and genealogical documents. The cabinet of medals is most valuable and well arranged. Of the other Madrid libraries it is enough to mention the Biblioteca de la Real Academia de la Historia, 1758 (20,000 vols. and 1500 MSS.), which contains some printed and MS. Spanish books of great value, including the well-known Salazar collection. The history of the library of the Escorial (*q.v.*) has been given elsewhere. In 1808, before the invasion, the Escorial is estimated to have contained 30,000 printed vols. and 3400 MSS.; Joseph removed the collection to Madrid, but when it was returned by Ferdinand 10,000 vols. were missing. There are now about 40,000 printed vols. The Arabic MSS. have been described by M. Casiri, 1760-1770; and a catalogue of the Greek codices by Müller was issued at the expense of the French government in 1848. There is a MS. catalogue of the printed books. Permission to study at the Escorial, which is one of the royal private libraries, must be obtained by special application. The Biblioteca Provincial y Universitaria of Barcelona (1841) contains about 155,000 vols., and that of Seville (1767) has 82,000 vols. Other cities in Spain possess provincial or university libraries open to students under various restrictions, among them may be mentioned the Biblioteca Universitaria of Salamanca (1254) with over 80,000 vols.

Among the libraries of Portugal the Bibliotheca Nacional at Lisbon (1796) naturally takes the first place. In 1841 it was largely increased from the monastic collections, which, however, seem to have been little cared for according to a report prepared by the principal librarian three years later. There are now said to be 400,000 vols. of printed books, among which theology, canon law, history and Portuguese and Spanish literature largely predominate. The MSS. number 16,000 including many of great value. There is also a cabinet of 40,000 coins and medals. The Bibliotheca da Academia, founded in 1780, is preserved in the suppressed convent of the Ordem Terceira da Penitencia. In 1836 the Academy acquired the library of that convent, numbering 30,000 vols., which have since been kept apart. The Archivo Nacional, in the same building, contains the archives of the kingdom, brought here after the destruction of the Torre do Castello during the great earthquake.

575

The Biblioteca Publica Municipal at Oporto is the second largest in Portugal, although only dating from the 9th of July 1833, the anniversary of the debarcation of D. Pedro, and when the memorable siege was still in progress; from that date to 1874 it was styled the Real Biblioteca do Porto. The regent (ex-emperor of Brazil) gave to the town the libraries of the suppressed convents in the northern provinces, the municipality undertaking to defray the expense of keeping up the collection. Recent accessions consist mainly of Portuguese and French books. The important Camoens collection is described in a printed catalogue (Oporto, 1880). A notice of the MSS. may be found in *Catalogo dos MSS. da B. Publica Eboresense*, by H. da Cunha Rivara (Lisbon, 1850-1870), 3 vols. folio, and the first part of an *Indice preparatorio do Catalogo dos Manuscriptos* was produced in 1880. The University Library of Coimbra (1591) contains about 100,000 vols., and other colleges possess libraries.

#### *Netherlands.*

Since 1900 there has been considerable progress made in both Belgium and Holland in the development of public libraries, and several towns in the latter country have established popular libraries after the fashion of the municipal libraries of the United Kingdom and America.

The national library of Belgium is the Bibliothèque Royale at Brussels, of which the basis may be said to consist of the famous Bibliothèque des ducs de Bourgogne, the library of the Austrian sovereigns of the Low Countries, which had gradually accumulated during three centuries. After suffering many losses from thieves and fire, in 1772 the Bibliothèque de Bourgogne received considerable augmentations from the libraries of the suppressed order of Jesuits, and was thrown open to the public. On the occupation of Brussels by the French in 1794 a number of books and MSS. were confiscated and transferred to Paris (whence the majority were returned in 1815); in 1795 the remainder were formed into a public library under the care of La Serna Santander, who was also town librarian, and who was followed by van Hulthem. At the end of the administration of van Hulthem a large part of the precious collections of the Bollandists was acquired. In 1830 the Bibliothèque de Bourgogne was added to the state archives, and the whole made available for students. Van Hulthem died in 1832, leaving one of the most important private libraries in Europe, described by Voisin in *Bibliotheca Hulthemiana* (Brussels, 1836), 5 vols., and extending to 60,000 printed vols, and 1016 MSS., mostly relating to Belgian history. The collection was purchased by the government in 1837, and, having been added to the Bibliothèque de Bourgogne (open since 1772) and the Bibliothèque de la Ville (open since 1794), formed what has since been known as the Bibliothèque Royale de Belgique. The printed volumes now number over 600,000 with 30,000 MSS., 105,000 prints and 80,000 coins and medals. The special collections, each with a printed catalogue, consist of the Fonds van Hulthem, for national history; the Fonds Fétis, for music; the Fonds Goethals, for genealogy; and the Fonds Müller, for physiology. The catalogue of the MSS. has been partly printed, and catalogues of accessions and other departments are also in course of publication. There are

libraries attached to most of the departments of the government, the ministry of war having 120,000 vols. and the ministry of the interior, 15,000 vols. An interesting library is the Bibliothèque Collective des Sociétés Savantes founded in 1906 to assemble in one place the libraries of all the learned societies of Brussels. It contains about 40,000 vols. which have been catalogued on cards. The Bibliothèque du Conservatoire royal de Musique (1832) contains 12,000 vols, and 6000 dramatic works. The popular or communal libraries of Brussels contain about 30,000 vols. and those of the adjoining suburbs about 50,000 vols., most of which are distributed through the primary and secondary schools. At Antwerp the Stadt Bibliothek (1805) has now 70,000 vols., and is partly supported by subscriptions and endowments. The valuable collection of books in the Musée Plantin-Moretus (1640) should also be mentioned. It contains 11,000 MSS. and 15,000 printed books, comprising the works issued by the Plantin family and many 15th-century books.

The University Library of Ghent, known successively as the Bibliothèque de l'École Centrale and Bibliothèque Publique de la Ville, was founded upon the old libraries of the Conseil de Flandres, of the College des Échevins, and of many suppressed religious communities. It was declared public in 1797, and formally opened in 1798. On the foundation of the university in 1817 the town placed the collection at its disposal, and the library has since remained under state control. The printed volumes now amount to 353,000. There are important special collections on archaeology, Netherlands literature, national history, books printed in Flanders, and 23,000 historical pamphlets of the 16th and 17th centuries. The main catalogue is in MS. on cards. There are printed catalogues of the works on jurisprudence (1839), and of the MSS. (1852). The Bibliothèque de l'Université Catholique of Louvain is based upon the collection of Beyerlinck, who bequeathed it to his alma mater in 1627; this example was followed by Jacques Romain, professor of medicine, but the proper organization of the library began in 1636. There are now said to be 211,000 vols. The Bibliothèque de l'Université de Liège dates from 1817, when on the foundation of the university the old Bibliothèque de la Ville was added to it. There are now 350,000 printed vols., pamphlets, MSS., &c. The Liège collection (of which a printed catalogue appeared in 3 vols. 8vo., 1872), bequeathed by M. Ulysse Capitaine, extends to 12,061 vols. and pamphlets. There are various printed catalogues. The Bibliothèques Populaires of Liège established in 1862, now number five, and contain among them 50,000 vols. which are circulated to the extent of 130,000 per annum among the school children. The Bibliothèque publique of Bruges (1798) contains 145,600 printed books and MSS., housed in a very artistic building, once the Tonlieu or douane, 1477. There are communal libraries at Alost, Arlon (1842), Ath (1842), Courtrai, Malines (1864), Mons (1797), Namur (1800), Ostend (1861), Tournai (1794, housed in the Hôtel des Anciens Prêtres, 1755), Ypres (1839) and elsewhere, all conducted on the same system as the French communal libraries. Most of them range in size from 5000 to 40,000 vols, and they are open as a rule only part of the day. Every small town has a similar library, and a complete list of them, together with much other information, will be found in the *Annuaire de la Belgique, scientifique, artistique et littéraire* (Brussels 1908 and later issues).

The national library of Holland is the Koninklijke Bibliotheek at Hague, which was established in 1798, when it was decided to join the library of the princes of Orange with those of the defunct government bodies in order to form a library for the States-General, to be called the Nationale Bibliotheek. In 1805 the present name was adopted; and since 1815 it has become the national library. In 1848 the **Holland.** Baron W. Y. H. van Westreeen van Tiellandt bequeathed his valuable books, MSS., coins and antiquities to the country, and directed that they should be preserved in his former residence as a branch of the royal library. There are now upwards of 500,000 vols. of printed books, and the MSS. number 6000, chiefly historical, but including many fine books of hours with miniatures. Books are lent all over the country. The library boasts of the richest collection in the world of books on chess, Dutch incunabula, Elzevirs and Spinozana. There is one general written catalogue arranged in classes, with alphabetical indexes. In 1800 a printed catalogue was issued, with four supplements down to 1811; and since 1866 a yearly list of additions has been published. Special mention should be made of the excellent catalogue of the incunabula published in 1856.

The next library in numerical importance is the famous Bibliotheca Academiae Lugduno-Batavae, which dates from the foundation of the university of Leiden by William I., prince of Orange, on the 8th of February 1575. It has acquired many valuable additions from the books and MSS. of the distinguished scholars, Golius, Joseph Scaliger, Isaac Voss, Ruhnken and Hemsterhuis. The MSS. comprehend many of great intrinsic importance. The library of the Society of Netherland Literature has been placed here since 1877; this is rich in the national history and literature. The Arabic and Oriental MSS. known as the Legatum Warnerianum are of great value and interest; and the collection of maps bequeathed in 1870 by J. J. Bodel Nyenhuis is also noteworthy. The library is contained in a building which was formerly a church of the Béguines, adapted in 1860 somewhat after the style of the British Museum. The catalogues (one alphabetical and one classified) are on slips, the titles being printed. A catalogue of books and MSS. was printed in 1716, one of books added between 1814 and 1847 and a supplementary part of MSS. only in 1850. A catalogue of the Oriental MSS. was published in 6 vols. (1851-1877). The Bibliotheek der Rijks Universiteit (1575) at Leiden contains over 190,000 vols.

The University Library at Utrecht dates from 1582, when certain conventual collections were brought together in order to form a public library, which was shortly afterwards enriched by the books bequeathed by Hub. Buchelius and Ev. Pollio. Upon the foundation of the university in 1636, the town library passed into its charge. Among the MSS. are some interesting cloister MSS. and the famous "Utrecht Psalter," which contains the oldest text of the Athanasian creed. The last edition of the catalogue was in 2 vols. folio, 1834, with supplement in 1845, index from 1845-1855 in 8vo., and additions 1856-1870, 2 vols. 8vo. A catalogue of the MSS. was issued in 1887. The titles of accessions are now printed in sheets and pasted down for insertion. There are now about 250,000 vols. in the library.

The basis of the University Library at Amsterdam consists of a collection of books brought together in the 15th century and preserved in the Nieuwe Kerk. At the time of the Reformation in 1578 they became the property of the city, but remained in the Nieuwe Kerk for the use of the public till 1632, when they were transferred to the Athenaeum. Since 1877 the collection has been known as the University Library, and in 1881 it was removed to a building designed upon the plan of the new library and reading-room of the British Museum. The library includes the best collection of medical works in Holland, and the Bibliotheca Rosenthaliana of Hebrew and Talmudic literature is of great fame and value; a catalogue of the last was printed in 1875. The libraries of the Dutch Geographical and other societies are preserved here. A general printed catalogue was issued in 6 vols. 8vo., Amsterdam (1856-1877); one describing the bequests of J. de Bosch Kemper, E. J. Potgieter and F. W. Rive, in 3 vols., 8vo. (1878-1879); a catalogue of the MSS. of Professor Moll was published in 1880, and one of those of P. Camper in 1881. Other catalogues have been published up to 1902, including one of the MSS. The library contains about half a million volumes. There are popular subscription libraries with reading-rooms in all parts of Holland, and in Rotterdam there is a society for the encouragement of social culture which has a large library as part of its equipment. At Hague, Leiden, Haarlem, Dordrecht and other towns popular libraries have been

established, and there is a movement of recent growth, in favour of training librarians on advanced English lines.

The library of the Genootschap van Kunsten en Wetenschappen at Batavia contains books printed in Netherlandish India, works relating to the Indian Archipelago and adjacent countries, and the history of the Dutch in the East. There are 20,000 printed vols. and 1630 MSS., of which 243 are Arabic, 445 Malay, 303 Javanese, 60 Batak and 517 on lontar leaves, in the ancient Kawi, Javanese and Bali languages, &c. Printed catalogues of the Arabic, Malay, Javanese and Kawi MSS. have been issued.

#### *Scandinavia.*

Owing largely to so many Scandinavian librarians having been trained and employed in American libraries, a greater approach has been made to Anglo-American library ideals in Norway, Sweden and Denmark than anywhere else on the continent of Europe.

The beginning of the admirably managed national library of Denmark, the great Royal Library at Copenhagen (Det Store Kongelige Bibliothek) may be said to have taken place during the reign of Christian III. (1533-1559), who took pride in importing foreign books and choice MSS.; but the true founder was **Denmark.** Frederick III. (1648-1670); to him is mainly due the famous collection of Icelandic literature and the acquisition of Tycho Brahe's MSS. The present building (in the Christiansborg castle) was begun in 1667. Among notable accessions may be mentioned the collections of C. Reitzer, the count of Danneskjöld (8000 vols. and 500 MSS.) and Count de Thott; the last bequeathed 6039 vols. printed before 1531, and the remainder of his books, over 100,000 vols., was eventually purchased. In 1793 the library was opened to the public, and it has since remained under state control. Two copies of every book published within the kingdom must be deposited here. The incunabula and block books form an important series. There is a general classified catalogue in writing for the use of readers; and an alphabetical one on slips arranged in boxes for the officials. A good catalogue of the de Thott collection was printed in 12 vols. 8vo. (1789-1795); a catalogue of the French MSS. appeared in 1844; of Oriental MSS., 1846; of the Danish collection, 1875, 8vo. Annual reports and accounts of notable MSS. have been published since 1864. The library now contains over 750,000 vols.

The University Library, founded in 1482, was destroyed by fire in 1728, and re-established shortly afterwards. A copy of every Danish publication must be deposited here. The MSS. include the famous Arne-Magnean collection. There are now about 400,000 vols. in this library. The Statsbiblioteket of Aarhus (1902) possesses about 200,000 vols. and the Landsbókasafn Islands (National Library) of Reykjavik, Iceland, has about 50,000 printed books and 5500 MSS. In Copenhagen there are 11 popular libraries supported in part by the city, and there are at least 50 towns in the provinces with public libraries and in some cases reading-rooms. An association for promoting public libraries was formed in 1905, and in 1909 the minister of public instruction appointed a special adviser in library matters. About 800 towns and villages are aided by the above named association, the state and local authorities, and it is estimated that they possess among them 500,000 vols., and circulate over 1,000,000 vols. annually.

The chief library in Norway is the University Library at Christiania, established at the same time as the university, September 2nd, 1811, by Frederick II., with a donation from the king of many thousands of duplicates from the Royal Library at Copenhagen, and since augmented by important bequests. Annual catalogues are issued and there are now over 420,000 vols. in the collection. The Deichmanske Bibliothek in Christiania was founded by Carl Deichmann in 1780 as a free library. In 1898 it was reorganized, and in 1903 the open shelf method was installed by Haakon Nyhuus, the librarian, who had been trained in the United States. The library is partly supported by endowment, partly by grants from the municipality. It now contains about 85,000 vols., and is a typical example of a progressive library. The Free Library at Bergen (1872) has about 90,000 vols. and has recently been re-housed in a new building. A free library, with open shelves, has also been opened at Trondhjem. The library connected with the Kongelige Videnskabers Selskab at Trondhjem now contains about 120,000 vols. Owing to the absence of small towns and villages in Norway, most of the library work is concentrated in the coast towns.

The Royal Library at Stockholm was first established in 1585. The original collection was given to the university of Upsala by Gustavus II., that formed by Christina is at the Vatican, and the library brought together by Charles X. was destroyed by fire in 1697. The present library was organized shortly afterwards. The Benzelstjerna-Engeström Library (14,500 printed vols. and 1200 MSS.) rich in materials for Swedish history, is now annexed to it. Natural history, medicine and mathematics are left to other libraries. Among the MSS. the *Codex Aureus* of the 6th or 7th century, with its interesting Anglo-Saxon inscription, is particularly noteworthy. The catalogues are in writing, and are both alphabetical and classified; printed catalogues have been issued of portions of the MSS. The present building was opened in 1882. The library now contains about 320,000 printed books and over 11,000 MSS. The Karolinska Institutet in Stockholm, contains a library of medical books numbering over 40,000.

The University Library at Upsala was founded by Gustavus Adolphus in 1620, from the remains of several convent libraries; he also provided an endowment. The MSS. chiefly relate to the history of the country, but include the *Codex Argenteus*, containing the Gothic gospels of Ulfilas. The general catalogue is in writing. A catalogue was printed in 1814; special lists of the foreign accessions have been published each year from 1850; the Arabic, Persian and Turkish MSS. are described by C. J. Tornberg, 1846. It now contains about 340,000 printed books and MSS. The library at Lund dates from the foundation of the university in 1668, and was based upon the old cathedral library. The MSS. include the de la Gardie archives, acquired in 1848. There are about 200,000 vols. in the library. The Stadsbibliotek of Gothenburg contains about 100,000 vols., and has a printed catalogue.

#### *Russia.*

The imperial Public Library at St Petersburg is one of the largest libraries in the world, and now possesses about 1,800,000 printed vols. and 34,000 MSS., as well as large collections of maps, autographs, photographs, &c. The beginning of this magnificent collection may be said to have been the books seized by the Czar Peter during his invasion of Courland in 1714; the library did not receive any notable augmentation, however, till the year 1795, when, by the acquisition of the famous Zaluski collection, the Imperial Library suddenly attained a place in the first rank among great European libraries. The Zaluski Library was formed by the Polish count Joseph Zaluski, who collected at his own expense during forty-three years no less than 200,000 vols., which were added to by his brother Andrew, bishop of Cracow, by whom in 1747 the library was thrown open to the public.

At his death it was left under the control of the Jesuit College at Warsaw; on the suppression of the order it was taken care of by the Commission of Education; and finally in 1795 it was transferred by Suwaroff to St Petersburg as a trophy of war. It then extended to 260,000 printed vols. and 10,000 MSS., but in consequence of the withdrawal of many medical and illustrated works to enrich other institutions, hardly 238,000 vols. remained in 1810. Literature, history and theology formed the main features of the Zaluski Library; the last class alone amounted to one-fourth of the whole number. Since the beginning of the 19th century, through the liberality of the sovereigns, the gifts of individuals, careful purchases, and the application of the law of 1810, whereby two copies of every Russian publication must be deposited here, the Imperial Library has attained its present extensive dimensions. Nearly one hundred different collections, some of them very valuable and extensive, have been added from time to time. They include, for example, the Tolstoi Slavonic collection (1830), Tischendorf's MSS. (1858), the Dolgorousky Oriental MSS. (1859), and the Firkowitsch Hebrew (Karaites) collection (1862-1863), the libraries of Adelung (1858) and Tobler (1877), that of the Slavonic scholar Jungmann (1856), and the national MSS. of Karamzin (1867). This system of acquiring books, while it has made some departments exceedingly rich, has left others comparatively meagre. The library was not regularly opened to the public until 1814; it is under the control of the minister of public instruction. There are fine collections of Aldines and Elzevirs, and the numerous incunabula are instructively arranged.

The manuscripts include 26,000 codices, 41,340 autographs, 4689 charters and 576 maps. The glory of this department is the celebrated *Codex Sinaiticus* of the Greek Bible, brought from the convent of St Catherine on Mount Sinai by Tischendorf in 1859. Other important Biblical and patristic codices are to be found among the Greek, and Latin MSS.; the Hebrew MSS. include some of the most ancient that exist, and the Samaritan collection is one of the largest in Europe; the Oriental MSS. comprehend many valuable texts, and among the French are some of great historical value. The general catalogues are in writing, but many special catalogues of the MSS. and printed books have been published.

577

The nucleus of the library at the Hermitage Palace was formed by the empress Catherine II., who purchased the books and MSS. of Voltaire and Diderot. In the year 1861 the collection amounted to 150,000 vols., of which nearly all not relating to the history of art were then transferred to the Imperial Library. There are many large and valuable libraries attached to the government departments in St Petersburg, and most of the academies and colleges and learned societies are provided with libraries.

The second largest library in Russia is contained in the Public Museum at Moscow. The class of history is particularly rich, and Russian early printed books are well represented. The MSS. number 5000, including many ancient Slavonic codices and historical documents of value. One room is devoted to a collection of Masonic MSS., which comprehend the archives of the lodges in Russia between 1816 and 1821. There is a general alphabetical catalogue in writing; the catalogue of the MSS. has been printed, as well as those of some of the special collections. This large and valuable library now contains close upon 1,000,000 printed books and MSS. The Imperial University at Moscow (1755) has a library of over 310,000 vols., and the Duchovnaja Academy has 120,000 vols. The Imperial Russian Historical Museum (1875-1883) in Moscow contains nearly 200,000 vols. and most of the state institutions and schools are supplied with libraries. All the Russian universities have libraries, some of them being both large and valuable—Dorpat (1802) 400,000 vols.; Charkov (1804) 180,000 vols.; Helsingfors (1640-1827) 193,000 vols.; Kasan (1804) 242,000 vols.; Kiev (1832) 125,000 vols.; Odessa (1865) 250,000 vols.; and Warsaw (1817) 550,000 vols. There are also communal or public libraries at Charkov (1886) 110,000 vols.; Odessa (1830) 130,000 vols.; Reval (1825) 40,000 vols.; Riga, 90,000 vols.; Vilna (1856) 210,000 vols. and many other towns. A text-book on library economy, based on Graesel and Brown, was issued at St Petersburg in 1904.

#### *Eastern Europe.*

At Athens the National Library (1842) possesses about 260,000 vols., and there is also a considerable library at the university. The Public Library at Corfu has about 40,000 vols. Belgrade University Library has 60,000 vols. and the University Library of Sofia has 30,000 vols. Constantinople University in 1910 had a library in process of formation, and there are libraries at the Greek Literary Society (20,000 vols.) and Theological School (11,000 vols.).

#### *China.*

Chinese books were first written on thin slips of bamboo, which were replaced by silk or cloth scrolls in the 3rd century B.C., paper coming into use in the beginning of the 2nd century. These methods were customary down to the 10th or 11th century. There were no public libraries in the western sense.

The practice of forming national collections of the native literature originated in the attempts to recover the works destroyed in the "burning of the books" by the "First Emperor" (220 B.C.). In 190 B.C. the law for the suppression of literary works was repealed, but towards the close of the 1st century B.C. many works were still missing. Hsiao Wu (139-86 B.C.) formed the plan of Repositories, in which books might be stored, with officers to transcribe them. Liu Hsiang (80-9 B.C.) was specially appointed to classify the literature and form a library. His task was completed by his son, and the *resumé* of their labours is a detailed catalogue with valuable notes describing 11,332 "sections" (volumes) by 625 authors. Similar national collections were formed by nearly every succeeding dynasty. The high estimation in which literature has always been held has led to the formation of very large imperial, official and private collections of books. Large numbers of works, chiefly relating to Buddhism and Taoism, are also stored in many of the temples. Chinese books are usually in several, and frequently in many volumes. The histories and encyclopaedias are mostly of vast dimensions. Collections of books are kept in wooden cupboards or on open shelves, placed on their sides, each set (*t'ao*) of volumes (*pên*) being protected and held together by two thin wooden or card boards, one forming the front cover (in a European book) and the other the back cover, joined by two cords or tapes running round the whole. By untying and tying these tapes the *t'ao* is opened and closed. The titles of the whole work and of each section are written on the edge (either the top or bottom in a European book) and so face outwards as it lies on the shelf. Catalogues are simple lists with comments on the books, not the systematic and scientific productions used in Western countries. There are circulating libraries in large numbers in Peking, Canton and other cities.

See E. T. C. Werner, "Chinese Civilisation" (in H. Spencer's *Descriptive Sociology*, pt. ix.).

#### *Japan.*

The ancient history of libraries in Japan is analogous to that of China, with whose civilization and literature it had close relations. Since about 1870, however, the great cities and institutions have established libraries on the European model.

Perhaps the most extensive library of the empire is that of the Imperial Cabinet (1885) at Tokio with over 500,000 vols., consisting of the collections of the various government departments, and is for official use alone. The University Library (1872) is the largest open to students and the public; it contains over 400,000 vols. of which 230,000 are Chinese and Japanese. The Public Library and reading-room (Tosho-Kwan) at Ueno Park (1872) was formed in 1872 and contains over 250,000 vols., of which about one-fifth are European books. At Tokio are also to be found the Ohashi Library (1902) with 60,000 vols. and the Hibaya Library (1908) with 130,000 vols. and the Nanki Library (1899) with 86,000 vols. The library of the Imperial University of Kyoto contains nearly 200,000 vols., of which over 90,000 are in European languages. To this is attached the library of the Fukuoka Medical College with 113,000 vols. The Municipal Library of Kyoto (1898) contains 46,000 vols. Other important municipal libraries in Japan are those at Akita in the province Of Ugo (1899), 47,000 vols., at Mito, province of Hitachi (1908), 25,000 vols., Narita, province of Shimosa (1901), 36,000 vols., chiefly Buddhistic, Yamaguchi, province of Suó (1907), 23,000 vols. The libraries of the large temples often contain books of value to the philologist. Lending libraries of native and Chinese literature have existed in Japan from very early times.

#### LIBRARY ASSOCIATIONS AND TRAINING

The first and largest association established for the study of librarianship was the American Library Association (1876). The Library Association of the United Kingdom was formed in 1877 as an outcome of the first International Library Conference, held at London, and in 1898 it received a royal charter. It publishes a *Year Book*, the monthly *Library Association Record*, and a number of professional handbooks. It also holds examinations in Literary History, Bibliography and Library Economy, and issues certificates and diplomas. There are also English and Scottish district library associations. The Library Assistants Association was formed in 1895 and has branches in different parts of England, Wales and Ireland. It issues a monthly magazine entitled *The Library Assistant*. There is an important Library Association in Germany which issues a year-book giving information concerning the libraries of the country, and a similar organization in Austria-Hungary which issues a magazine at irregular intervals. An Association of Archivists and Librarians was formed at Brussels in 1907, and there are similar societies in France, Italy, Holland and elsewhere. In every country there is now some kind of association for the study of librarianship, archives or bibliography. International conferences have been held at London, 1877; London, 1897; Paris (at Exhibition), 1903; St Louis, 1904; Brussels (preliminary), 1908; and Brussels, 1910.

LIBRARY PERIODICALS.—The following is a list of the current periodicals which deal with library matters, with the dates of their establishment and place of publication: *The Library Journal* (New York, 1876); *The Library* (London, 1889); *Public Libraries* (Chicago, 1896); *The Library World* (London, 1898); *The Library Assistant* (1898); *The Library Association Record* (1899); *Library Work* (Minneapolis, U.S., 1906); *Bulletin of the American Library Association* (Boston, 1907); *Revue des bibliothèques* (Paris, 1891); *Bulletin des bibliothèques populaires* (Paris, 1906); *Courrier des Bibliothèques* (Paris); *Bulletin de l'institut international de bibliographie* (Brussels, 1895); *Revue des bibliothèques et archives de Belgique* (Brussels, 1903); *Tijdschrift voor boek- en bibliotheekwezen* (Hague, 1903); *De Boekzaal* (Hague, 1907); *Bogsamlingsbladet* (Copenhagen, 1906); *For Folke-og Barnboksamlinger* (Christiania, 1906); *Folkebibliotheksbladet* (Stockholm, 1903); *Zentralblatt für Bibliothekswesen* (Leipzig, 1884); *Blätter für Volksbibliotheken und Lesehallen* (1899; occasional supplement to the above); *Bibliographie des Bibliotheks- und Buchwesens* (ed. by Adalbert Hortschansky, 1904; issued in the *Zentralblatt*); *Jahrbuch der Deutschen Bibliotheken* (Leipzig, 1902); *Minerva. Jahrbuch der gelehrten Welt* (Strassburg, 1890); *Mitteilungen des österreichischen Vereins für Bibliothekswesen* (Vienna, 1896); *Ceská Osvěta* (Novy Bydov, Bohemia, 1905); *Revista delle biblioteche e degli archivi* (Florence, 1890); *Bollettino delle biblioteche popolari* (Milan, 1907); *Revista de Archivos, Bibliotecas y Museos Madrid* (1907); *The Gakuto* (Tokio, Japan, 1897).

(H. R. T.; J. D. BR.)

- 1 See Menant, *Bibliothèque du palais de Ninive* (Paris, 1880).
- 2 Grote, *History of Greece*, iv. 37, following Becker.
- 3 Ritschl, *Die alexandrinischen Bibliotheken*, p. 22; *Opusc. phil.* i. § 123.
- 4 N.A. vi. 17.
- 5 *De tranq. an.* 9.
- 6 Parthey (*Alexandrinisches Museum*) assigns topographical reasons for doubting this story.
- 7 Some of the authorities have been collected by Parthey, *op. cit.*
- 8 The oldest catalogue of a western library is that of the monastery of Fontanelle in Normandy compiled in the 8th century. Many catalogues may be found in the collections of D'Achery, Martene and Durand, and Pez, in the bibliographical periodicals of Naumann and Petzholdt and the *Centralblatt f. Bibliothekswissenschaft*. The Rev. Joseph Hunter has collected some particulars as to the contents of the English monastic libraries, and Ed. Edwards has printed a list of the catalogues (*Libraries and Founders of Libraries*, 1865, pp. 448-454). See also G. Becker, *Catalogi Bibliothecarum Antiqui* (1885). There are said to be over six hundred such catalogues in the Royal Library at Munich. In the 14th century the Franciscans compiled a general catalogue of the MSS. in 160 English libraries and about the year 1400 John Boston, a Benedictine monk of Bury, travelled over England and a part of Scotland and examined the libraries of 195 religious houses (Tanner, *Bibliotheca Brit. Hibern.* 1748). Leland's list of the books he found during his visitation of the houses in 1539-1545 is printed in his *Collectanea* (ed. Hearne, 1715, 6 vols.). T. W. Williams has treated Gloucestershire and Bristol medieval libraries and their catalogues in a paper in the Bristol and Gloucestershire *Arch. Soc.* vol. xxxi.
- 9 This subject has been specially treated by J. Willis Clark in several works, of which the chief is a masterly volume, *The Care of Books* (1901). See also Dom Gasquet, "On Medieval Monastic Libraries," in his *Old English Bible* (1897).
- 10 Among the Arabs, however, as among the Christians, theological bigotry did not always approve of non-theological literature, and the great library of Cordova was sacrificed by Almanzor to his reputation for orthodoxy, 978 A.D.



**LIBRATION** (Lat. *libra*, a balance), a slow oscillation, as of a balance; in astronomy especially the seeming oscillation of the moon around her axis, by which portions of her surface near the edge of the disk are alternately brought into sight and swung out of sight.



**LIBYA**, the Greek name for the northern part of Africa, with which alone Greek and Roman history are concerned. It is mentioned as a land of great fertility in Homer (*Odyssey*, iv. 85), but no indication of its extent is given. It did not originally include Egypt, which was considered part of Asia, and first assigned to Africa by Ptolemy, who made the isthmus of Suez and the Red Sea the boundary between the two continents. The name Africa came into general use through the Romans. In the early empire, North Africa (excluding Egypt) was divided into Mauretania, Numidia, Africa Propria and Cyrenaica. The old name was reintroduced by Diocletian, by whom Cyrenaica (detached from Crete) was divided into Marmarica (Libya inferior) in the east, and Cyrenaica (Libya superior) in the west. A further distinction into Libya interior and exterior is also known. The former (ἡ ἐντὸς) included the interior (known and unknown) of the continent, as contrasted with the N. and N.E. portion; the latter (ἡ ἔξω, called also simply Libya, or *Libyae nomos*), between Egypt and Marmarica, was so called as having once formed an Egyptian "nome." See [AFRICA, ROMAN](#).



**LICATA**, a seaport of Sicily, in the province of Girgenti, 24 m. S.E. of Girgenti direct and 54 m. by rail. Pop. (1901) 22,931. It occupies the site of the town which Phintias of Acragas (Agrigentum) erected after the destruction of Gela, about 281 B.C., by the Mamertines, and named after himself. The river Salso, which flows into the sea on the east of the town, is the ancient *Himera Meridionalis*. The promontory at the foot of which the town is situated, the *Poggio di Sant' Angelo*, is the *Eknomos* (*Eknomon*) of the Greeks, and upon its slopes are scanty traces of ancient structures and rock tombs. It was off this promontory that the Romans gained the famous naval victory over the Carthaginians in the spring of 256 B.C., while the plain to the north was the scene of the defeat of Agathocles by Hamilcar in 310 B.C. The modern town is mainly important as a shipping port for sulphur.



**LICENCE** (through the French from Lat. *licentia*, *licere*, to be lawful), permission, leave, liberty, hence an abuse of liberty, licentiousness; in particular, a formal authority to do some lawful act. Such authority may be either verbal or written; when written, the document containing the authority is called a "licence." Many acts, lawful in themselves, are regulated by statutory authority, and licences must be obtained. For the sale of alcoholic liquor see [LIQUOR LAWS](#).



**LICHEN** (*lichen ruber*), in medical terminology, a papular disease of the skin, consisting of an eruption in small thickly set, slightly elevated red points, more or less widely distributed over the body, and accompanied by slight febrile symptoms.





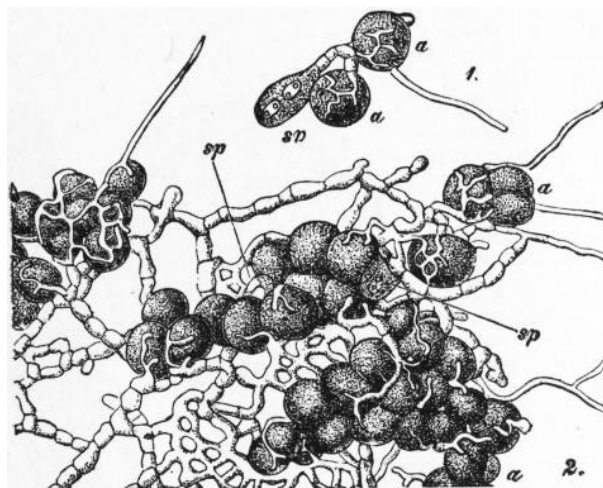
**LICHENS**, in botany, compound or dual organisms each consisting of an association of a higher fungus, with a usually unicellular, sometimes filamentous, alga. The fungal part of the organism nearly always consists of a number of the *Discomycetes* or *Pyrenomycetes*, while the algal portion is a member of the Schizophyceae (Cyanophyceae or Blue-green Algae) or of the Green Algae; only in a very few cases is the fungus a member of the Basidiomycetes. The special fungi which take part in the association are, with rare exceptions, not found growing separately, while the algal forms are constantly found free. The reproductive organs of the lichen are of a typically fungal character, *i.e.* are apothecia or perithecia (see **FUNGI**) and spermogonia. The algal cells are never known to form spores while part of the lichen-thallus, but they may do so when separated from it and growing free. The fungus thus clearly takes the upper hand in the association.

Owing to their peculiar dual nature, lichens are able to live in situations where neither the alga nor fungus could exist alone. The enclosed alga is protected by the threads (hyphae) of the fungus, and supplied with water and salts and, possibly, organic nitrogenous substances; in its turn the alga by means of its green or blue-green colouring matter and the sun's energy manufactures carbohydrates which are used in part by the fungus. An association of two organisms to their mutual advantage is known as *symbiosis*, and the lichen in botanical language is described as a symbiotic union of an alga and a fungus. This form of relationship is now known in other groups of plants (see **BACTERIOLOGY** and **FUNGI**), but it was first discovered in the lichens. The lichens are characterized by their excessively slow growth and their great length of life.

Until comparatively recent times the lichens were considered as a group of simple organisms on a level with algae and fungi. The green (or blue-green) cells were termed gonidia by Wallroth, who looked upon them as asexual reproductive cells, but when it was later realized that they were not reproductive elements they were considered as mere outgrowths of the hyphae of the thallus which had developed chlorophyll. In 1865 De Bary suggested the possibility that such lichens as *Collema*, *Ephebe*, &c., arose as a result of the attack of parasitic Ascomycetes upon the algae, Nostoc, Chroococcus, &c. In 1867 the observations of Famintzin and Baranetzky showed that the gonidia, in certain cases, were able to live outside the lichen-thallus, and in the case of *Physcia*, *Evernia* and *Cladonia* were able to form zoospores. Baranetzky therefore concluded that a certain number, if not all of the so-called algae were nothing more than free living lichen-gonidia. In 1869 Schwendener put forward the really illuminating view—exactly opposite to that of Baranetzky—that the gonidia in all cases were algae which had been attacked by parasitic fungi. Although Schwendener supported this view of the “dual” nature of lichens by very strong evidence and identified the more common lichen-gonidia with known free-living algae, yet the theory was received with a storm of opposition by nearly all lichenologists. These workers were unable to consider with equanimity the loss of the autonomy of their group and its reduction to the level of a special division of the fungi. The observations of Schwendener, however, received ample support from Bornet's (1873) examination of 60 genera. He investigated the exact relation of fungus and alga and showed that the same alga is able to combine with a number of different fungi to form lichens; thus *Chroolepus umbrinus* is found as the gonidia of 13 different lichen genera.

The view of the dual nature of lichens had hitherto been based on analysis; the final proof of this view was now supplied by the actual *synthesis* of a lichen from fungal and algal constituents. Rees in 1871 produced the sterile thallus of a *Collema* from its constituents; later Stahl did the same for three species. Later Bonnier (1886) succeeded in producing fertile thalli by sowing lichen spores and the appropriate algae upon sterile glass plates or portions of bark, and growing them in sterilized air (fig. 1). Möller also in 1887 succeeded in growing small lichen-thalli without their algal constituent (gonidia) on nutritive solutions; in the case of *Calicium* pycnidia were actually produced under these conditions.

The thallus or body of the lichen is of very different form in different genera. In the simplest filamentous lichens (*e.g.* *Ephebe pubescens*) the form of thallus is the form of the filamentous alga which is merely surrounded by the fungal hyphae (fig. 2). The next simplest forms are gelatinous lichens (*e.g.* *Collema*); in these the algae are Chroococcaceae and Nostocaceae, and the fungus makes its way into the gelatinous membranes of the algal cells and ramifies there (fig. 3). We can distinguish this class of forms as lichens with a *homoiomorous* thallus, *i.e.* one in which the alga and fungus are equally distributed. The majority of the lichens, however, possess a stratified thallus in which the gonidia are found as a definite layer or layers embedded in a pseudo-parenchymatous mass of fungal hyphae, *i.e.* they are *heteromorous* (figs. 8 and 9). Obviously these two conditions may merge into one another, and the distinction is not of classificatory value.



After Bonnier, from v. Tavel. From Strasburger's *Lehrbuch der Botanik*, by permission of Gustav Fischer.

FIG. 1.—*Xanthoria parietina*. By the fusion of the hyphae in the middle of the mycelium a pseudo-parenchymatous cortical layer has begun to form.

1, Germinating ascospore (*sp*) with branching germ-tube applied to the *Cystococcus* cells (*a*).

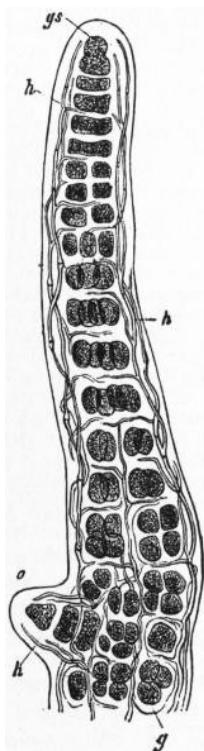
2, Thallus in process of formation.  
*sp*, Two ascospores.  
*p*, *Cystococcus* cells.

In external form the heteromerous thallus presents the following modifications. (*a*) The *foliaceous* (leaf-like) thallus, which may be either peltate, *i.e.* rounded and entire, as in *Umbilicaria*, &c., or variously lobed and lacinated, as in *Sticta*, *Parmelia*, *Cetraria* (fig. 4), &c. This is the highest type of its development, and is sometimes very considerably expanded. (*b*) The *fruticose* thallus may be either erect, becoming pendulous, as in *Usnea* (fig. 5), *Ramalina*, &c., or prostrate, as in *Alectoria jubata*, var. *chalybeiformis*. It is usually divided into branches and branchlets, bearing some resemblance to a miniature shrub. An erect cylindrical thallus terminated by the fruit is termed a *podetium*, as in *Cladonia* (fig. 7). (*c*) The *crustaceous* thallus, which is the most common of all, forms a mere crust on the substratum, varying in thickness, and may be squamose (in *Squamaria*), radiate (in *Placodium*), areolate, granulose or pulverulent (in various *Lecanorae* and *Lecideae*). (*d*) The *hypophloeodal* thallus is often concealed beneath the bark of trees (as in some *Verrucariae* and *Arthoniae*), or enters into the fibres of wood (as in *Xylographa* and *Agyrium*), being indicated externally only by a very thin film (figs. 3, 4, 5, 6, 7 and 8). In colour also the thallus externally is very variable. In the dry and more typical state it is most frequently white or whitish, and almost as often greyish or greyish glaucous. Less commonly it is of different shades of brown, red, yellow and black. In the moist state of the thallus these colours are much less apparent, as the textures then become more or less translucent, and the thallus usually prevents the greenish colour of the gonidia (*e.g.* *Parmelia Borreri*, *Peltidea aphthosa*, *Umbilicaria pustulata* and pulverulent *Lecideae*).

The thallus may be free upon the surface of the substratum (*e.g.* *Collema*) or may be fixed more or less closely to it by special hyphae or rhizoids. These may penetrate but slightly into the substratum, but the connexion established may be so close that it is impossible to remove the thallus from the substratum without injury (*e.g.* *Physcia*, *Placodium*). In some cases the rhizoids are united together into larger strands, the *rhizines*.

The typical heteromerous thallus shows on section a peripheral, thin and therefore transparent, layer, the *cortical layer*, and centrally a mass of denser tissue the so-called *medullary layer*, between these two layers is the algal zone or gonidial layer (figs. 8 and 9).

The term *epithallus* is sometimes applied to the superficial dense portion of the cortical layer and the term *hypothallus* to the layer, when specially modified, in immediate contact with the substratum; the hypothallus is usually dark or blackish. The cylindrical branches of the fruticose forms are usually radially symmetrical, but the flattened branches of these forms and also the thalli of the foliaceous form show a difference in the cortex of the upper and lower side. The cortical layer is usually more developed on the side towards the light, while in many lichens this is the only side provided with a cortical layer. The podetia of some species of *Cladonia* possess no cortical layer at all. The surface of the thallus often exhibits outgrowths in the form of warts, hairs, &c. The medullary layer, which usually forms the main part of the thallus, is distinguished from the cortical layer by its looser consistence and the presence in it of numerous, large, air-containing spaces.



After Sachs, from De Bary's *Vergleichende Morphologie und Biologie der Pilze, Mycetozen und Bacterien*, by permission of Wilhelm Engelmann.

FIG. 2.—*Ephebe pubescens*, Fr. A branched filiform thallus of *Stigonema* with the hyphae of the fungus growing through its gelatinous membranes. Extremity of a branch of the thallus with a young lateral branch *a*; *h*, hyphae; *g*, cells of the alga; *gs*, the apex of the thallus.

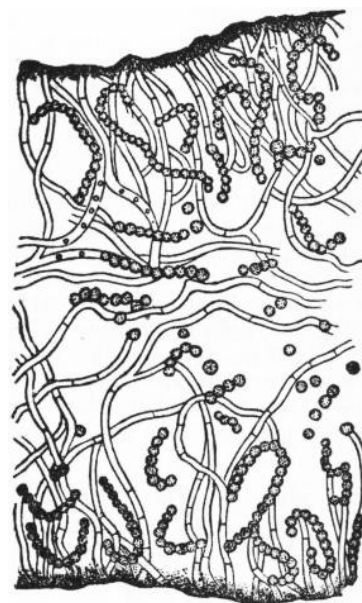
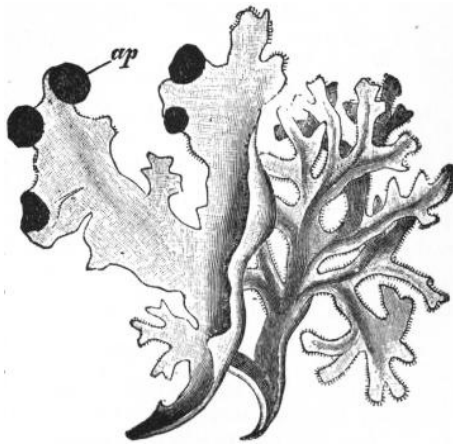


FIG. 3.—Section of Homioimerous Thallus of *Collema conglomeratum*, with *Nostoc* threads scattered among the hyphae.

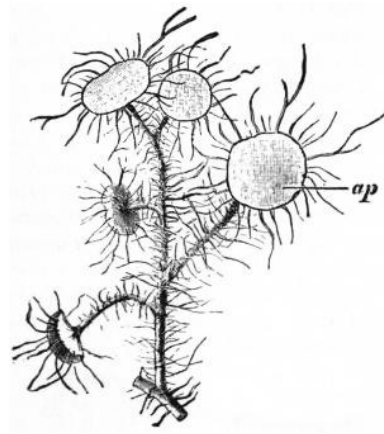
*Gonidia*.—It has been made clear above that the gonidia are nothing more than algal cells, which have been ensnared by fungal hyphae and made to develop in captivity (fig. 1). Funfstuck gives ten free living algae which have been identified as the gonidia of lichens. *Pleurococcus* (*Cystococcus*) *humicola* in the majority of lichens,

*e.g. Usnea, Cladonia, Physcia, Parmelia, Calicium*, many species of *Lecidea*, &c., *Trentepohlia (Chroolepus) umbrina* in many species of *Verrucaria, Graphidieae* and *Lecidea*; *Parmelia botryoides* in *Epigloea*; *Pleurococcus vulgaris* in *Acarospora, Dermatocarpon, Catillaria*; *Dactylococcus infusionum* in *Solorina, Nephromia*; *Nostoc lichenoides* in most of the *Collema*ceae; *Rivularia rutida* in *Omphalaria*; *Lichina*, &c., *Polycoccus punctiformis* in *Peltigera, Pannaria* and *Stictina*; *Gloeocapsa polydermatica* in *Baeomyces* and *Omphalaria*; *Sirosiphon pulvinatus* in *Ephebe pubescens*. The majority of lichens are confined to one particular kind of gonidium (*i.e.* species of alga) but a few forms are known (*Lecanora granatina, Solorina crocea*) which make use of more than one kind in their development. In the case of *Solorina*, for example, the principal alga is a green alga, one of the *Parmellaceae*, but *Nostoc* (a blue-green alga) is also found playing a subsidiary part as gonidia. In *L. granatina* the primary alga is *Pleurococcus*, the secondary, *Gloeocapsa*.



From Strasburger's *Lehrbuch der Botanik*, by permission of Gustav Fischer.

FIG. 4.—*Cetraria islandica*. (Nat. size.) *ap*, Apothecium.



From Strasburger's *Lehrbuch der Botanik*, by permission of Gustav Fischer.

FIG. 5.—*Usnea barbata*. (Nat. size.) *ap*, Apothecium.

*Cephalodia*.—In about 100 species of lichens peculiar growths are developed in the interior of the thallus which cause a slight projection of the upper or lower surface. These structures are known as *cephalodia* and they usually occupy a definite position in the thallus. They are distinguished by possessing as gonidia algae foreign to the ordinary part of the thallus. The foreign algae are always members of the *Cyanophyceae* and on the same individual and even in the same cephalodium more than one type of gonidium may be found. The function of these peculiar structures is unknown. Zukal has suggested that they may play the part of water-absorbing organs.

The exact relation of gonidia and hyphae has been investigated especially by Bornet and also by Hedlund, and very considerable differences have been shown to exist in different genera. In *Physma, Arnoldia, Phylliscum* and other genera the gonidia are killed sooner or later by special hyphal branches, *haustoria*, which pierce the membrane of the algal cell, penetrate the protoplasm and absorb the contents (fig. 11, C). In other cases, *e.g. Synalissa, Micarea*, the haustoria pierce the membrane, but do not penetrate the protoplasm (fig. 11, D). In many other cases, especially those algae possessing *Pleurococcus* as their gonidia, there are no penetrating hyphae, but merely special short hyphal branches which are in close contact with the membrane of the algal cell (fig. 3).

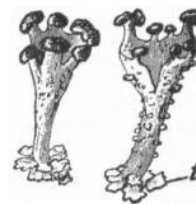


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FIG. 6.—*Cladonia rangiferina*. (Nat. size.)

A, Sterile.

B, With ascus-fruit at the ends of the branches.



From Strasburger's *Lehrbuch der Botanik*, by permission of Gustav Fischer.

FIG. 7.—*Cladonia coccifera*. Podetia bearing apothecia. (Nat. size.)

*t*, Scales of primary thallus.

### Reproduction.

There are three methods of reproduction of the lichen: by fragmentation, by soredia, by the formation of fungal spores. In the first process, portions of thallus containing gonidia may be accidentally separated and so may start new plants. The second method is only a special process of fragmentation. The soredia are found in a large number of lichens, and consist of a single gonidium or groups of gonidia, surrounded by a sheath and hyphae. They arise usually in the gonidial layer of the thallus by division of the gonidia and the development around them of the hyphal investment; their increase in number leads to the rupture of the enclosing cortical

layer and the soredia escape from the thallus as a powdery mass (fig. 12). Since they are provided with both fungal and algal elements, they are able to develop directly, under suitable conditions, into a new thallus. The soredia are the most successful method of reproduction in lichens, for not only are some forms nearly always without spore-formation and in others the spores largely abortive, but in all cases the spore represents only the fungal component of the thallus, and its success in the development of a new lichen-thallus depends on the chance meeting, at the time of germination, with the appropriate algal component.

*Conidia*.—Contrary to the behaviour of the non-lichen forming Ascomycetes the lichen-fungi show very few cases of ordinary conidial formation. Bornet describes free conidia in *Arnoldia minutula*, and *Placodium decipiens* and *Conidia*-formation has been described by Neubner in the Caliciae.

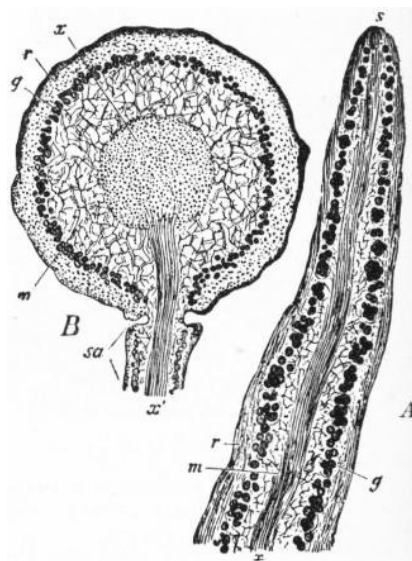
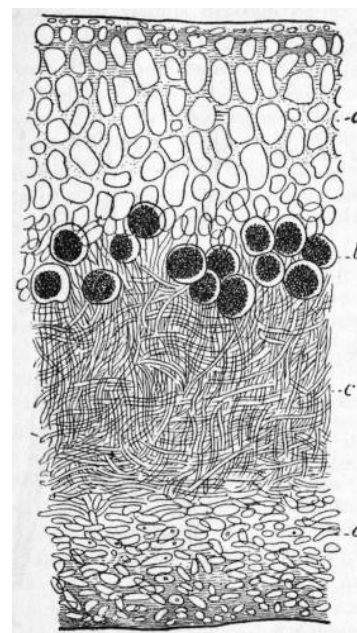


FIG. 8.—*Usnea barbata*. (Mag. nearly 100 times.)

- A, Optical longitudinal section of the extremity of a thin branch of the thallus which has become transparent in solution of potash.  
 B, Transverse section through a stronger branch with the point of origin of an adventitious branch (*sa*).  
*r*, Cortical layer.  
*m*, Medullary layer.  
*x*, Stout axile strand.  
*g*, The algal zone (*Cystococcus*).  
*s*, Apex of the branch.

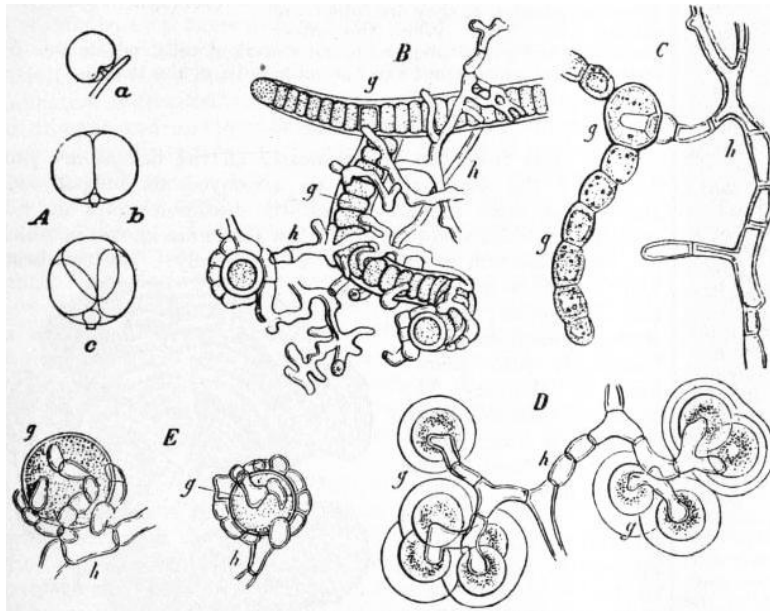


From *Beiträge zur Wissenschaftlichen Botanik*.

FIG. 9.—Section of Heteromerous Lichen Thallus.

- a*, Upper cortical layer.  
*d*, Lower cortical layer.  
*c*, Medullary layer.  
*b*, Gonidial layer.

*Spermatia*.—In the majority of genera of lichens small flask-shaped structures are found embedded in the thallus (fig. 13). These were investigated by Tulasne in 1853, who gave them the name *spermogonia*. The lower, ventral portion of the spermogonium is lined by delicate hyphae, the *sterigmata*, which give origin to minute colourless cells, the *spermatia*. The sterigmata are either simple (fig. 13, C) or septate—the so-called arthrosterigmata (fig. 13, B). The spermogonia open by a small pore at the apex, towards which the sterigmata converge and through which the spermatia escape (fig. 13). There are two views as to the nature of the spermatia. In one view they are mere asexual conidia, and the term *pycnoconidia* is accordingly applied since they are borne in structures like the non-sexual *pycnidia* of other fungi. In the other view the spermatia are the male sexual cells and thus are rightly named; it should, however, be pointed out that this was not the view of Tulasne, though we owe to him the designation which carries with it the sexual significance. The question is one very difficult to settle owing to the fact that the majority of spermatia appear to be functionless. In favour of the conidial view is the fact that in the case of *Collema* and a few other forms the spermatia have been made to germinate in artificial cultures, and in the case of *Calicium parietinum* Möfler succeeded in producing a spermogonia bearing thallus from a spermatium. For the germination of the spermatia in nature there is only the observation of Hedlund, that in *Catillaria denigrata* and *C. prasena* a thallus may be derived from the spermatia under natural conditions. In relation to the view that the spermatia are sexual cells, or at least were primitively so, it must be pointed out that although the actual fusion of the spermatial nucleus with a female nucleus has not been observed, yet in a few cases the spermatia have been seen to fuse with a projecting portion (trichogyne) of the ascogonium, as in *Collema* and *Physcia*, and there is very strong circumstantial evidence that fertilization takes place (see later in section on development of ascocarp). The resemblance of the spermatia and spermogonia to those of Uredineae should be pointed out, where also there is considerable evidence for their original sexual nature, though they appear in that group to be functionless in all cases. The observations of Möller, &c., on the germination cannot be assumed to negative the sexual hypothesis for the sexual cells of *Ulothrix* and *Ectocarpus*, for example are able to develop with or without fusion. The most satisfactory view in the present state of our knowledge seems to be that the spermatia are male cells which, while retaining their fertilizing action in a few cases are now mainly functionless. The female sexual organs, the ascogonia, would thus in the majority of cases develop by the aid of some reduced sexual process or the ascocarps be developed without relation to sexual organs. A further argument in support of this view is that it is in complete agreement with what we know of the sexuality of the ordinary, free-living ascomycetes, where we find both normal and reduced forms (see FUNGI).



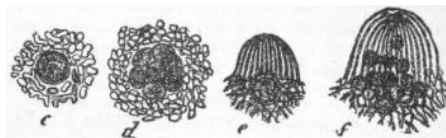
After Bornet, from De Bary's *Vergleichende Morphologie und Biologie der Pilze, Mycetozoen und Bacterien*, by permission of Wilhelm Engelmann.

FIG. 11.—Lichen-forming Algae. (A, C, D, E mag. 950, B 650 times.) The alga is in all cases indicated by the letter *g*, the assailing hyphae by *h*.

A, *Pleurococcus*, Ag. (*Cystococcus*, Näg.) attacked by the germ-tube from a spore of *Physica parietina*.  
 B, *Scytonema* from the thallus of *Stereocaulon famulosum*.

C, *Nostoc* from the thallus of *Physma chalazanum*.  
 D, *Gloeocapsa* from the thallus of *Synalissa Symphorea*.  
 E, *Pleurococcus* Sp. (*Cystococcus*) from the thallus of *Cladonia furcata*.

**Fruit Bodies.**—We find two chief types of fruit bodies in the lichens, the *perithecium* and *apothecium*; the first when the fungal element is a member of the Pyrenomycetes division of the Ascomycetes, the second when the fungus belongs to the Discomycetes division. In the two genera of lichens—the *Basidiolichens*—in which the fungus is a member of the Basidiomycetes, we have the fructification characteristic of that class of fungi: these are dealt with separately. The perithecium is very constant in form and since the gonidia take no part in the formation of this organ or that of the apothecium it has the general structure characteristic of that division of fungi. The apothecia, though of the normal fungal type and usually disk-shaped, are somewhat more variable, and since the variations are of value in classification some more details may be added.

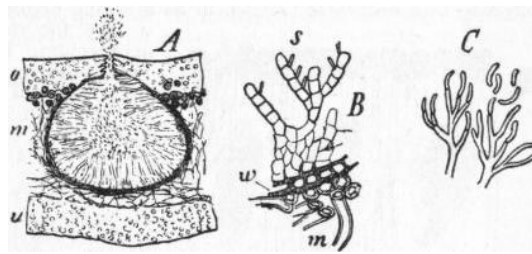


After Schwendener, from De Bary's *Vergleichende Morphologie und Biologie der Pilze Mycetozoen und Bacterien*, by permission of Wilhelm Engelmann.

FIG. 12.—*Usnea barbata*. (Mag. more than 500 times.)

*c*, An isolated mature soredium, with an algal cell (*Pleurococcus*) in the envelope or hyphae.  
*d*, Another with several algal cells in optical longitudinal section.  
*e, f*, Two soredia in the act of germinating; the hyphal envelope has grown out below into rhizoid branches, and above shows already the structure of the apex of the thallus (see fig 9).

They present various shapes, of which the following are the principal: (*a*) *peltate*, which are large, rounded, without any distinct thalline margin<sup>1</sup> (e.g. *Usnea, Peltigera*); (*b*) *lecanorine*, or scutelliform, which are orbicular and surrounded by a distinct, more or less prominent thalline margin (e.g. *Parmelia, Lecanora*), having sometimes also in addition a proper one<sup>1</sup> (e.g. *Thelotrema, Urceolaria*); (*c*) *lecideine*, or patelliform, which are typically orbicular, with only a proper margin (e.g. *Lecidea*), sometimes obsolete, and which are occasionally irregular in shape, angular or flexuose (e.g. *Lecidea jurana, L. myrmecina*), or complicated and gyrose (e.g. *Gyrophora*), and even stipitate (e.g. *Baeomyces*); (*d*) *lirelliform*, which are of very irregular figure, elongated, branched or flexuose, with only a proper margin (e.g. *Xylographa, Graphis*, &c.) or none (e.g. some *Arthoniae*), and often very variable even in the same species. In colour the apothecia are extremely variable, and it is but rarely that they are the same colour as the thallus (e.g. *Usnea, Ramalina*). Usually they are of a different colour, and may be black, brown, yellowish, or also less frequently rose-coloured, rusty-red, orange-reddish, saffron, or of various intermediate shades. Occasionally in the same species their colour is very variable (e.g. *Lecanora metaboloides, Lecidea decolorans*), while sometimes they are white or glaucous, rarely greenish, pruinose. Lecideine apothecia, which are not black, but otherwise variously coloured, are termed *biatorine*.



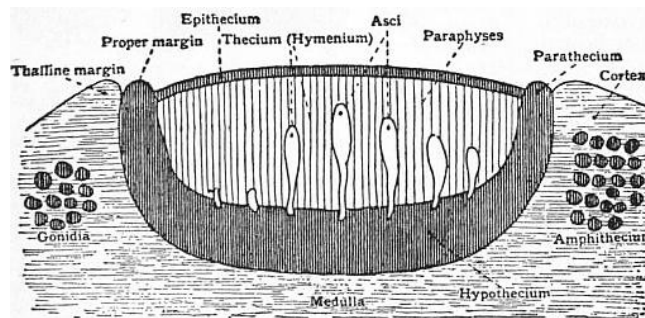
After Tulasne, from De Bary's *Vergleichende Morphologie und Biologie der Pilze, Mycetozen und Bacterien*, by permission of Wilhelm Engelmann.

FIG. 13.—A, B, *Gyrophora cylindrica*. (A mag. 90, B 390 times, C highly magnified.)

- A, A vertical median section through a spermogonium imbedded in the thallus.  
 o, Upper rind.  
 u, Under rind.  
 m, Medullary layer of the thallus.  
 B, Portion of a very thin section from the base of the spermogonium.  
 w, Its wall from which proceed sterigmata with rod-like spermatia (s).  
 m, Medullary hyphae of the thallus.  
 C, *Cladonia novae Angliae*, Delise; sterigmata with spermatia from the spermogonium.

The two principal parts of which an apothecium consists are the *hypothecium* and the hymenium, or thecium. The *hypothecium* is the basal part of the apothecium on which the *hymenium* is borne; the latter consists of asci (thecae) with ascospores, and paraphyses. The paraphyses (which may be absent entirely in the Pyrenolichens) are erect, colourless filaments which are usually dilated and coloured at the apex; the apices are usually cemented together into a definite layer, the *epithecium* (fig. 14). The spores themselves may be unicellular without a septum or multicellular with one or more septa. Sometimes the two cavities are restricted to the two ends of the spore, the *polari-bilocular* type and the two loculi may be united by a narrow channel (fig. 15). At other times the spores are divided by both transverse and longitudinal septa producing the muriform (murallidivided) spore so called from the resemblance of the individual chambers to the stones in a wall. The very large single spores of *Pertusaria* have been shown to contain numerous nuclei and when they germinate develop a large number of germ tubes.

582



After Darbishire, from *Berichte der deutschen botanischen Gesellschaft*, by permission of Borntraeger & Co.

FIG. 14.—Diagram showing Apothecium in Section and surrounding Portion of Thallus, and special terms used to designate these parts.

*Development of the Ascocarps.*—As the remarks on the nature of the spermatia show, the question of the sexuality of the lichens has been hotly disputed in common with that of the rest of the Ascomycetes. As indicated above, the weight of evidence seems to favour what has been put forward in the case of the non-lichen-forming fungi (see FUNGI), that in some cases the ascogonia develop as a result of a previous fertilization by spermatia, in other cases the ascogonia develop without such a union, while in still other cases the reduction goes still farther and the ascogenous hyphae instead of developing from the ascogonia are derived directly from the vegetative hyphae.

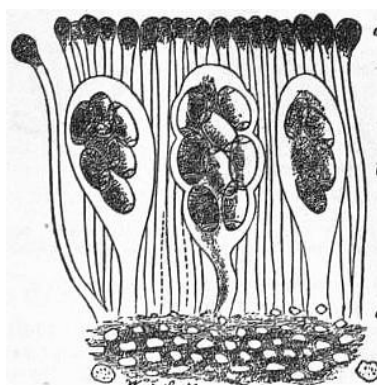


FIG. 15.—Vertical Section of Apothecium of *Xanthoria parietina*.

a, Paraphyses.

b, Asci (thecae) with bilocular spores.  
c, Hypothecium.

The first exact knowledge as to the origin of the ascocarp was the work of Stahl on *Collema* in 1877. He showed that the archicarp consisted of two parts, a lower coiled portion, the ascogonium, and an upper portion, the trichogyne, which projected from the thallus. Only when a spermatium was found attached to the trichogyne did the further development of the ascogonium take place. From these observations he drew the natural conclusion that the spermatium was a male, sexual cell. This view was hotly contested by many workers and it was sought to explain the trichogyne—without much success—as a respiratory organ, or as a boring organ which made a way for the developing apothecium. It was not till 1898, however, that Stahl's work received confirmation and addition at the hands of Baur (fig. 16). The latter showed that in *Collema crispum* there are two kinds of thalli, one with numerous apothecia, the other quite sterile or bearing only a few. The sterile thalli possessed no spermogonia, but were found to show sometimes as many as 1000 archicarps with trichogynes; yet none or very few came to maturity. The fertile thalli were shown to bear either spermogonia or to be in immediate connexion with spermogonia-bearing thalli. Furthermore Baur showed that after the fusion of the spermatium with the trichogyne the transverse walls of that organ became perforated. There was thus very strong circumstantial evidence in favour of fertilization, although the male nucleus was not traced. The further work of Baur, and that of Darbishire, Funfstuck and Lindau, have shown that in a number of other cases trichogynes are present. Thus ascogonia with trichogynes have been observed in *Endocarpon*, *Collema*, *Pertusaria*, *Lecanora*, *Gyrophora*, *Parmelia*, *Ramalina*, *Physcia*, *Anaptychia* and *Cladonia*. In *Nephroma*, *Peltigera*, *Peltidea* and *Solorina* a cogonia without trichogynes have been observed. In *Collema* and a form like *Xanthoria parietina* it is probable that actual fertilization takes place, and possibly also in some of the other forms. It is probable, however, that in the majority of cases the ascogonia develop without normal fertilization, as is necessarily the case where the ascogonia have no trichogynes or the spermatia are absent. In these cases we should expect to find some reduced process of fertilization similar to that of *Humaria granulata* among the ordinary Ascomycetes, where in the absence of the antheridia the female nuclei fuse in pairs. In other lichens we should expect to find the ascogenous hyphae arising directly from the vegetative hyphae as in *Humaria rutilans* among the ordinary fungi, where the process is associated with the fusion of vegetative nuclei. It is possible that *Solorina saccata* belongs to this class. Cytological details of nuclear behaviour among the lichens are, however, difficult to obtain owing to the slow growth of these forms and the often refractory nature of the material in the matter of preparation for microscopical examination.



After E. Baur, from Strasburger's *Lehrbuch der Botanik*, by permission of Gustav Fischer.

FIG. 16.—*Collema crispum*.

A, Carpogonium, c, with its trichogyne t.  
B, Apex of the trichogyne with the spermatium, s, attached.

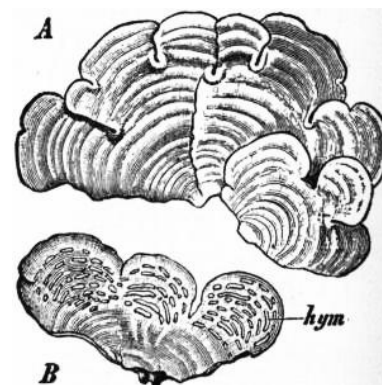
*Ejection of Spores.*—The spores are ejected from the apothecia and perithecia as in the fungi by forcible ejaculation from the asci. In the majority of forms it is clear that the soredia rather than the ascospore must play the more important part in lichen distribution as the development of the ordinary spores is dependent on their finding the proper alga on the substratum on which they happen to fall. In a number of forms (*Endocarpon pusillum*, *Stigmaetonima cataleptum*, various species of *Staurothete*), however, there is a special arrangement by which the spores are, on ejection, associated with gonidia. In these forms gonidia are found in connexion with the young fruit; such algal cells undergo numerous divisions becoming very small in size and penetrating into the hymenium among the asci and paraphyses. When the spores are thrown out some of these hymenial gonidia, as they are called, are carried with them. When the spores germinate the germ-tubes surround the algal cells, which now increase in size and become the normal gonidia of the thallus.

#### Basidiolichens.

As is clear from the above, nearly all the lichens are produced by the association of an ascomycetous fungus with algae. For some obscure reason the Basidiomycetes do not readily form lichens, so that only a few forms are known in which the fungal element is a member of this family. The two best-known genera are *Cora* and *Dictyonema*; *Corella*, whose hymenium is unknown, is also placed here by Wainio. The so-called Gasterolichens, *Trichocoma* and *Emericella*, have been shown to be merely ascomycetous fungi. *Clavaria mucida*, however, has apparently some claims to be considered as a Basidiolichen, since the base of the fruit body and the thallus from which it arises, according to Coker, always shows a mixture of hyphae and algae.

The best-known species is *Cora pavonia*, which is found in tropical regions growing on the bare earth and on trees; the gonidia belong to the genus *Chroococcus* while the fungus belongs, apparently, to the Thelephoreae (see FUNGI). This lichen seems unique in the fact that the fungal element is also found growing and fruiting entirely devoid of algae, while in the ascolichens the fungus portion seems to have become so specialized to its symbiotic mode of life that it is never found growing independently.

The genus *Dictyonema* has gonidia belonging to the blue-green alga, *Scytonema*. When the fungus predominates in the thallus it has a bracket-like mode of growth and is found projecting from the branches of trees with the hymenium on the under side. When the alga is predominant it forms felted patches on the bark of trees, the *Laudatea* form. It is said that the fungus of *Cora pavonia* and of *Dictyonema* is identical, the difference



From Strasburger's *Lehrbuch der Botanik*, by permission of Gustav Fischer.

FIG. 17.—*Cora pavonia*. A, Viewed from above; B, From below; *hym*, hymenium. (Nat. size.)

being in the nature of the alga.

#### *Mode of Life.*

Lichens are found growing in various situations such as bare earth, the bark of trees, dead wood, the surface of stones and rocks, where they have little competition to fear from ordinary plants. As is well known, the lichens are often found in the most exposed and arid situations; in the extreme polar regions these plants are practically the only vegetable forms of life. They owe their capacity to live under the most inhospitable conditions to the dual nature of the organism, and to their capacity to withstand extremes of heat, cold and drought without destruction. On a bare rocky surface a fungus would die from want of organic substance and an alga from drought and want of mineral substances. The lichen, however, is able to grow as the alga supplies organic food material and the fungus has developed a battery of acids (see below) which enable it actually to dissolve the most resistant rocks. It is owing to the power of disintegrating by both mechanical and chemical means the rocks on which they are growing that lichens play such an important part in soil-production. The resistance of lichens is extraordinary; they may be cooled to very low temperatures and heated to high temperatures without being killed. They may be dried so thoroughly that they can easily be reduced to powder yet their vitality is not destroyed but only suspended; on being supplied with water they absorb it rapidly by their general surface and renew their activity. The life of many lichens thus consists of alternating periods of activity when moisture is plentiful, and completely suspended animation under conditions of dryness. Though so little sensitive to drought and extremes of temperature lichens appear to be very easily affected by the presence in the air of noxious substances such as are found in large cities or manufacturing towns. In such districts lichen vegetation is entirely or almost entirely absent. The growth of lichens is extremely slow and many of them take years before they arrive at a spore-bearing stage. *Xanthoria parietina* has been known to grow for forty-five years before bearing apothecia. This slowness of growth is associated with great length of life and it is probable that individuals found growing on hard mountain rocks or on the trunks of aged trees are many hundreds of years old. It is possible that specimens of such long-lived species as *Lecidea geographica* actually outlive in longevity the oldest trees.

#### *Relation of Fungus and Alga.*

The relation of the two constituents of the lichen have been briefly stated in the beginning of this article. The relation of the fungus to the alga, though it may be described in general terms as one of symbiosis, partakes also somewhat of the nature of parasitism. The algal cells are usually controlled in their growth by the hyphae and are prevented from forming zoospores, and in some cases, as already described, the algal cells are killed sooner or later by the fungus. The fungus seems, on the other hand, to stimulate the algal cells to special development, for those in the lichen are larger than those in the free state, but this is not necessarily adverse to the idea of parasitism, for it is well known that an increase in the size of the cells of the host is often the result of the attacks of parasitic fungi. It must be borne in mind that the exact nutritive relations of the two constituents of the lichen have not been completely elucidated, and that it is very difficult to draw the line between symbiosis and parasitism. The lichen algae are not alone in their specialization to the symbiotic (or parasitic) mode of life, for, as stated earlier, the fungus appear in the majority of cases to have completely lost the power of independent development since with very rare exceptions they are not found alone. They also differ very markedly from free living fungi in their chemical reactions.

#### *Chemistry of Lichens.*

The chemistry of lichens is very complex, not yet fully investigated and can only be very briefly dealt with here. The wall of the hyphae of the fungus give in the young state the ordinary reactions of cellulose but older material shows somewhat different reactions, similar to those of the so-called fungus-cellulose. In many lichen-fungi the wall shows various chemical modifications. In numerous lichens, e.g. *Cetraria islandica*, the wall contains Lichenin ( $C_6H_{10}O_5$ ), a gummy substance which swells in cold water and dissolves in hot. Besides this substance, a very similar one, Isolichenin, is also found which is distinguished from lichenin by the fact that it dissolves in cold water and turns blue under the reaction of Iodine. Calcium oxalate is a very common substance, especially in crustaceous lichens; fatty oil in the form of drops or as an infiltration in the membrane is also common; it sometimes occurs in special cells and in extreme cases may represent 90% of the dry substance as in *Verrucaria calciseda*, *Biatra immersa*.

*Colouring Matters.*—Many lichens, as is well known, exhibit a vivid colouring which is usually due to the incrustation of the hyphae with crystalline excretory products. These excretory products have usually an acid nature and hence are generally known as lichen-acids. A large number of these acids, which are mostly benzene derivatives, have been isolated and more or less closely investigated. They are characterized by their insolubility or very slight solubility in water; as examples may be mentioned erythrinic acid in *Roccella* and *Lecanora*; evernic acid in species of *Evernia*, *Ramalina* and *Cladonia*; lecanoric acid in *Lecanora*, *Gyrophora*. The so-called chrysophanic acid found in *Xanthoria* (*Physcia*) *parietina* is not an acid but a quinone and is better termed phycion.

*Colour Reactions of Lichens.*—The classification of lichens is unique in the fact that chemical colour reactions are used by many lichenologists in the discrimination of species, and these reactions are included in the specific diagnoses. The substances used as tests in these reactions are caustic potash and calcium hypochlorite; the former being the substance dissolved in an equal weight of water and the latter a saturated extract of bleaching powder in water. These substances are represented by lichenologists by the signs K and CaCl respectively, and the presence or absence of the colour reactions are represented thus, K+, CaCl+, or K-, CaCl-. If the cortical layer should exhibit positive reaction and the medulla of the same species a negative reaction with both reagents, the result is represented thus, K±CaCl±. If a reaction is only produced after the consecutive addition of the two reagents, this is symbolized by K(CaCl)+. A solution of iodine is also used as a test owing to the blue or wine-red colour which the thallus, hymenium or spores may give with this reagent. The objection to the case of these colour reactions is due to the indefinite nature of the reaction and the doubt as to the constant presence of a definite chemical compound in a given species. A yellow colour with caustic potash solution is produced not only by atranoric acid but also by evernic acid, thamnolic acid, &c. Again in the case of *Xanthoria parietina*



vulpinic acid is only to be found in young thalli growing on sandstone; in older forms or in those growing on another substratum it is not to be detected. A similar relation between oil formation and the nature of the substratum has been observed in many lichens. Considerations such as these should make one very wary in placing reliance on these colour reactions for the purposes of classification.

#### *Economic Uses of Lichens.*

In the arts, as food and as medicine, many lichens have been highly esteemed, though others are not now employed for the same purposes as formerly.

1. *Lichens Used in the Arts.*—Of these the most important are such as yield, by maceration in ammonia, the dyes known in commerce as archil, cudbear and litmus. These, however, may with propriety be regarded as but different names for the same pigmentary substance, the variations in the character of which are attributable to the different modes in which the pigments are manufactured. Archil proper is derived from several species of *Roccella* (e.g. *R. Montaguei*, *R. tinctoria*), which yield a rich purple dye; it once fetched a high price in the market. Of considerable value is the “perelle” prepared from *Lecanora parella*, and used in the preparation of a red or crimson dye. Inferior to this is “cudbear,” derived from *Lecanora tartarea*, which was formerly very extensively employed by the peasantry of north Europe for giving a scarlet or purple colour to woollen cloths. By adding certain alkalis to the other ingredients used in the preparation of these pigments, the colour becomes indigo-blue, in which case it is the litmus of the Dutch manufacturers. Amongst other lichens affording red, purple or brown dyes may be mentioned *Ramalina scopulorum*, *Parmelia saxatilis* and *P. amphalodes*, *Umbilicaria pustulata* and several species of *Gyrophora*, *Urceolaria scruposa*, all of which are more or less employed as domestic dyes. Yellow dyes, again, are derived from *Chlorea vulpina*, *Platysma juniperinum*, *Parmelia caperata* and *P. conspersa*, *Physcia flavicans*, *Ph. parietina* and *Ph. lychnea*, though like the preceding they do not form articles of commerce, being merely used locally by the natives of the regions in which they occur most plentifully. In addition to these, many exotic lichens, belonging especially to *Parmelia* and *Sticta* (e.g. *Parmelia tinctorum*, *Sticta argyracea*), are rich in colouring matter, and, if obtained in sufficient quantity, would yield a dye in every way equal to archil. These pigments primarily depend upon special acids contained in the thalli of lichens, and their presence may readily be detected by means of the reagents already noticed. In the process of manufacture, however, they undergo various changes, of which the chemistry is still but little understood. At one time also some species were used in the arts for supplying a gum as a substitute for gum-arabic. These were chiefly *Ramalina fraxinea*, *Evernia prunastri* and *Parmelia physodes*, all of which contain a considerable proportion of gummy matter (of a much inferior quality, however, to gum-arabic), and were employed in the process of calico-printing and in the making of parchment and cardboard. In the 17th century some filamentose and fruticulose lichens, viz. species of *Usnea* and *Ramalina*, also *Evernia furfuracea* and *Cladonia rangiferina*, were used in the art of perfumery. From their supposed aptitude to imbibe and retain odours, their powder was the basis of various perfumes, such as the celebrated “Poudre de Cypre” of the hairdressers, but their employment in this respect has long since been abandoned.

2. *Nutritive Lichens.*—Of still greater importance is the capacity of many species for supplying food for man and beast. This results from their containing starchy substances, and in some cases a small quantity of saccharine matter of the nature of mannite. One of the most useful nutritious species is *Cetraria islandica*, “Iceland moss,” which, after being deprived of its bitterness by boiling in water, is reduced to a powder and made into cakes, or is boiled and eaten with milk by the poor Icelander, whose sole food it often constitutes. Similarly *Cladonia rangiferina* and *Cl. sylvatica*, the familiar “reindeer moss,” are frequently eaten by man in times of scarcity, after being powdered and mixed with flour. Their chief importance, however, is that in Lapland and other northern countries they supply the winter food of the reindeer and other animals, who scrape away the snow and eagerly feed upon them. Another nutritious lichen is the “Tripe de Roche” of the arctic regions, consisting of several species of the *Gyrophorei*, which when boiled is often eaten by the Canadian hunters and Red Indians when pressed by hunger. But the most singular esculent lichen of all is the “manna lichen,” which in times of drought and famine has served as food for large numbers of men and cattle in the arid steppes of various countries stretching from Algiers to Tartary. This is derived chiefly from *Lecanora esculenta*, which grows unattached on the ground in layers from 3 to 6 in. thick over large tracts of country in the form of small irregular lumps of a greyish or white colour. In connexion with their use as food we may observe that of recent years in Scandinavia and Russia an alcoholic spirit has been distilled from *Cladonia rangiferina* and extensively consumed, especially in seasons when potatoes were scarce and dear. Formerly also *Sticta pulmonaria* was much employed in brewing instead of hops, and it is said that a Siberian monastery was much celebrated for its beer which was flavoured with the bitter principle of this species.

3. *Medicinal Lichens.*—During the middle ages, and even in some quarters to a much later period, lichens were extensively used in medicine in various European countries. Many species had a great repute as demulcents, febrifuges, astringents, tonics, purgatives and anthelmintics. The chief of those employed for one or other, and in some cases for several, of these purposes were *Cladonia pyxidata*, *Usnea barbata*, *Ramalina farinacea*, *Evernia prunastri*, *Cetraria islandica*, *Sticta pulmonaria*, *Parmelia saxatilis*, *Xanthoria parietina* and *Pertusaria amara*. Others again were believed to be endowed with specific virtues, e.g. *Peltigera canina*, which formed the basis of the celebrated “pulvis antilyssus” of Dr Mead, long regarded as a sovereign cure for hydrophobia; *Platysma juniperinum*, lauded as a specific in jaundice, no doubt on the *similia similibus* principle from a resemblance between its yellow colour and that of the jaundiced skin; *Peltidea aphthosa*, which on the same principle was regarded by the Swedes, when boiled in milk, as an effectual remedy for the *aphthae* or rash on their children. Almost all of these virtues, general or specific, were imaginary; and at the present day, except perhaps in some remoter districts of northern Europe, only one of them is employed as a remedial agent. This is the “Iceland moss” of the druggists’ shops, which is undoubtedly an excellent demulcent in various dyspeptic and chest complaints. No lichen is known to be possessed of any poisonous properties to man, although *Chlorea vulpina* is believed by the Swedes to be so. Zukal has considered that the lichen acids protect the lichen from the attacks of animals; the experiments of Zopf, however, have cast doubt on this; certainly lichens containing very bitter acids are eaten by mites though some of the acids appear to be poisonous to frogs.

#### *Classification.*

The dual nature of the lichen thallus introduces at the outset a classificatory difficulty. Theoretically the lichens may be classified on the basis of their algal constituent, on the basis of their fungal constituent, or they may be classified as if they were homogeneous organisms. The first of these systems is impracticable owing to the absence of algal reproductive organs and the similarity of the algal cells (gonidia) in a large number of different forms. The second system is the most obvious one, since the fungus is the dominant partner and produces reproductive organs. The third system was that of Nylander and his followers, who did not accept the Schwenderian doctrine of duality. In actual practice the difference between the second and third methods is not very great since the fungus is the producer of the reproductive organs and generally the main constituent. Most systems agree in deriving the major divisions from the characters of the reproductive organs (perithecia, apothecia, or basidiospore bearing fructification), while the characters of the algal cells and those of the thallus generally are used for the minor divisions. The difference between the various systems lies in the relative importance given to the reproductive characters on the one hand and the vegetative characters on the other. In the system (1854-1855) of Nylander the greater weight is given to the latter, while in more modern systems the former characters receive the more attention.

A brief outline of a system of classification, mainly that of Zahlbruckner as given in Engler and Prantl's *Pflanzenfamilien*, is outlined below.

There are two main divisions of lichens, *Ascolichenes* and *Basidiolichenes*, according to the nature of the fungal element, whether an ascomycete or basidiomycete. The *Ascolichenes* are again divided into *Pyrenocarpeae* or *Pyrenolichenes* and *Gymnocarpeae* or *Discolichenes*; the first having an ascocarp of the nature of a perithecium, the second bearing their ascospores in an open apothecium.

#### PYRENOLICHENES

Series I. Perithecium simple not divided.

- a. With *Pleurococcus* or *Parmelia* gonidia. Moriaceae, Verrucariaceae, Pyrenothamnaceae.
- b. With *Chroolepus* gonidia. Pyrenulaceae, Paratheliaceae.
- c. With *Phylactidium* or *Cephaleurus* gonidia. Strigulaceae.
- d. With *Nostoc* or *Scytonema* gonidia. Pyrenidiaceae.

Series II. Perithecia divided or imperfectly divided by cross-walls. Mycoporaceae with *Parmelia* or *Chroolepus* gonidia.

#### DISCOLICHENES

Series I. Coniocarpineae. The paraphyses branch and form a network (capillitium) over the asci, the capillitium and ejected spores forming a long persistent powdery mass (mazaedium).

Caliciaceae, Cypheliaceae, Sphaerophoraceae.

Series II. Graphidineae. Apothecia seldom round, usually elongated-ellipsoidal, no capillitium.

Arthoniaceae, Graphidiaceae, Roccellaceae.

Series III. Cyclocarpineae, Apothecium usually circular, no capillitium.

A. Spores usually two-celled, either with a strongly thickened cross-wall often perforated by a narrow canal or with cross-wall only slightly thickened. In the first case the spores are usually colourless, the second case always brown. Buelliaceae, Physciaceae.

B. Spores unicellular, parallel-multicellular or muriform, usually colourless, cross-walls usually thin.

α Thallus in moist state more or less gelatinous. Gonidia always belonging to the Cyanophyceae, Lichinaceae, Ephebeae, Collemaceae, Pyrenopsidaceae.

β Thallus not gelatinous. Coenogoniaceae, Lecideaceae, Cladoniaceae, Lecanoraceae, Pertusariaceae, Peltigeraceae, Stictaceae, Pannariaceae, Gyrophoraceae, Parmeliaceae, Cladoniaceae, Usneaceae.

#### BASIDIOLICHENES (Hymenolichenes)

*Cora*, *Dictyonema* (incl. *Laudatea*), *Corella* (doubtfully placed here as the hymenium is unknown).

#### *Habitats and Distribution of Lichens.*

1. *Habitats.*—These are extremely varied, and comprise a great number of very different substrata. Chiefly, however, they are the bark of trees, rocks, the ground, mosses and, rarely, perennial leaves. (a) With respect to *corticolous* lichens, some prefer the rugged bark of old trees (*e.g. Ramalina, Parmelia, Stictis*) and others the smooth bark of young trees and shrubs (*e.g. Graphidei* and some *Lecideae*). Many are found principally in large forests (*e.g. Usnea, Alectoria jubata*); while a few occur more especially on trees by roadsides (*e.g. Physcia parietina* and *Ph. pulverulenta*). In connexion with corticolous lichens may be mentioned those *lignicole* species which grow on decayed, or decaying wood of trees and on old pales (*e.g. Caliciei*, various *Lecideae, Xylographa*), (b) As to *saxicolous* lichens, which occur on rocks and stones, they may be divided into two sections, viz. *calcicolous* and *calcifugous*. To the former belong such as are found on calcareous and cretaceous rocks, and the mortar of walls (*e.g. Lecanora calcarea, Lecidea calcivora* and several *Verrucariae*), while all other saxicolous lichens may be regarded as belonging to the latter, whatever may be the mineralogical character of the substratum. It is here worthy of notice that the apothecia of several calcicolous lichens (*e.g. Lecanora Prevostii, Lecidea calcivora*) have the power of forming minute cavities in the rock, in which they are partially buried. (c) With respect to terrestrial species, some prefer peaty soil (*e.g. Cladonia, Lecidea decolorans*), others calcareous soil (*e.g. Lecanora crassa, Lecidea decipiens*), others sandy soil or hardened mud (*e.g. Collema limosum, Peltidea venosa*); while many may be found growing on all kinds of soil, from the sands of the sea-shore to the granitic detritus of lofty mountains, with the exception of course of cultivated ground, there being no agrarian

lichens. (d) *Muscicolous* lichens again are such as are most frequently met with on decayed mosses and *Jungermannia*, whether on the ground, trees or rocks (e.g. *Leptogium muscicola*, *Gomphillus calicioides*). (e) The *epiphyllous* species are very peculiar as occurring upon perennial leaves of certain trees and shrubs, whose vitality is not at all affected by their presence as it is by that of fungi. In so far, however, as is known, they are very limited in number (e.g. *Lecidea*, *Bouteillei*, *Strigula*).

Sometimes various lichens occur abnormally in such unexpected habitats as dried dung of sheep, bleached bones of reindeer and whales, old leather, iron and glass, in districts where the species are abundant. It is apparent that in many cases lichens are quite indifferent to the substrata on which they occur, whence we infer that the preference of several for certain substrata depends upon the temperature of the locality or that of the special habitat. Thus in the case of saxicolous lichens the mineralogical character of the rock has of itself little or no influence upon lichen growth, which is influenced more especially and directly by their physical properties, such as their capacity for retaining heat and moisture. As a rule lichens grow commonly in open exposed habitats, though some are found only or chiefly in shady situations; while, as already observed, scarcely any occur where the atmosphere is impregnated with smoke. Many species also prefer growing in moist places by streams, lakes and the sea, though very few are normally and probably none entirely, *aquatic*, being always at certain seasons exposed for a longer or shorter period to the atmosphere (e.g. *Lichina*, *Leptogium rivulare*, *Endocarpon fluviatile*, *Verrucaria maura*). Some species are entirely parasitical on other lichens (e.g. various *Lecideae* and *Pyrenocarpei*), and may be peculiar to one (e.g. *Lecidea vitellinaria*) or common to several species (e.g. *Habrothallus parmeliarum*). A few, generally known as *erratic* species, have been met with growing unattached to any substratum (e.g. *Parmella revoluta*, var. *concentrica*, *Lecanora esculenta*); but it can hardly be that these are really free *ab initio* (vide Crombie in *Journ. Bot.*, 1872, p. 306). It is to the different characters of the stations they occupy with respect to exposure, moisture, &c., that the variability observed in many types of lichens is to be attributed.

2. *Distribution*.—From what has now been said it will readily be inferred that the distribution of lichens over the surface of the globe is regulated, not only by the presence of suitable substrata, but more especially by climatic conditions. At the same time it may safely be affirmed that their geographical range is more extended than that of any other class of plants, occurring as they do in the coldest and warmest regions—on the dreary shores of arctic and antarctic seas and in the torrid valleys of tropical climes, as well as on the greatest mountain elevations yet attained by man, on projecting rocks even far above the snowline (e.g. *Lecidea geographica*). In arctic regions lichens form by far the largest portion of the vegetation, occurring everywhere on the ground and on rocks, and fruiting freely; while terrestrial species of *Cladonia* and *Stereocaulon* are seen in the greatest luxuriance and abundance spreading over extensive tracts almost to the entire exclusion of other vegetation. The lichen flora of temperate regions again is essentially distinguished from the preceding by the frequency of corticolous species belonging to *Lecanora*, *Lecidea* and *Graphidei*. In intertropical regions lichens attain their maximum development (and beauty) in the foliaceous *Stictei* and *Parmeliei*, while they are especially characterized by epiphyllous species, as *Strigula*, and by many peculiar corticole *Thelotremai*, *Graphidei* and *Pyrenocarpei*. Some lichens, especially saxicolous ones, seem to be cosmopolitan (e.g. *Lecanora subfusca*, *Cladonia pyxidata*); and others, not strictly cosmopolitan, have been observed in regions widely apart. A considerable number of species, European and exotic, seem to be *endemic*, but further research will no doubt show that most of them occur in other climatic regions similar to those in which they have hitherto alone been detected. To give any detailed account, however, of the distribution of the different genera (not to speak of that of individual species) of lichens would necessarily far exceed available limits.

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(J. M. C; V. H. B.)

- 1 The *thalline margin* (margo thallinus) is the projecting edge of a special layer of thallus, the amphithecium, round the actual apothecium; the *proper margin* (margo proprius) is the projecting edge of the apothecium itself.



**LICHFIELD**, a city, county of a city, and municipal borough in the Lichfield parliamentary division of Staffordshire, England, 118 m. N.W. from London. Pop. (1901) 7902. The London and North-Western railway has stations at Trent Valley Junction on the main line, and in the city on a branch westward. The town lies in a pleasant country, on a small stream draining eastward to the Trent, with low hills to the E. and S. The cathedral is small (the full internal length is only 370 ft., and the breadth of the nave 68 ft.), but beautiful in both situation and style. It stands near a picturesque sheet of water named Minster Pool. The present building dates from various periods in the 13th and early 14th centuries, but the various portions cannot be allocated to fixed years, as the old archives were destroyed during the Civil Wars of the 17th century. The earlier records of the church are equally doubtful. A Saxon church founded by St Chad, who was subsequently enshrined here, occupied the

site from the close of the 7th century; of its Norman successor portions of the foundations have been excavated, but no record exists either of its date or of its builders. The fine exterior of the cathedral exhibits the feature, unique in England, of a lofty central and two lesser western spires, of which the central, 252 ft. high, is a restoration attributed to Sir Christopher Wren after its destruction during the Civil Wars. The west front is composed of three stages of ornate arcading, with niches containing statues, of which most are modern. Within, the south transept shows simple Early English work, the north transept and chapter house more ornate work of a later period in that style, the nave, with its geometrical ornament, marks the transition to the Decorated style, while the Lady chapel is a beautiful specimen of fully developed Decorated work with an apsidal east end. The west front probably falls in date between the nave and the Lady chapel. Among numerous monuments are—memorials to Samuel Johnson, a native of Lichfield, and to David Garrick, who spent his early life and was educated here; a monument to Major Hodson, who fell in the Indian mutiny, and whose father was canon of Lichfield; the tomb of Bishop Hacket, who restored the cathedral after the Civil Wars; and a remarkable effigy of Perpendicular date displaying Sir John Stanley stripped to the waist and awaiting chastisement. Here is also the "Sleeping Children," a masterpiece by Chantrey (1817).

A picturesque bishop's palace (1687) and a theological college (1857) are adjacent to the cathedral. The diocese covers the greater part of Staffordshire and about half the parishes in Shropshire, with small portions of Cheshire and Derbyshire. The church of St Chad is ancient though extensively restored; on its site St Chad is said to have occupied a hermit's cell. The principal schools are those of King Edward and St Chad. There are many picturesque half-timbered and other old houses, among which is that in which Johnson was born, which stands in the market-place, and is the property of the corporation and opened to the public. There is also in the market place a statue to Johnson. A fair is held annually on Whit-Monday, accompanied by a pageant of ancient origin. Brewing is the principal industry, and in the neighbourhood are large market gardens. The city is governed by a mayor, 6 aldermen and 18 councillors. Area, 3475 acres.

There is a tradition that "Christianfield" near Lichfield was the site of the martyrdom of a thousand Christians during the persecutions of Maximian about 286, but there is no evidence in support of the tradition. At Wall, 3 m. from the present city, there was a Romano-British village called Letocetum ("grey wood"), from which the first half of the name Lichfield is derived. The first authentic notice of Lichfield (*Lycidfelth*, *Lychfeld*, *Litchfield*) occurs in Bede's history where it is mentioned as the place where St Chad fixed the episcopal see of the Mercians. After the foundation of the see by St Chad in 669, it was raised in 786 by Pope Adrian through the influence of Offa, King of Mercia, to the dignity of an archbishopric, but in 803 the primacy was restored to Canterbury. In 1075 the see of Lichfield was removed to Chester, and thence a few years later to Coventry, but it was restored in 1148. At the time of the Domesday Survey Lichfield was held by the bishop of Chester: it is not called a borough, and it was a small village, whence, on account of its insignificance, the see had been moved. The lordship and manor of the town were held by the bishop until the reign of Edward VI., when they were leased to the corporation. There is evidence that a castle existed here in the time of Bishop Roger Clinton (*temp.* Henry I.), and a footpath near the grammar-school retains the name of Castle-ditch. Richard II. gave a charter (1387) for the foundation of the gild of St Mary and St John the Baptist; this gild obtained the whole local government, which it exercised until its dissolution by Edward VI., who incorporated the town (1548), vesting the government in two bailiffs and twenty-four burgesses; further charters were given by Mary, James I. and Charles II. (1664), the last, incorporating it under the title of the "bailiffs and citizens of the city of Lichfield," was the governing charter until 1835; under this charter the governing body consisted of two bailiffs and twenty-four brethren. Lichfield sent two members to the parliament of 1304 and to a few succeeding parliaments, but the representation did not become regular until 1552; in 1867 it lost one member, and in 1885 its representation was merged in that of the county. By the charter of James I. the market day was changed from Wednesday to Tuesday and Friday; the Tuesday market disappeared during the 19th century; the only existing fair is a small pleasure fair of ancient origin held on Ash-Wednesday; the annual fête on Whit-Monday claims to date from the time of Alfred. In the Civil Wars Lichfield was divided. The cathedral authorities with a certain following were for the king, but the townsfolk generally sided with the parliament, and this led to the fortification of the close in 1643. Lord Brooke, notorious for his hostility to the church, came against it, but was killed by a deflected bullet on St Chad's day, an accident welcomed as a miracle by the Royalists. The close yielded and was retaken by Prince Rupert in this year; but on the breakdown of the king's cause in 1646 it again surrendered. The cathedral suffered terrible damage in these years.

See Rev. T. Harwood, *Hist. and Antiquities of Church and City of Lichfield* (1806), *Victoria County History, Stafford*.



**LICH-GATE**, or LYCH-GATE (from O. Eng. *lic* "a body, a corpse"; cf. Ger. *Leiche*), the roofed-in gateway or porch-entrance to churchyards. Lich-gates existed in England certainly thirteen centuries ago, but comparatively few early ones survive, as they were almost always of wood. One at Bray, Berkshire, is dated 1448. Here the clergy meet the corpse and some portion of the service is read. The gateway was really part of the church; it also served to shelter the pall-bearers while the bier was brought from the church. In some lich-gates there stood large flat stones called lich-stones upon which the corpse, usually uncoffined, was laid. The most common form of lich-gate is a simple shed composed of a roof with two gabled ends, covered with tiles or thatch. At Berrynarbor, Devon, there is a lich-gate in the form of a cross, while at Troutbeck, Westmorland, there are three lich-gates to one churchyard. Some elaborate gates have chambers over them. The word *lich* entered into composition constantly in old English, thus, lich-bell, the hand-bell rung before a corpse; lich-way, the path along which a corpse was carried to burial (this in some districts was supposed to establish a right-of-way); lich-owl, the screech-owl, because its cry was a portent of death; and lyke-wake, a night watch over a corpse.



**LICHTENBERG, GEORG CHRISTOPH** (1742-1799), German physicist and satirical writer, was born at Oberramstadt, near Darmstadt, on the 1st of July 1742. In 1763 he entered Göttingen university, where in 1769 he became extraordinary professor of physics, and six years later ordinary professor. This post he held till his death on the 24th of February 1799. As a physicist he is best known for his investigations in electricity, more especially as to the so-called Lichtenberg figures, which are fully described in two memoirs *Super nova methodo motum ac naturam fluidi electrici investigandi* (Göttingen, 1777-1778). These figures, originally studied on account of the light they were supposed to throw on the nature of the electric fluid or fluids, have reference to the distribution of electricity over the surface of non-conductors. They are produced as follows: A sharp-pointed needle is placed perpendicular to a non-conducting plate, such as of resin, ebonite or glass, with its point very near to or in contact with the plate, and a Leyden jar is discharged into the needle. The electrification of the plate is now tested by sifting over it a mixture of flowers of sulphur and red lead. The negatively electrified sulphur is seen to attach itself to the positively electrified parts of the plate, and the positively electrified red lead to the negatively electrified parts. In addition to the distribution of colour thereby produced, there is a marked difference in the *form* of the figure, according to the nature of the electricity originally communicated to the plate. If it be positive, a widely extending patch is seen on the plate, consisting of a dense nucleus, from which branches radiate in all directions; if negative the patch is much smaller and has a sharp circular boundary entirely devoid of branches. If the plate receives a mixed charge, as, for example, from an induction coil, a "mixed" figure results, consisting of a large red central nucleus, corresponding to the negative charge, surrounded by yellow rays, corresponding to the positive charge. The difference between the positive and negative figures seems to depend on the presence of the air; for the difference tends to disappear when the experiment is conducted in vacuo. Riess explains it by the negative electrification of the plate caused by the friction of the water vapour, &c., driven along the surface by the explosion which accompanies the disruptive discharge at the point. This electrification would favour the spread of a positive, but hinder that of a negative discharge. There is, in all probability, a connexion between this phenomenon and the peculiarities of positive and negative brush and other discharge in air.

As a satirist and humorist Lichtenberg takes high rank among the German writers of the 18th century. His biting wit involved him in many controversies with well-known contemporaries, such as Lavater, whose science of physiognomy he ridiculed, and Voss, whose views on Greek pronunciation called forth a powerful satire, *Über die Pronunciation der Schöpse des alten Griechenlandes* (1782). In 1769 and again in 1774 he resided for some time in England and his *Briefe aus England* (1776-1778), with admirable descriptions of Garrick's acting, are the most attractive of his writings. He contributed to the *Göttinger Taschenkalender* from 1778 onwards, and to the *Göttingisches Magazin der Literatur und Wissenschaft*, which he edited for three years (1780-1782) with J. G. A. Forster. He also published in 1794-1799 an *Ausführliche Erklärung der Hogarthschen Kupferstiche*.

Lichtenberg's *Vermischte Schriften* were published by F. Kries in 9 vols. (1800-1805); new editions in 8 vols. (1844-1846 and 1867). Selections by E. Grisebach, *Lichtenbergs Gedanken und Maximen* (1871); by F. Robertag (in Kürschner's *Deutsche Nationalliteratur* (vol. 141, 1886); and by A. Wilbrandt (1893). Lichtenberg's *Briefe* have been published in 3 vols, by C. Schüddekopf and A. Leitzmann (1900-1902); his *Aphorismen* by A. Leitzmann (3 vols., 1902-1906). See also R. M. Meyer, *Swift und Lichtenberg* (1886); F. Lauchert, *Lichtenbergs schriftstellerische Tätigkeit* (1893); and A. Leitzmann, *Aus Lichtenbergs Nachlass* (1899).



**LICHTENBERG**, formerly a small German principality on the west bank of the Rhine, enclosed by the Nahe, the Blies and the Glan, now belonging to the government district of Trier, Prussian Rhine province. The principality was constructed of parts of the electorate of Trier, of Nassau-Saarbrücken and other districts, and lay between Rhenish Bavaria and the old Prussian province of the Rhine. Originally called the lordship of Baumholder, it owed the name of Lichtenberg and its elevation in 1819 to a principality to Ernest, duke of Saxe-Coburg, to whom it was ceded by Prussia, in 1816, in accordance with terms agreed upon at the congress of Vienna. The duke, however, restored it to Prussia in 1834, in return for an annual pension of £12,000 sterling. The area is about 210 sq. m.



**LICINIANUS, GRANIUS**, Roman annalist, probably lived in the age of the Antonines (2nd century A.D.). He was the author of a brief epitome of Roman history based upon Livy, which he utilized as a means of displaying his antiquarian lore. Accounts of omens, portents, prodigies and other remarkable things apparently took up a considerable portion of the work. Some fragments of the books relating to the years 163-178 B.C. are preserved in a British Museum MS.

EDITIONS.—C. A. Pertz (1857); seven Bonn students (1858); M. Flemisch (1904); see also J. N. Madvig, *Kleine philologische Schriften* (1875), and the list of articles in periodicals in Flemisch's edition (p. iv.).



**LICINIUS** [FLAVIUS GALERIUS VALERIUS LICINIANUS], Roman emperor, A.D. 307-324, of Illyrian peasant origin, was born probably about 250. After the death of Flavius Valerius Severus he was elevated to the rank of Augustus by Galerius, his former friend and companion in arms, on the 11th of November 307, receiving as his immediate command the provinces of Illyricum. On the death of Galerius, in May 311, he shared the entire empire with Maximinus, the Hellespont and the Thracian Bosphorus being the dividing line. In March 313 he married Constantia, half-sister of Constantine, at Mediolanum (Milan), in the following month inflicted a decisive defeat on Maximinus at Heraclea Pontica, and established himself master of the East, while his brother-in-law, Constantine, was supreme in the West. In 314 his jealousy led him to encourage a treasonable enterprise on the part of Bassianus against Constantine. When his perfidy became known a civil war ensued, in which he was twice severely defeated—first near Cibalae in Pannonia (October 8th, 314), and next in the plain of Mardia in Thrace; the outward reconciliation, which was effected in the following December, left Licinius in possession of Thrace, Asia Minor, Syria and Egypt, but added numerous provinces to the Western empire. In 323 Constantine, tempted by the “advanced age and unpopular vices” of his colleague, again declared war against him, and, having defeated his army at Adrianople (3rd of July 323), succeeded in shutting him up within the walls of Byzantium. The defeat of the superior fleet of Licinius by Flavius Julius Crispus, Constantine’s eldest son, compelled his withdrawal to Bithynia, where a last stand was made; the battle of Chrysopolis, near Chalcedon (18th of September), finally resulted in his submission. He was interned at Thessalonica and executed in the following year on a charge of treasonable correspondence with the barbarians.

See Zosimus ii. 7-28; Zonaras xiii. 1; Victor, *Caes.* 40, 41; Eutropius x. 3; Orosius vii. 28.



**LICINIUS CALVUS STOLO, GAIUS**, Roman statesman, the chief representative of the plebeian Licinian gens, was tribune in 377 B.C., consul in 361. His name is associated with the Licinian or Licinio-Sextian laws (proposed 377, passed 367), which practically ended the struggle between patricians and plebeians. He was himself fined for possessing a larger share of the public land than his own law allowed.

See **ROME**: *History*, II. “The Republic.”



**LICINIUS MACER CALVUS, GAIUS** (82-47 B.C.), Roman poet and orator, was the son of the annalist Licinius Macer. As a poet he is associated with his friend Catullus, whom he followed in style and choice of subjects. As an orator he was the leader of the opponents of the florid Asiatic school, who took the simplest Attic orators as their model and attacked even Cicero as wordy and artificial. Calvus held a correspondence on questions connected with rhetoric, perhaps (if the reading be correct) the *commentarii* alluded to by Tacitus (*Dialogus*, 23; compare also Cicero, *Ad Fam.* xv. 21). Twenty-one speeches by him are mentioned, amongst which the most famous were those delivered against Publius Vatinius. Calvus was very short of stature, and is alluded to by Catullus (Ode 53) as *Salaputium disertum* (eloquent Lilliputian).

For Cicero’s opinion see *Brutus*, 82; Quintilian x. I. 115; Tacitus, *Dialogus*, 18. 21; the monograph by F. Plessis (Paris, 1896) contains a collection of the fragments (verse and prose).



**LICODIA EUBEA**, a town of Sicily in the province of Catania, 4 m. W. of Vizzini, which is 39 m. S.W. of Catania by rail. Pop. (1901) 7033. The name Eubea was given to the place in 1872 owing to a false identification with the Greek city of Euboea, a colony of Leontini, founded probably early in the 6th century B.C. and taken by Gelon. The town occupies the site of an unknown Sicel city, the cemeteries of which have been explored. A few vases of the first period were found, but practically all the tombs explored in 1898 belonged to the fourth period (700-500 B.C.) and show the gradual process of Hellenization among the Sicels.

See *Römische Mitteilungen*, 1898, 305 seq.; *Notizie degli scavi*, 1902, 219.

(T. As.)



**LICTORS** (*lictiores*), in Roman antiquities, a class of the attendants (*apparitores*) upon certain Roman and provincial magistrates.<sup>1</sup> As an institution (supposed by some to have been borrowed from Etruria) they went back to the regal period and continued to exist till imperial times. The majority of the city lictors were freedmen; they formed a corporation divided into decuries, from which the lictors of the magistrates in office were drawn; provincial officials had the nomination of their own. In Rome they wore the toga, perhaps girded up; on a campaign and at the celebration of a triumph, the red military cloak (*sagulum*); at funerals, black. As representatives of magistrates who possessed the *imperium*, they carried the fasces and axes in front of them (see **FASCES**). They were exempt from military service; received a fixed salary; theoretically they were nominated for a year, but really for life. They were the constant attendants, both in and out of the house, of the magistrate to whom they were attached. They walked before him in Indian file, cleared a passage for him (*summovere*) through the crowd, and saw that he was received with the marks of respect due to his rank. They stood by him when he took his seat on the tribunal; mounted guard before his house, against the wall of which they stood the fasces; summoned offenders before him, seized, bound and scourged them, and (in earlier times) carried out the death sentence. It should be noted that directly a magistrate entered an allied, independent state, he was obliged to dispense with his lictors. The king had twelve lictors; each of the consuls (immediately after their institution) twelve, subsequently limited to the monthly officiating consul, although Caesar appears to have restored the original arrangement; the dictator, as representing both consuls, twenty-four; the emperors twelve, until the time of Domitian, who had twenty-four. The Flamen Dialis, each of the Vestals, the *magister-vicorum* (overseer of the sections into which the city was divided) were also accompanied by lictors. These lictors were probably supplied from the *lictiores curiatii*, thirty in number, whose functions were specially religious, one of them being in attendance on the pontifex maximus. They originally summoned the comitia curiata, and when its meetings became merely a formality, acted as the representatives of that assembly. Lictors were also assigned to private individuals at the celebration of funeral games, and to the aediles at the games provided by them and the theatrical representations under their supervision.

For the fullest account of the lictors, see Mommsen, *Römisches Staatsrecht*, i. 355, 374 (3rd ed., 1887).

- <sup>1</sup> The Greek equivalents of *lictior* are *ῥαβδοῦχος*, *ῥαβδοφόρος*, *ῥαβδονόμος* (rod-bearer); the Latin word is variously derived from: (a) *ligere*, to bind or arrest a criminal; (b) *licere*, to summon, as convoking assemblies or haling offenders before the magistrate; (c) *licium*, the girdle with which (according to some) their toga was held up; (d) Plutarch (*Quaestiones Romanae*, 67), assuming an older form *λιτωρ*, suggests an identification with *λειτουργός*, one who performs a public office.



**LIDDELL, HENRY GEORGE** (1811-1898), English scholar and divine, eldest son of the Rev. Henry George Liddell, younger brother of the first Baron Ravensworth, was born at Binchester, near Bishop Auckland, on the 6th of February 1811. He was educated at Charterhouse and Christ Church, Oxford. Gaining a double first in 1833, Liddell became a college tutor, and was ordained in 1838. In the same year Dean Gaisford appointed him Greek reader in Christ Church, and in 1846 he was appointed to the headmastership of Westminster School. Meanwhile his life work, the great *Lexicon* (based on the German work of F. Passow), which he and Robert Scott began as early as 1834, had made good progress, and the first edition appeared in 1843. It immediately became the standard Greek-English dictionary and still maintains this rank, although, notwithstanding the great additions made of late to our Greek vocabulary from inscriptions, papyri and other sources, scarcely any enlargement has been made since about 1880. The 8th edition was published in 1897. As headmaster of Westminster Liddell enjoyed a period of great success, followed by trouble due to the outbreak of fever and cholera in the school. In 1855 he accepted the deanery of Christ Church, then vacant by the death of Gaisford. In the same year he brought out a *History of Ancient Rome* (much used in an abridged form as the *Student's History of Rome*) and took a very active part in the first Oxford University Commission. His tall figure, fine presence and aristocratic mien were for many years associated with all that was characteristic of Oxford life. Coming just at the transition period when the "old Christ Church," which Pusey strove so hard to preserve, was inevitably becoming broader and more liberal, it was chiefly due to Liddell that necessary changes were effected with the minimum of friction. In 1859 Liddell welcomed the then prince of Wales when he matriculated at Christ Church, being the first holder of that title who had matriculated since Henry V. In conjunction with Sir Henry Acland, Liddell did much to encourage the study of art at Oxford, and his taste and judgment gained him the admiration and friendship of Ruskin. In 1891, owing to advancing years, he resigned the deanery. The last years of his life were spent at Ascot, where he died on the 18th of January 1898. Dean Liddell married in July 1846 Miss Lorina Reeve (d. 1910), by whom he had a numerous family.

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



**LIDDESDALE**, the valley of Liddel Water, Roxburghshire, Scotland, extending in a south-westerly direction from the vicinity of Peel Fell to the Esk, a distance of 21 m. The Waverley route of the North British railway runs down the dale, and the Catrail, or Picts' Dyke, crosses its head. At one period the points of vantage on the river and its affluents were occupied with freebooters' peel-towers, but many of them have disappeared

and the remainder are in decay. Larriston Tower belonged to the Elliots, Mangerton to the Armstrongs and Park to "little Jock Elliot," the outlaw who nearly killed Bothwell in an encounter in 1566. The chief point of interest in the valley, however, is Hermitage Castle, a vast, massive H-shaped fortress of enormous strength, one of the oldest baronial buildings in Scotland. It stands on a hill overlooking Hermitage Water, a tributary of the Liddel. It was built in 1244 by Nicholas de Soulis and was captured by the English in David II.'s reign. It was retaken by Sir William Douglas, who received a grant of it from the king. In 1492 Archibald Douglas, 5th earl of Angus, exchanged it for Bothwell Castle on the Clyde with Patrick Hepburn, 1st earl of Bothwell. It finally passed to the duke of Buccleuch, under whose care further ruin has been arrested. It was here that Sir Alexander Ramsay of Dalhousie was starved to death by Sir William Douglas in 1342, and that James Hepburn, 4th earl of Bothwell, was visited by Mary, queen of Scots, after the assault referred to.

To the east of the castle is Ninestane Rig, a hill 943 ft. high, 4 m. long and 1 m. broad, where it is said that William de Soulis, hated for oppression and cruelty, was (in 1320) boiled by his own vassals in a copper cauldron, which was supported on two of the nine stones which composed the "Druidical" circle that gave the ridge its name. Only five of the stones remain. James Telfer (1802-1862), the writer of ballads, who was born in the parish of Southdean (pronounced Soudan), was for several years schoolmaster of Saughtree, near the head of the valley. The castle of the lairds of Liddesdale stood near the junction of Hermitage Water and the Liddel and around it grew up the village of Castleton.



**LIDDON, HENRY PARRY** (1829-1890), English divine, was the son of a naval captain and was born at North Stoneham, Hampshire, on the 20th of August 1829. He was educated at King's College School, London, and at Christ Church, Oxford, where he graduated, taking a second class, in 1850. As vice-principal of the theological college at Cuddesdon (1854-1859) he wielded considerable influence, and, on returning to Oxford as vice-principal of St Edmund's Hall, became a growing force among the undergraduates, exercising his influence in strong opposition to the liberal reaction against Tractarianism, which had set in after Newman's secession in 1845. In 1864 the bishop of Salisbury (W. K. Hamilton), whose examining chaplain he had been, appointed him prebendary of Salisbury cathedral. In 1866 he delivered his Bampton Lectures on the doctrine of the divinity of Christ. From that time his fame as a preacher, which had been steadily growing, may be considered established. In 1870 he was made canon of St Paul's Cathedral, London. He had before this published *Some Words for God*, in which, with great power and eloquence, he combated the scepticism of the day. His preaching at St Paul's soon attracted vast crowds. The afternoon sermon, which fell to the lot of the canon in residence, had usually been delivered in the choir, but soon after Liddon's appointment it became necessary to preach the sermon under the dome, where from 3000 to 4000 persons used to gather to hear the preacher. Few orators belonging to the Church of England have acquired so great a reputation as Liddon. Others may have surpassed him in originality, learning or reasoning power, but for grasp of his subject, clearness of language, lucidity of arrangement, felicity of illustration, vividness of imagination, elegance of diction, and above all, for sympathy with the intellectual position of those whom he addressed, he has hardly been rivalled. In the elaborate arrangement of his matter he is thought to have imitated the great French preachers of the age of Louis XIV. In 1870 he had also been made Ireland professor of exegesis at Oxford. The combination of the two appointments gave him extensive influence over the Church of England. With Dean Church he may be said to have restored the waning influence of the Tractarian school, and he succeeded in popularizing the opinions which, in the hands of Pusey and Keble, had appealed to thinkers and scholars. His forceful spirit was equally conspicuous in his opposition to the Church Discipline Act of 1874, and in his denunciation of the Bulgarian atrocities of 1876. In 1882 he resigned his professorship and utilized his thus increased leisure by travelling in Palestine and Egypt, and showed his interest in the Old Catholic movement by visiting Döllinger at Munich. In 1886 he became chancellor of St Paul's, and it is said that he declined more than one offer of a bishopric. He died on the 9th of September 1890, in the full vigour of his intellect and at the zenith of his reputation. He had undertaken and nearly completed an elaborate life of Dr Pusey, for whom his admiration was unbounded; and this work was completed after his death by Messrs Johnston and Wilson. Liddon's great influence during his life was due to his personal fascination and the beauty of his pulpit oratory rather than to any high qualities of intellect. As a theologian his outlook was that of the 16th rather than the 19th century; and, reading his Bampton Lectures now, it is difficult to realize how they can ever have been hailed as a great contribution to Christian apologetics. To the last he maintained the narrow standpoint of Pusey and Keble, in defiance of all the developments of modern thought and modern scholarship; and his latter years were embittered by the consciousness that the younger generation of the disciples of his school were beginning to make friends of the Mammon of scientific unrighteousness. The publication in 1889 of *Lux Mundi*, a series of essays attempting to harmonize Anglican Catholic doctrine with modern thought, was a severe blow to him, for it showed that even at the Pusey House, established as the citadel of Puseyism at Oxford, the principles of Pusey were being departed from. Liddon's importance is now mainly historical. He was the last of the classical pulpit orators of the English Church, the last great popular exponent of the traditional Anglican orthodoxy. Besides the works mentioned, Liddon published several volumes of *Sermons*, a volume of Lent lectures entitled *Some Elements of Religion* (1870), and a collection of *Essays and Addresses* on such themes as Buddhism, Dante, &c.

See *Life and Letters*, by J. O. Johnston (1904); G. W. E. Russell, *H. P. Liddon* (1903); A. B. Donaldson, *Five Great Oxford Leaders* (1900), from which the life of Liddon was reprinted separately in 1905.





**LIE, JONAS LAURITZ EDEMIL** (1833-1908), Norwegian novelist, was born on the 6th of November 1833 close to Hougsund (Eker), near Drammen. In 1838, his father being appointed sheriff of Tromsø, the family removed to that Arctic town. Here the future novelist enjoyed an untrammelled childhood among the shipping of the little Nordland capital, and gained acquaintance with the wild seafaring life which he was afterwards to describe. In 1846 he was sent to the naval school at Frederiksvaern, but his extreme near-sight unfitted him for the service, and he was transferred to the Latin school at Bergen. In 1851 he went to the university of Christiania, where Ibsen and Björnson were among his fellow-students. Jonas Lie, however, showed at this time no inclination to literature. He pursued his studies as a lawyer, took his degrees in law in 1858, and settled down to practice as a solicitor in the little town of Kongsvinger. In 1860 he married his cousin, Thomasine Lie, whose collaboration in his work he acknowledged in 1893 in a graceful article in the *Samtiden* entitled "Min hustru." In 1866 he published his first book, a volume of poems. He made unlucky speculations in wood, and the consequent financial embarrassment induced him to return to Christiania to try his luck as a man of letters. As a journalist he had no success, but in 1870 he published a melancholy little romance, *Den Fremsynte* (Eng. trans., *The Visionary*, 1894), which made him famous. Lie proceeded to Rome, and published *Tales* in 1871 and *Tremasteren "Fremtiden"* (Eng. trans., *The Barque "Future,"* Chicago, 1879), a novel, in 1872. His first great book, however, was *Lodsen og hans Hustru (The Pilot and his Wife)*, 1874, which placed him at the head of Norwegian novelists; it was written in the little town of Rocca di Papa in the Albano mountains. From that time Lie enjoyed, with Björnson and Ibsen, a stipend as poet from the Norwegian government. Lie spent the next few years partly in Dresden, partly in Stuttgart, with frequent summer excursions to Berchtesgaden in the Bavarian highlands. During his exile he produced the drama in verse called *Faustina Strozzi* (1876). Returning to Norway, Lie began a series of romances of modern life in Christiania, of which *Thomas Ross* (1878) and *Adam Schrader* (1879) were the earliest. He returned to Germany, and settled first in Dresden again, then in Hamburg, until 1882, when he took up his abode in Paris, where he lived in close retirement in the society of Scandinavian friends. His summers were spent at Berchtesgaden in Tirol. The novels of his German period are *Rutland* (1881) and *Gaa paa ("Go Ahead!")* 1882, tales of life in the Norwegian merchant navy. His subsequent works, produced with great regularity, enjoyed an immense reputation in Norway. Among the best of them are: *Livsslaven* (1883, Eng. trans., "One of Life's Slaves," 1895); *Familjen paa Gilje ("The Family of Gilje,"* 1883); *Malstroem* (1885), describing the gradual ruin of a Norwegian family; *Et Samliv ("Life in Common,"* 1887), describing a marriage of convenience. Two of the most successful of his novels were *The Commodore's Daughters* (1886) and *Niobe* (1894), both of which were presented to English readers in the International library, edited by Mr Gosse. In 1891-1892 he wrote, under the influence of the new romantic impulse, twenty-four folk-tales, printed in two volumes entitled *Trold*. Some of these were translated by R. N. Bain in *Weird Tales* (1893), illustrated by L. Housman. Among his later works were the romance *Naar Sol gaar ned ("When the Sun goes down,"* 1895), the powerful novel of *Dyre Rein* (1896), the fairy drama of *Lindeliv* (1897), *Faste Forland* (1899), a romance which contains much which is autobiographical, *When the Iron Curtain falls* (1901), and *The Consul* (1904). *His Samlede Vaerker* were published at Copenhagen in 14 vols. (1902-1904). Jonas Lie left Paris in 1891, and, after spending a year in Rome, returned to Norway, establishing himself at Holskogen, near Christiansand. He died at Christiania on the 5th of July 1908. As a novelist he stands with those minute and unobtrusive painters of contemporary manners who defy arrangement in this or that school. He is with Mrs Gaskell or Ferdinand Fabre; he is not entirely without relation with that old-fashioned favourite of the public, Fredrika Bremer.

590

His son, Erik Lie (b. 1868), published a successful volume of stories, *Med Blyanten*, in 1890; and is also the author of various works on literary history. An elder son, Mons Lie (b. 1864), studied the violin in Paris, but turned to literature in 1894. Among his works are the plays *Tragedier om Kjaerlighed* (1897); *Lombardo and Agrippina* (1898); *Don Juan* (1900); and the novels, *Sjöfärerren* (1901); *Adam Ravn* (1903) and *I Kvindensnet* (1904).

(E. G.)



**LIE, MARIUS SOPHUS** (1842-1899), Norwegian mathematician, was born at Nordfjordeif, near Bergen, on the 17th of December 1842, and was educated at the university of Christiania, where he took his doctor's degree in 1868 and became extraordinary professor of mathematics (a chair created specially for him) four years later. In 1886 he was chosen to succeed Felix Klein in the chair of geometry at Leipzig, but as his fame grew a special post was arranged for him in Christiania. But his health was broken down by too assiduous study, and he died at Christiania on the 18th of February 1899, six months after his return. Lie's work exercised a great influence on the progress of mathematical science during the later decades of the 19th century. His primary aim has been declared to be the advancement and elaboration of the theory of differential equations, and it was with this end in view that he developed his theory of transformation groups, set forth in his *Theorie der Transformationsgruppen* (3 vols., Leipzig, 1888-1893), a work of wide range and great originality, by which probably his name is best known. A special application of his theory of continuous groups was to the general problem of non-Euclidean geometry. The latter part of the book above mentioned was devoted to a study of the foundations of geometry, considered from the standpoint of B. Riemann and H. von Helmholtz; and he intended to publish a systematic exposition of his geometrical investigations, in conjunction with Dr G. Scheffers, but only one volume made its appearance (*Geometrie der Berührungstransformationen*, Leipzig, 1896). Lie was a foreign member of the Royal Society, as well as an honorary member of the Cambridge Philosophical Society and the London Mathematical Society, and his geometrical inquiries gained him the much-coveted honour of the Lobatchewsky prize.

An analysis of Lie's works is given in the *Bibliotheca Mathematica* (Leipzig, 1900).



**LIEBER, FRANCIS** (1800-1872), German-American publicist, was born at Berlin on the 18th of March 1800. He served with his two brothers under Blücher in the campaign of 1815, fighting at Ligny, Waterloo and Namur, where he was twice dangerously wounded. Shortly afterwards he was arrested for his political sentiments, the chief evidence against him being several songs of liberty which he had written. After several months he was discharged without a trial, but was forbidden to pursue his studies at the Prussian universities. He accordingly went to Jena, where he took his degrees in 1820, continuing his studies at Halle and Dresden. He subsequently took part in the Greek War of Independence, publishing his experiences in his *Journal in Greece* (Leipzig, 1823, and under the title *The German Anacharsis*, Amsterdam, 1823). For a year he was in Rome as tutor to the son of the historian Niebuhr, then Prussian ambassador. Returning to Berlin in 1823, he was imprisoned at Koepenik, but was released after some months through the influence of Niebuhr. In 1827 he went to the United States and as soon as possible was naturalized as a citizen. He settled at Boston, and for five years edited *The Encyclopaedia Americana* (13 vols.). From 1835 to 1856 he was professor of history and political economy in South Carolina College at Columbia, S.C., and during this period wrote his three chief works, *Manual of Political Ethics* (1838), *Legal and Political Hermeneutics* (1839), and *Civil Liberty and Self Government* (1853). In 1856 he resigned and next year was elected to a similar post in Columbia College, New York, and in 1865 became professor of constitutional history and public law in the same institution. During the Civil War Lieber rendered services of great value to the government. He was one of the first to point out the madness of secession, and was active in upholding the Union. He prepared, upon the requisition of the president, the important *Code of War for the Government of the Armies of the United States in the Field*, which was promulgated by the Government in General Orders No. 100 of the war department. This code suggested to Bluntschli his codification of the law of nations, as may be seen in the preface to his *Droit International Codifié*. During this period also Lieber wrote his *Guerilla Parties with Reference to the Laws and Usages of War*. At the time of his death he was the umpire of the commission for the adjudication of Mexican claims. He died on the 2nd of October 1872. His books were acquired by the University of California, and his papers were placed in the Johns Hopkins University.

His *Miscellaneous Writings* were published by D. C. Gilman (Philadelphia, 1881). See T. S. Perry, *Life and Letters* (1882), and biography by Harby (1899).



**LIEBERMANN, MAX** (1849- ), German painter and etcher, was born in Berlin. After studying under Steffek, he entered the school of art at Weimar in 1869. Though the straightforward simplicity of his first exhibited picture, "Women plucking Geese," in 1872, presented already a striking contrast to the conventional art then in vogue, it was heavy and bituminous in colour, like all the artist's paintings before his visit to Paris at the end of 1872. A summer spent at Barbizon in 1873, where he became personally acquainted with Millet and had occasion to study the works of Corot, Troyon, and Daubigny, resulted in the clearing and brightening of his palette, and taught him to forget the example of Munkacsy, under whose influence he had produced his first pictures in Paris. He subsequently went to Holland, where the example of Israels confirmed him in the method he had adopted at Barbizon; but on his return to Munich in 1878 he caused much unfavourable criticism by his realistic painting of "Christ in the Temple," which was condemned by the clergy as irreverent and remained his only attempt at a scriptural subject. Henceforth he devoted himself exclusively to the study of free-light and to the painting of the life of humble folk. He found his best subjects in the orphanages and asylums for the old in Amsterdam, among the peasants in the fields and village streets of Holland, and in the beer-gardens, factories, and workrooms of his own country. Germany was reluctant, however, in admitting the merit of an artist whose style and method were so markedly at variance with the time-honoured academic tradition. Only when his fame was echoed back from France, Belgium, and Holland did his compatriots realize the eminent position which is his due in the history of German art. It is hardly too much to say that Liebermann has done for his country what Millet did for France. His pictures hold the fragrance of the soil and the breezes of the heavens. His people move in their proper atmosphere, and their life is stated in all its monotonous simplicity, without artificial pathos or melodramatic exaggeration. His first success was a medal awarded him for "An Asylum for Old Men" at the 1881 Salon. In 1884 he settled again in Berlin, where he became professor of the Academy in 1898. He became a member of the Société nationale des Beaux Arts, of the Société royale belge des Aquarellistes, and of the Cercle des Aquarellistes at the Hague. Liebermann is represented in most of the German and other continental galleries. The Berlin National Gallery owns "The Flax-Spinners"; the Munich Pinakothek, "The Woman with Goats"; the Hamburg Gallery, "The Net-Menders"; the Hanover Gallery, the "Village Street in Holland." "The Seamstress" is at the Dresden Gallery; the "Man on the Dunes" at Leipzig; "Dutch Orphan Girls" at Strassburg; "Beer-cellar at Brandenburg" at the Luxembourg Museum in Paris, and the "Knöpflerinnen" in Venice. His etchings are to be found in the leading print cabinets of Europe.



**LIEBIG, JUSTUS VON**, BARON (1803-1873), German chemist, was born at Darmstadt, according to his baptismal certificate, on the 12th of May 1803 (4th of May, according to his mother). His father, a drysalter and dealer in colours, used sometimes to make experiments in the hope of finding improved processes for the production of his wares, and thus his son early acquired familiarity with practical chemistry. For the theoretical side he read all the text-books which he could find, somewhat to the detriment of his ordinary school studies.

Having determined to make chemistry his profession, at the age of fifteen he entered the shop of an apothecary at Appenheim, near Darmstadt; but he soon found how great is the difference between practical pharmacy and scientific chemistry, and the explosions and other incidents that accompanied his private efforts to increase his chemical knowledge disposed his master to view without regret his departure at the end of ten months. He next entered the university of Bonn, but migrated to Erlangen when the professor of chemistry, K. W. G. Kastner (1783-1857), was appointed in 1821 to the chair of physics and chemistry at the latter university. He followed this professor to learn how to analyse certain minerals, but in the end he found that the teacher himself was ignorant of the process. Indeed, as he himself said afterwards, it was a wretched time for chemistry in Germany. No laboratories were accessible to ordinary students, who had to content themselves with what the universities could give in the lecture-room and the library, and though both at Bonn and Erlangen Liebig endeavoured to make up for the deficiencies of the official instruction by founding a students' physical and chemical society for the discussion of new discoveries and speculations, he felt that he could never become a chemist in his own country. Therefore, having graduated as Ph.D. in 1822, he left Erlangen—where he subsequently complained that the contagion of the "greatest philosopher and metaphysician of the century" (Schelling), in a period "rich in words and ideas, but poor in true knowledge and genuine studies," had cost him two precious years of his life—and by the liberality of Louis I., grand-duke of Hesse-Darmstadt, was enabled to go to Paris. By the help of L. J. Thénard he gained admission to the private laboratory of H. F. Gaultier de Claubry (1792-1873), professor of chemistry at the École de Pharmacie, and soon afterwards, by the influence of A. von Humboldt, to that of Gay-Lussac, where in 1824 he concluded his investigations on the composition of the fulminates. It was on Humboldt's advice that he determined to become a teacher of chemistry, but difficulties stood in his way. As a native of Hesse-Darmstadt he ought, according to the academical rules of the time, to have studied and graduated at the university of Giessen, and it was only through the influence of Humboldt that the authorities forgave him for straying to the foreign university of Erlangen. After examination his Erlangen degree was recognized, and in 1824 he was appointed extraordinary professor of chemistry at Giessen, becoming ordinary professor two years later. In this small town his most important work was accomplished. His first care was to persuade the Darmstadt government to provide a chemical laboratory in which the students might obtain a proper practical training. This laboratory, unique of its kind at the time, in conjunction with Liebig's unrivalled gifts as a teacher, soon rendered Giessen the most famous chemical school in the world; men flocked from every country to enjoy its advantages, and many of the most accomplished chemists of the 19th century had to thank it for their early training. Further, it gave a great impetus to the progress of chemical education throughout Germany, for the continued admonitions of Liebig combined with the influence of his pupils induced many other universities to build laboratories modelled on the same plan. He remained at Giessen for twenty-eight years, until in 1852 he accepted the invitation of the Bavarian government to the ordinary chair of chemistry at Munich university, and this office he held, although he was offered the chair at Berlin in 1865, until his death, which occurred at Munich on the 10th of April 1873.

Apart from Liebig's labours for the improvement of chemical teaching, the influence of his experimental researches and of his contributions to chemical thought was felt in every branch of the science. In regard to methods and apparatus, mention should be made of his improvements in the technique of organic analysis, his plan for determining the natural alkaloids and for ascertaining the molecular weights of organic bases by means of their chloroplatinates, his process for determining the quantity of urea in a solution—the first step towards the introduction of precise chemical methods into practical medicine—and his invention of the simple form of condenser known in every laboratory. His contributions to inorganic chemistry were numerous, including investigations on the compounds of antimony, aluminium, silicon, &c., on the separation of nickel and cobalt, and on the analysis of mineral waters, but they are outweighed in importance by his work on organic substances. In this domain his first research was on the fulminates of mercury and silver, and his study of these bodies led him to the discovery of the isomerism of cyanic and fulminic acids, for the composition of fulminic acid as found by him was the same as that of cyanic acid, as found by F. Wöhler, and it became necessary to admit them to be two bodies which differed in properties, though of the same percentage composition. Further work on cyanogen and connected substances yielded a great number of interesting derivatives, and he described an improved method for the manufacture of potassium cyanide, an agent which has since proved of enormous value in metallurgy and the arts. In 1832 he published, jointly with Wöhler, one of the most famous papers in the history of chemistry, that on the oil of bitter almonds (benzaldehyde), wherein it was shown that the radicle benzoyl might be regarded as forming an unchanging constituent of a long series of compounds obtained from oil of bitter almonds, throughout which it behaved like an element. Berzelius hailed this discovery as marking the dawn of a new era in organic chemistry, and proposed for benzoyl the names "Proïn" or "Orthrin" (from πρωϊν and ὀρθρινος). A continuation of their work on bitter almond oil by Liebig and Wöhler, who remained firm friends for the rest of their lives, resulted in the elucidation of the mode of formation of that substance and in the discovery of the ferment emulsin as well as the recognition of the first glucoside, amygdalin, while another and not less important and far-reaching inquiry in which they collaborated was that on uric acid, published in 1837. About 1832 he began his investigations into the constitution of ether and alcohol and their derivatives. These on the one hand resulted in the enunciation of his ethyl theory, by the light of which he looked upon those substances as compounds of the radicle ethyl ( $C_2H_5$ ), in opposition to the view of J. B. A. Dumas, who regarded them as hydrates of olefiant gas (ethylene); on the other they yielded chloroform, chloral and aldehyde, as well as other compounds of less general interest, and also the method of forming mirrors by depositing silver from a slightly ammoniacal solution by acet aldehyde. In 1837 with Dumas he published a note on the constitution of organic acids, and in the following year an elaborate paper on the same subject appeared under his own name alone; by this work T. Graham's doctrine of polybasicity was extended to the organic acids. Liebig also did much to further the hydrogen theory of acids.

These and other studies in pure chemistry mainly occupied his attention until about 1838, but the last thirty-five years of his life were devoted more particularly to the chemistry of the processes of life, both animal and vegetable. In animal physiology he set himself to trace out the operation of determinate chemical and physical laws in the maintenance of life and health. To this end he examined such immediate vital products as blood, bile and urine; he analysed the juices of flesh, establishing the composition of creatin and investigating its decomposition products, creatinin and sarcosin; he classified the various articles of food in accordance with the special function performed by each in the animal economy, and expounded the philosophy of cooking; and in opposition to many of the medical opinions of his time taught that the heat of the body is the result of the processes of combustion and oxidation performed within the organism. A secondary result of this line of study was the preparation of his food for infants and of his extract of meat. Vegetable physiology he pursued with special reference to agriculture, which he held to be the foundation of all trade and industry, but which could not

be rationally practised without the guidance of chemical principles. His first publication on this subject was *Die Chemie in ihrer Anwendung auf Agricultur und Physiologie* in 1840, which was at once translated into English by Lyon Playfair. Rejecting the old notion that plants derive their nourishment from humus, he taught that they get carbon and nitrogen from the carbon dioxide and ammonia present in the atmosphere, these compounds being returned by them to the atmosphere by the processes of putrefaction and fermentation—which latter he regarded as essentially chemical in nature—while their potash, soda, lime, sulphur, phosphorus, &c., come from the soil. Of the carbon dioxide and ammonia no exhaustion can take place, but of the mineral constituents the supply is limited because the soil cannot afford an indefinite amount of them; hence the chief care of the farmer, and the function of manures, is to restore to the soil those minerals which each crop is found, by the analysis of its ashes, to take up in its growth. On this theory he prepared artificial manures containing the essential mineral substances together with a small quantity of ammoniacal salts, because he held that the air does not supply ammonia fast enough in certain cases, and carried out systematic experiments on ten acres of poor sandy land which he obtained from the town of Giessen in 1845. But in practice the results were not wholly satisfactory, and it was a long time before he recognized one important reason for the failure in the fact that to prevent the alkalis from being washed away by the rain he had taken pains to add them in an insoluble form, whereas, as was ultimately suggested to him by experiments performed by J. T. Way about 1850, this precaution was not only superfluous but harmful, because the soil possesses a power of absorbing the soluble saline matters required by plants and of retaining them, in spite of rain, for assimilation by the roots.

Liebig's literary activity was very great. The Royal Society's *Catalogue of Scientific Papers* enumerates 318 memoirs under his name, exclusive of many others published in collaboration with other investigators. A certain impetuosity of character which disposed him to rush into controversy whenever doubt was cast upon the views he supported accounted for a great deal of writing, and he also carried on an extensive correspondence with Wöhler and other scientific men. In 1832 he founded the *Annalen der Pharmazie*, which became the *Annalen der Chemie und Pharmazie* in 1840 when Wöhler became joint-editor with himself, and in 1837 with Wöhler and Poggendorff he established the *Handwörterbuch der reinen und angewandten Chemie*. After the death of Berzelius he continued the *Jahresbericht* with H. F. M. Kopp. The following are his most important separate publications, many of which were translated into English and French almost as soon as they appeared: *Anleitung zur Analyse der organischen Körper* (1837); *Die Chemie in ihrer Anwendung auf Agricultur und Physiologie* (1840); *Die Thier-Chemie oder die organische Chemie in ihrer Anwendung auf Physiologie und Pathologie* (1842); *Handbuch der organischen Chemie mit Rücksicht auf Pharmazie* (1843); *Chemische Briefe* (1844); *Chemische Untersuchungen über das Fleisch und seine Zubereitung zum Nahrungsmittel* (1847); *Die Grundsätze der Agricultur-Chemie* (1855); *Über Theorie und Praxis in der Landwirthschaft* (1856); *Naturwissenschaftliche Briefe über die moderne Landwirtschaft* (1859). A posthumous collection of his miscellaneous addresses and publications appeared in 1874 as *Reden und Abhandlungen*, edited by his son George (b. 1827). His criticism of Bacon, *Über Francis von Verulam*, was first published in 1863 in the *Augsburger allgemeine Zeitung*, where also most of his letters on chemistry made their first appearance.

See *The Life Work of Liebig* (London, 1876), by his pupil A. W. von Hofmann, which is the Faraday lecture delivered before the London Chemical Society in March 1875, and is reprinted in Hofmann's *Zur Erinnerung an vorangegangene Freunde*; also W. A. Shenstone, *Justus von Liebig, his Life and Work* (1895).



**LIEBKNECHT, WILHELM** (1826-1900), German socialist, was born at Giessen on the 29th of March 1826. Left an orphan at an early age, he was educated at the gymnasium in his native town, and attended the universities of Giessen, Bonn and Marburg. Before he left school he had become affected by the political discontent then general in Germany; he had already studied the writings of St Simon, from which he gained his first interest in communism, and had been converted to the extreme republican theories of which Giessen was a centre. He soon came into conflict with the authorities, and was expelled from Berlin apparently in consequence of the strong sympathy he displayed for some Poles, who were being tried for high treason. He proposed in 1846 to migrate to America, but went instead to Switzerland, where he earned his living as a teacher. As soon as the revolution of 1848 broke out he hastened to Paris, but the attempt to organize a republican corps for the invasion of Germany was prevented by the government. In September, however, in concert with Gustav von Struve, he crossed the Rhine from Switzerland at the head of a band of volunteers, and proclaimed a republic in Baden. The attempt collapsed; he was captured, and, after suffering eight months' imprisonment, was brought to trial. Fortunately for him, a new rising had just broken out; the mob burst into the court, and he was acquitted. During the short duration of the revolutionary government he was an active member of the most extreme party, but on the arrival of the Prussian troops he succeeded in escaping to France. Thence he went to Geneva, where he came into intercourse with Mazzini; but, unlike most of the German exiles, he was already an adherent of the socialist creed, which at that time was more strongly held in France. Expelled from Switzerland he went to London, where he lived for thirteen years in close association with Karl Marx. He endured great hardships, but secured a livelihood by teaching and writing; he was a correspondent of the *Augsburger Allgemeine Zeitung*. The amnesty of 1861 opened for him the way back to Germany, and in 1862 he accepted the post of editor of the *Norddeutsche Allgemeine Zeitung*, the founder of which was an old revolutionist. Only a few months elapsed before the paper, passed under Bismarck's influence. There is no more curious episode in German history than the success with which Bismarck acquired the services of many of the men of 1848, but Liebknecht remained faithful to his principles and resigned his editorship. He became a member of the Arbeiterverein, and after the death of Ferdinand Lassalle he was the chief mouthpiece in Germany of Karl Marx, and was instrumental in spreading the influence of the newly-founded *International*. Expelled from Prussia in 1865, he settled at Leipzig, and it is primarily to his activity in Saxony among the newly-formed unions of workers that the modern social democrat party owes its origin. Here he conducted the *Demokratisches Wochenblatt*. In 1867 he was elected a member of the North German Reichstag, but in opposition to Lassalle's followers he refused all compromise with the "capitalists," and avowedly used his position merely for purposes of agitation whilst taking every opportunity for making the parliament ridiculous. He was strongly influenced by the "great German" traditions of the democrats of 1848, and, violently anti-Prussian, he distinguished himself by his attacks on the policy of 1866 and

the "revolution from above," and by his opposition to every form of militarism. His adherence to the traditions of 1848 are also seen in his dread of Russia, which he maintained to his death. His opposition to the war of 1870 exposed him to insults and violence, and in 1872 he was condemned to two years' imprisonment in a fortress for treasonable intentions. The Union of the German Socialists in 1874 at the congress of Gotha was really a triumph of his influence, and from that time he was regarded as founder and leader of the party. From 1874 till his death he was a member of the German Reichstag, and for many years also of the Saxon diet. He was one of the chief spokesmen of the party, and he took a very important part in directing its policy. In 1881 he was expelled from Leipzig, but took up his residence in a neighbouring village. After the lapse of the Socialist law (1890) he became chief editor of the *Vorwärts*, and settled in Berlin. If he did not always find it easy in his later years to follow the new developments, he preserved to his death the idealism of his youth, the hatred both of Liberalism and of State Socialism; and though he was to some extent overshadowed by Bebel's greater oratorical power, he was the chief support of the orthodox Marxian tradition. Liebknecht was the author of numerous pamphlets and books, of which the most important were: *Robert Blum und seine Zeit* (Nuremberg, 1892); *Geschichte der Französischen Revolution* (Dresden, 1890); *Die Emser Depesche* (Nuremberg, 1899) and *Robert Owen* (Nuremberg, 1892). He died at Charlottenburg on the 6th of August 1900.

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



**LIECHTENSTEIN**, the smallest independent state in Europe, save San Marino and Monaco. It lies some way S. of the Lake of Constance, and extends along the right bank of the Rhine, opposite Swiss territory, between Sargans and Sennwald, while on the E. it also comprises the upper portion of the Samina glen that joins the Ill valley at Frastanz, above Feldkirch. It is about 12 m. in length, and covers an area of 61.4 or 68.8 sq. m. (according to different estimates). Its loftiest point rises at the S.E. angle of the state, in the Rhätikon range, and is named to Naafkopf or the Rothe Wand (8445 ft.); on its summit the Swiss, Vorarlberg, and Liechtenstein frontiers join. In 1901 the population was 9477 (of whom 4890 were women and 4587 men). The capital is Vaduz (1523 ft.), with about 1100 inhabitants, and 2 m. S. of the Schaan railway station, which is 2 m. from Buchs (Switz.). Even in the 17th century the Romonsch language was not extinguished in the state, and many Romonsch place-names still linger, e.g. Vaduz, Samina, Gavadura, &c. Now the population is German-speaking and Romanist. The constitution of 1862 was amended in 1878, 1895 and 1901. All males of 24 years of age are primary electors, while the diet consists of 12 members, holding their seats for 4 years and elected indirectly, together with 3 members nominated by the prince. The prince has a lieutenant resident at Vaduz, whence there is an appeal to the prince's court at Vienna, with a final appeal (since 1884) to the supreme district court at Innsbruck. Compulsory military service was abolished in 1868, the army having till then been 91 strong. The principality forms ecclesiastically part of the diocese of Coire, while as regards customs duties it is joined with the Vorarlberg, and as regards postal and coinage arrangements with Austria, which (according to the agreement of 1852, renewed in 1876, by which the principality entered the Austrian customs union) must pay it at least 40,000 crowns annually. In 1904 the revenues of the principality amounted to 888,931 crowns, and its expenditure to 802,163 crowns. There is no public debt.

593

The county of Vaduz and the lordship of Schellenberg passed through many hands before they were bought in 1613 by the count of Hohenems (to the N. of Feldkirch). In consequence of financial embarrassments, that family had to sell both (the lordship in 1699, the county in 1713) to the Liechtenstein family, which had since the 12th century owned two castles of that name (both now ruined), one in Styria and the other a little S.W. of Vienna. In 1719 these new acquisitions were raised by the emperor into a principality under the name of Liechtenstein, which formed part successively of the Holy Roman Empire (till 1806) and of the German Confederation (1815-1866), having been sovereign 1806-1815 as well as since 1866.

See J. Falke's *Geschichte d. fürstlichen Hauses Liechtenstein* (3 vols., Vienna, 1868-1883); J. C. Heer, *Vorarlberg und Liechtenstein* (Feldkirch, 1906); P. Kaiser, *Geschichte d. Fürstenthums Liechtenstein* (Coire, 1847); F. Umlauf, *Das Fürstenthum Liechtenstein* (Vienna, 1891); E. Walder, *Aus den Bergen* (Zürich, 1896); A. Waltenberger, *Algäu, Vorarlberg, und Westtirol* (Rtes. 25 and 26) (10th ed., Innsbruck, 1906).

(W. A. B. C.)



**LIÉGE**, one of the nine provinces of Belgium, touching on the east the Dutch province of Limburg and the German district of Rhenish Prussia. To a certain extent it may be assumed to represent the old prince-bishopric. Besides the city of Liége it contains the towns of Verviers, Dolhain, Seraing, Huy, &c. The Meuse flows through the centre of the province, and its valley from Huy down to Herstal is one of the most productive mineral districts in Belgium. Much has been done of late years to develop the agricultural resources of the Condruz district south of the Meuse. The area of the province is 723,470 acres, or 1130 sq. m. The population in 1904 was 863,254, showing an average of 763 per sq. m.



**LIÈGE** (Walloon, *Lige*, Flemish, *Luik*, Ger. *Lüttich*), the capital of the Belgian province that bears its name. It is finely situated on the Meuse, and was long the seat of a prince-bishopric. It is the centre of the Walloon country, and Scott commits a curious mistake in *Quentin Durward* in making its people talk Flemish. The Liège Walloon is the nearest existing approach to the old Romance language. The importance of the city to-day arises from its being the chief manufacturing centre in Belgium, and owing to its large output of arms it has been called the Birmingham of the Netherlands. The productive coal-mines of the Meuse valley, extending from its western suburb of Seraing to its northern faubourg of Herstal, constitute its chief wealth. At Seraing is established the famous manufacturing firm of Cockerill, whose offices are in the old summer palace of the prince-bishops.

The great cathedral of St Lambert was destroyed and sacked by the French in 1794, and in 1802 the church of St Paul, dating from the 10th century but rebuilt in the 13th, was declared the cathedral. The law courts are installed in the old palace of the prince-bishops, a building which was constructed by Bishop Everard de la Marck between 1508 and 1540. The new boulevards are well laid out, especially those flanking the river, and the views of the city and surrounding country are very fine. The university, which has separate schools for mines and arts and manufactures, is one of the largest in the country, and enjoys a high reputation for teaching in its special line.

Liège is a fortified position of far greater strength than is generally appreciated. In the wars of the 18th century Liège played but a small part. It was then defended only by the citadel and a detached fort on the right side of the Meuse, but at a short distance from the river, called the Chartreuse. Marlborough captured these forts in 1703 in preparation for his advance in the following year into Germany which resulted in the victory of Blenheim. The citadel and the Chartreuse were still the only defences of Liège in 1888 when, after long discussions, the Belgian authorities decided on adequately fortifying the two important passages of the Meuse at Liège and Namur. A similar plan was adopted at each place, viz. the construction of a number of detached forts along a perimeter drawn at a distance varying from 4 to 6 m. of the town, so as to shelter it so far as possible from bombardment. At Liège twelve forts were constructed, six on the right bank and six on the left. Those on the right bank beginning at the north and following an eastern curve are Barchon, Evegnée, Fléron, Chaudfontaine, Embourg and Boncelles. The average distance between each fort is 4 m., but Fléron and Chaudfontaine are separated by little over 1 m. in a direct line as they defend the main line of railway from Germany. The six forts on the left bank also commencing at the north, but following a western curve, are Pontisse, Liers, Lantin, Loncin, Hollogne and Flemalle. These forts were constructed under the personal direction of General Brialmont, and are on exactly the same principle as those he designed for the formidable defences of Bucearest. All the forts are constructed in concrete with casemates, and the heavy guns are raised and lowered automatically. Communication is maintained between the different forts by military roads in all cases, and by steam tramways in some. It is estimated that 25,000 troops would be required for the defence of the twelve forts, but the number is inadequate for the defence of so important and extensive a position. The population of Liège, which in 1875 was only 117,600, had risen by 1900 to 157,760, and in 1905 it was 168,532.

*History.*—Liège first appears in history about the year 558, at which date St Monulph, bishop of Tongres, built a chapel near the confluence of the Meuse and the Legia. A century later the town, which had grown up round this chapel, became the favourite abode of St Lambert, bishop of Tongres, and here he was assassinated. His successor St Hubert raised a splendid church over the tomb of the martyred bishop about 720 and made Liège his residence. It was not, however, until about 930 that the title bishop of Tongres was abandoned for that of bishop of Liège. The episcopate of Notger (972-1008) was marked by large territorial acquisitions, and the see obtained recognition as an independent principality of the Empire. The popular saying was "Liège owes Notger to God, and everything else to Notger." By the munificent encouragement of successive bishops Liège became famous during the 11th century as a centre of learning, but the history of the town for centuries records little else than the continuous struggles of the citizens to free themselves from the exactions of their episcopal sovereigns; the aid of the emperor and of the dukes of Brabant being frequently called in to repress the popular risings. In 1316 the citizens compelled Bishop Adolph de la Marck to sign a charter, which made large concessions to the popular demands. It was, however, a triumph of short duration, and the troubles continued, the insurgent subjects now and again obtaining a fleeting success, only to be crushed by the armies of the powerful relatives of the bishops, the houses of Brabant or of Burgundy. During the episcopate of Louis de Bourbon (1456-1484) the Liégeois, having expelled the bishop, had the temerity to declare war on Philip V., duke of Burgundy. Philip's son, Charles the Bold, utterly defeated them in 1467, and razed the walls of the town to the ground. In the following year the citizens again revolted, and Charles being once more successful delivered up the city to sack and pillage for three days, and deprived the remnant of the citizens of all their privileges. This incident is narrated in *Quentin Durward*. The long episcopate of Eberhard de la Marck (1505-1538) was a time of good administration and of quiet, during which the town regained something of its former prosperity. The outbreak of civil war between two factions, named the *Cluroux* and the *Grignoux*, marked the opening of the 17th century. Bishop Maximilian Henry of Bavaria (1650-1688) at last put an end to the internal strife and imposed a regulation (*règlement*) which abolished all the free institutions of the citizens and the power of the gilds. Between this date and the outbreak of the French Revolution the chief efforts of the prince-bishops were directed to maintaining neutrality in the various wars, and preserving their territory from being ravaged by invading armies. They were only in part successful. Liège was taken by Marlborough in 1702, and the fortress was garrisoned by the Dutch until 1718. The French revolutionary armies overran the principality in 1792, and from 1794 to the fall of Napoleon it was annexed to France, and was known as the department of the Ourthe. The Congress of Vienna in 1815 decreed that Liège with the other provinces of the southern Netherlands should form part of the new kingdom of the Netherlands under the rule of William I., of the house of Orange. The town of Liège took an active part in the Belgian revolt of 1830, and since that date the ancient principality has been incorporated in the kingdom of Belgium.

The see, which at first bore the name of the bishopric of Tongres, was under the metropolitan jurisdiction of the archbishops of Cologne. The principality comprised besides the town of Liège and its district, the counties of Looz and Hoorn, the marquessate of Franchimont, and the duchy of Bouillon.

AUTHORITIES.—Théodore Bouille, *Histoire de la ville et du pays de Liège* (3 vols., Liège, 1725-1732); A. Borgnet, *Histoire de la révolution liégeoise* (2 vols., Liège, 1865); Baron B. C. de Gerlache, *Histoire de Liège* (Brussels, 1843); J. Daris, *Histoire du diocèse et de la principauté de Liège* (10 vols., Liège, 1868-1885); Ferdinand Henaux, *Histoire du pays de Liège* (2 vols., Liège, 1857); L. Polain, *Histoire de l'ancien pays de Liège* (2 vols., Liège,



**LIEGE**, an adjective implying the mutual relationship of a feudal superior and his vassal; the word is used as a substantive of the feudal superior, more usually in this sense, however, in the form "liege lord," and also of the vassals, his "lieges." Hence the word is often used of the loyal subjects of a sovereign, with no reference to feudal ties. It appears that *ligeitas* or *ligentia*, the medieval Latin term for this relationship, was restricted to a particular form of homage. According to N. Broussel (*Nouvel examen de l'usage général des fiefs en France*, 1727) the homage of a "liege" was a stronger form of the ordinary homage, the especial distinction being that while the ordinary vassal only undertook forty days' military service, the liege promised to serve as long as the war might last, in which his superior was engaged (cf. Ducange, *Glossarium*, s.v. "*Ligius*").

The etymology of the word has been much discussed. It comes into English through the O. Fr. *lige* or *liege*, Med. Lat. *ligius*. This was early connected with the Lat. *ligatus*, bound, *ligare*, to bind, from the sense of the obligation of the vassal to his lord, but this has been generally abandoned. Broussel takes the Med. Lat. *liga*, i.e., *foedus*, *confederatio*, the English "league," as the origin. Ducange connects it with the word *lities*, which appears in a gloss of the Salic law, and is defined as a *scriptitius*, *servus glebae*. The more usually accepted derivation is now from the Old High Ger. *ledic*, or *ledig*, meaning "free" (Mod. Ger. *ledig* means unoccupied, *vacuus*). This is confirmed by the occurrence in a charter of Otto of Bentheim, 1253, of a word "ledigh-man" (quoted in Ducange, *Glossarium*, s.v.), *Proinde affecti sumus ligius homo, quod Teutonice dicitur Ledighman*. Skeat, in explaining the application of "free" to such a relationship as that subsisting between a feudal superior and his vassal, says "'a liege lord' seems to have been the lord of a free band; and his lieges, though serving under him, were privileged men, free from all other obligations; their name being due to their freedom, not to their service" (*Etym. Dict.*, ed. 1898). A. Luchaire (*Manuel des institutions françaises*, 1892, p. 189, n. 1) considers it difficult to call a man "free" who is under a strict obligation to another; further that the "liege" was not free from all obligation to a third party, for the charters prove without doubt that the "liege men" owed duty to more than one lord.



**LIEGNITZ**, a town in Germany, in the Prussian province of Silesia, picturesquely situated on the Katzbach, just above its junction with the Schwarzwasser, and 40 m. W.N.W. of Breslau, on the main line of railway to Berlin via Sommerfeld. Pop. (1885) 43,347, (1905) 59,710. It consists of an old town, surrounded by pleasant, shady promenades, and several well-built suburbs. The most prominent building is the palace, formerly the residence of the dukes of Liegnitz, rebuilt after a fire in 1835 and now used as the administrative offices of the district. The Ritter Akademie, founded by the emperor Joseph I. in 1708 for the education of the young Silesian nobles, was reconstructed as a gymnasium in 1810. The Roman Catholic church of St John, with two fine towers, contains the burial vault of the dukes. The principal Lutheran church, that of SS. Peter and Paul (restored in 1892-1894), dates from the 14th century. The manufactures are considerable, the chief articles made being cloth, wool, leather, tobacco, pianos and machinery. Its trade in grain and its cattle-markets are likewise important. The large market gardens in the suburbs grow vegetables of considerable annual value.

Liegnitz is first mentioned in an historical document in the year 1004. In 1163 it became the seat of the dukes of Liegnitz, who greatly improved and enlarged it. The dukes were members of the illustrious Piast family, which gave many kings to Poland. During the Thirty Years' War Liegnitz was taken by the Swedes, but was soon recaptured by the Imperialists. The Saxon army also defeated the imperial troops near Liegnitz in 1634. On the death of the last duke of Liegnitz in 1675, the duchy came into the possession of the Empire, which retained it until the Prussian conquest of Silesia in 1742. On the 15th of August 1760 Frederick the Great gained a decisive victory near Liegnitz over the Austrians, and in August 1813 Blücher defeated the French in the neighbourhood at the battle of the Katzbach. During the 19th century Liegnitz rapidly increased in population and prosperity. In 1906 the German autumn manœuvres were held over the terrain formerly the scene of the great battles already mentioned.

See Schuchard, *Die Stadt Liegnitz* (Berlin, 1868); Sammter and Kraffert, *Chronik von Liegnitz* (Liegnitz, 1861-1873); Jander, *Liegnitz in seinem Entwicklungsgange* (Liegnitz, 1905); and *Führer für Liegnitz und seine Umgebung* (Liegnitz, 1897); and the *Urkundenbuch der Stadt Liegnitz bis 1455*, edited by Schirrmacher (Liegnitz, 1866).



**LIEN**, in law. The word *lien* is literally the French for a band, cord or chain, and keeping in mind that meaning we see in what respect it differs from a pledge on the one hand and a mortgage on the other. It is the bond which attaches a creditor's right to a debtor's property, but which gives no right *ad rem*, i.e. to property in

the thing; if the property is in the possession of the creditor he may retain it, but in the absence of statute he cannot sell to recover what is due to him without the ordinary legal process against the debtor; and if it is not in possession, the law would indeed assist him to seize the property, and will hold it for him, and enable him to sell it in due course and pay himself out of the proceeds, but does not give him the property itself. It is difficult to say at what period the term lien made its appearance in English law; it probably came from more than one source. In fact, it was used as a convenient phrase for any right against the owner of property in regard to the property not specially defined by other better recognized species of title.

The possessory lien of a tradesman for work done on the thing, of a carrier for his hire, and of an innkeeper for his bill, would seem to be an inherent right which must have been in existence from the dawn, or before the dawn, of civilization. Probably the man who made or repaired weapons in the Stone Age was careful not to deliver them until he received what was stipulated for, but it is also probable that the term itself resulted from the infusion of the civil law of Rome into the common law of England which the Norman Conquest brought about, and that it represents the "tacit pledge" of the civil law. As might be expected, so far as the possessory lien is concerned the common law and civil law, and probably the laws of all countries, whether civilized or not, coincide; but there are many differences with respect to other species of lien. For instance, by the common law—in this respect a legacy of the feudal system—a landlord has a lien over his tenant's furniture and effects for rent due, which can be enforced without the assistance of the law simply by the landlord taking possession, personally or by his agent, and selling enough to satisfy his claim; whereas the maritime lien is more distinctly the product of the civil law, and is only found and used in admiralty proceedings, the high court of admiralty having been founded upon the civil law, and still (except so far as restrained by the common-law courts prior to the amalgamation and co-ordination of the various courts by the Judicature Acts, and as affected by statute law) acting upon it. The peculiar effects of this maritime lien are discussed below. There is also a class of liens, usually called equitable liens (*e.g.* that of an unpaid vendor of real property over the property sold), which are akin to the nature of the civil law rather than of the common law. The word lien does not frequently occur in statute law, but it is found in the extension of the common-law "carriers' or shipowners' lien" in the Merchant Shipping Act 1894; in the definition, extension and limitation of the vendor's lien; in the Factors Act 1877, and the Sale of Goods Act 1893; in granting a maritime lien to a shipmaster for his wages and disbursements, and in regulating that of the seamen in the Merchant Shipping Act 1894; and in the equity jurisdiction of the county courts 1888.

*Common-Law Liens.*—These may be either particular, *i.e.* a right over one or more specified articles for a particular debt, or general, *i.e.* for all debts owing to the creditor by the debtor.

The requisites for a particular lien are, firstly, that the creditor should be in possession of the article; secondly, that the debt should be incurred with reference to the article; and thirdly, that the amount of the debt should be certain. It may be created by express contract, by implied contract (such as the usage of a particular trade or business), or as a consequence of the legal relation existing between the parties. As an example of the first, a shipowner at common law has a lien on the cargo for the freight; but though the shipper agrees to pay dead freight in addition, *i.e.* to pay freight on any space in the ship which he fails to occupy with his cargo, the shipowner has no lien on the cargo for such dead freight except by express agreement. The most usual form of the second is that which is termed a possessory lien—the right a ship-repairer has to retain a ship in his yard till he is paid for the repairs executed upon her,<sup>1</sup> and the right a cobbler has to retain a pair of shoes till he is paid for the repairs done to them. But this lien is only in respect of the work done on, and consequent benefit received by, the subject of the lien. Hence an agistor of cattle has no lien at common law upon them for the value of the pasturage consumed, though he may have one by agreement; nor a conveyancer upon deeds which he has not drawn, but which are in his possession for reference. The most common example of the third is that of a carrier, who is bound by law to carry for all persons, and has, therefore, a lien for the price of the carriage on the goods carried. It has been held that even if the goods are stolen, and entrusted to the carrier by the thief, the carrier can hold them for the price of the carriage against the rightful owner. Of the same nature is the common-law lien of an innkeeper on the baggage of his customer for the amount of his account, he being under a legal obligation to entertain travellers generally. Another instance of the same class is where a person has obtained possession of certain things over which he claims to hold a lien in the exercise of a legal right. For example, when a lord of a manor has seized cattle as estrays, he has a lien upon them for the expense of their keep as against the real owner; but the holder's claim must be specific, otherwise a general tender of compensation releases the lien.

A general lien is a right of a creditor to retain property, not merely for charges relating to it specifically, but for debts due on a general account. This not being a common-law right, is viewed by the English courts with the greatest jealousy, and to be enforced must be strictly proved. This can be done by proof either of an express or implied contract or of a general usage of trade. The first of these is established by the ordinary methods or by previous dealings between the parties on such terms; the second is recognized in certain businesses; it would probably be exceedingly difficult, if not impossible, to extend it at the present time to any other trades. When, however, a lien by general usage has once been judicially established, it becomes part of the Law Merchant, and the courts are bound to recognize and enforce it. The best known and most important instance is the right of a solicitor to retain papers in his hands belonging to his client until his account is settled. The solicitor's lien, though probably more commonly enforced than any other, is of no great antiquity in English law, the earliest reported case of it being in the reign of James II.; but it is now of a twofold nature. In the first place there is the retaining lien. This is similar in kind to other possessory liens, but of a general nature attaching to all papers of the client, and even to his money, up to the amount of the solicitor's bill, in the hands of the solicitor in the ordinary course of business. There are certain exceptions which seem to have crept in for the same reason as the solicitor's lien itself, *i.e.* general convenience of litigation; such exceptions are the will of the client after his decease, and proceedings in bankruptcy. In this latter case the actual possessory lien is given up, the solicitor's interests and priorities being protected by the courts, and it may be said that the giving up the papers is really only a means of enforcing the lien they give in the bankruptcy proceedings. In the second place there is what is called a charging lien—more correctly classed under the head of equitable lien, since it does not require possession, but is a lien the solicitor holds over property recovered or preserved for his client. He had the lien on an order by the court upon a fund in court by the common law, but as to property generally it was only given by 23 & 24 Vict. c. 127, § 28; and it has been held to attach to property recovered in a probate action (*ex parte Tweed*, C.A. 1899, 2 Q.B. 167). A banker's lien is the right of a banker to retain securities belonging to his



customer for money due on a general balance. Other general liens, judicially established, are those of wharfingers, brokers and factors (which are in their nature akin to those of solicitors and bankers), and of calico printers, packers of goods, fullers (at all events at Exeter), dyers and millers; but in all these special trades it is probable that the true reason is that the account due was for one continuous transaction. The calico would come to be printed, the goods to be packed, the cloth to be bleached, the silk to be dyed, and the corn to be ground, in separate parcels, and at different times, but all as one undertaking; and they are therefore, though spoken of as instances of general lien, only adaptations by the courts of the doctrine of particular lien to special peculiarities of business. In none of these cases would the lien exist, in the absence of special agreement, for other matters of account, such as money lent or goods sold.

*Equitable Liens.*—"Where equity has jurisdiction to enforce rights and obligations growing out of an executory contract," *e.g.* in a suit for specific performance, "this equitable theory of remedies cannot be carried out unless the notion is admitted that the contract creates some right or interest in or over specific property, which the decree of the court can lay hold of, and by means of which the equitable relief can be made efficient. The doctrine of equitable liens supplies this necessary element; and it was introduced for the sole purpose of furnishing a ground for these specific remedies which equity confers, operating upon particular identified property instead of the general pecuniary recoveries granted by courts of common law. It follows, therefore, that in a large class of executory contracts express and implied, which the common law regards as creating no property, right nor interest analogous to property, but only a mere personal right to obligation, equity recognizes in addition to the personal obligation a particular right over the thing with which the contract deals, which it calls a *lien*, and which though not property is analogous to property, and by means of which the plaintiff is enabled to follow the identical thing and to enforce the defendant's obligation by a remedy which operates directly on the thing. The theory of equitable liens has its ultimate foundation, therefore, in contracts express or implied which either deal or in some manner relate to specific property, such as a tract of land, particular chattels or securities, a certain fund and the like. It is necessary to divest oneself of the purely legal notion concerning the effects of such contracts, and to recognize the fact that equity regards them as creating a charge upon, or hypothecation of, the specific thing, by means of which the personal obligation arising from the agreement may be more effectively enforced than by a mere pecuniary recovery at law" (Pomeroy, 2 Eq. Jur. 232).

596

This description from an American text-book seems to give at once the fullest and most concise definition and description of an equitable lien. It differs essentially from a common-law lien, inasmuch as in the latter possession or occupation is as a rule necessary, whereas in the equitable lien the person claiming the lien is seldom in possession or occupation of the property, its object being to obtain the possession wholly or partially. A special instance of such a lien is that claimed by a publisher over the copyright of a book which he has agreed to publish on terms which are not complied with—for example, the author attempting to get the book published elsewhere. It cannot perhaps be said that this has been absolutely decided to exist, but a strong opinion of the English court of exchequer towards the close of the 18th century was expressed in its favour (*Brook v. Wentworth*, 3 Anstruther 881). Other instances are the charging lien of a solicitor, and the lien of a person on improvements effected by him on the property of another who "lies by" and allows the work to be done before claiming the property. So also of a trustee for expenses lawfully incurred about the trust property. The power of a limited liability company to create a lien upon its own shares was in 1901 established (*Allen v. Gold Reefs, &c.*, C.A. 1900, 1 Ch. 656).

*Maritime Liens.*—Maritime lien differs from all the others yet considered, in its more elastic nature. Where a maritime lien has once attached to property—and it may and generally does attach without possession—it will continue to attach, unless lost by laches, so long as the thing to which it attaches exists, notwithstanding changes in the possession of and property in the thing, and notwithstanding that the new possessor or owner may be entirely ignorant of its existence; and even if enforced it leaves the owner's personal liability for any balance unrealized intact (the "*Gemma*," 1899, P. 285). So far as England is concerned, it must be borne in mind that the courts of admiralty were conducted in accordance with the principles of civil law, and in that law both the pledge with possession and the hypothecation without possession were well recognized. The extreme convenience of such a right as the latter with regard to such essentially movable chattels as ships is apparent. Strictly speaking, a maritime lien is confined to cases arising in those matters over which the courts of admiralty had original jurisdiction, viz. collisions at sea, seamen's wages, salvage and bottomry, in all of which cases the appropriate remedy is a proceeding *in rem* in the admiralty court. In the first of these—collisions at sea—if there were no maritime lien there would frequently be no remedy at all. When two ships have collided at sea it may well be that the innocent ship knows neither the name nor the nationality of the wrongdoer, and the vessel may escape with slight damage and not have to make a port of refuge in the neighbourhood. Months afterwards it is ascertained that she was a foreign ship, and in the interval she has changed owners. Then, were it not a fact that a maritime lien invisible to the wrongdoer nevertheless attaches itself to his ship at the moment of collision, and continues to attach, the unfortunate owner of the innocent ship would have no remedy, except the doubtful one of pursuing the former owner of the wrong-doing vessel in his own country in a personal action where such proceedings are allowed—which is by no means the case in all foreign countries. The same reasons apply, though not possibly with quite the same force, to the other classes of cases mentioned.

Between 1840 and 1873 the jurisdiction of the admiralty court was largely extended. At the latter date it was merged in the probate, divorce and admiralty division of the High Court of Justice. Since the merger questions have arisen as to how far the enlargement of jurisdiction has extended the principle of maritime lien. An interesting article on this subject by J. Mansfield, barrister-at-law, will be found in the *Law Quarterly Review*, vol. iv., October 1888. It must be sufficient to state here that where legislation has extended the already existing jurisdiction to which a maritime lien pertained, the maritime lien is extended to the subject matter, but that where a new jurisdiction is given, or where a jurisdiction formerly existing without a maritime lien is extended, no maritime lien is given, though even then the extended jurisdiction can be enforced by proceedings *in rem*. Of the first class of extended jurisdictions are collisions, salvage and seamen's wages. Prior to 1840 the court of admiralty only had jurisdiction over these when occurring or earned on the high seas. The jurisdiction, and with it the maritime lien, is extended to places within the body of a county in collision or salvage; and as to seamen's wages, whereas they were dependent on the earning of freight, they are now free from any such limitation; and also, whereas the remedy *in rem* was limited to seamen's wages not earned under a special contract, it is now extended to all seamen's wages, and also to a master's wages and disbursements, and the maritime lien covers

all these. The new jurisdiction given over claims for damage to cargo carried into any port in England or Wales, and on appeal from the county courts over all claims for damage to cargo under £300, though it may be prosecuted by proceedings *in rem*, i.e. by arrest of the ship, yet confers no maritime lien; and so also in the case of claims by material men (builders and fitters-out of ships) and for necessaries. Even though in the latter case the admiralty court had jurisdiction previously to 1840 where the necessaries were supplied on the high seas, yet as it could not be shown that such jurisdiction had ever been held to confer a maritime lien, no such lien is given. Even now there is much doubt as to whether towage confers a maritime lien or not, the services rendered being pursuant to contract, and frequently to a contract made verbally or in writing on the high seas, and being rendered also to a great extent on the high seas. In these cases and to that extent the high court of admiralty would have had original jurisdiction. But prior to 1840 towage, as now rendered by steam tugs expressly employed for the service, was practically unknown, and therefore there was no established catena of precedent to show the exercise of a maritime lien. It may be argued on the one hand that towage is only a modified form of salvage, and therefore entitled to a maritime lien, and on the other that it is only a form of necessary power supplied like a new sail or mast to a ship to enable her to complete her voyage expeditiously, and therefore of the nature of necessaries, and as such not entitled to a maritime lien. The matter is not of academical interest only, for though in the case of an inward-bound ship the tug owner can make use of his statutory right of proceeding *in rem*, and so obtain much of the benefit of a maritime lien, yet in the case of an outward-bound ship, if she once gets away without payment, and the agent or other authorized person refuses or is unable to pay, the tug owner's claim may, on the return of the ship to a British port, be met by an allegation of a change of ownership, which defeats his right of proceeding at all if he has no maritime lien; whereas if he has a maritime lien he can still proceed against the ship and recover his claim, if he has not been guilty of laches.

A convenient division of the special liens other than possessory on ships may be made by classifying them as maritime, statutory-maritime or quasi-maritime, and statutory. The first attach only in the case of damage done by collision between ships on the high seas, salvage on the high seas, bottomry and seamen's wages so far as freight has been earned; the second attach in cases of damage by collision within the body of a county, salvage within the body of a county, life salvage everywhere, seamen's wages even if no freight has been earned, master's wages and disbursements. These two classes continue to attach notwithstanding a change of ownership without notice of the lien, if there have been no laches in enforcing it (the "*Bold Buccleuch*," 1852, 7 Moo. P.C. 267; the "*Kong Magnus*," 1891, P. 223). The third class, which only give a right to proceed *in rem*, i.e. against the ship itself, attach, so long as there is no *bona fide* change of ownership, without citing the owners, in all cases of claims for damage to ship and of claims for damage to cargo where no owner is domiciled in England or Wales. Irrespective of this limitation, they attach in all cases not only of damage to cargo, but also of breaches of contract to carry where the damage does not exceed £300, when the suit must be commenced in a county court having admiralty jurisdiction; and in cases of claims for necessaries supplied elsewhere than in the ship's home port, for wages earned even under a special contract by masters and mariners, and of claims for towage. In all three classes the lien also exists over cargo where the suit from its nature extends to it, as in salvage and in some cases of bottomry or respondentia, and in cases where proceedings are taken against cargo by the shipowner for a breach of contract (cargo *ex "Argos"* and the "*Hewsons*," 1873, L.R. 5 P.C. 134; the "*Alina*," 1880, 5 Ex. D. 227).

597

Elsewhere than in England, and those countries such as the United States which have adopted her jurisprudence in maritime matters generally, the doctrine of maritime lien, or that which is substituted for it, is very differently treated. Speaking generally, those states which have adopted the Napoleonic codes or modifications of them—France, Italy, Spain, Holland, Portugal, Belgium, Greece, Turkey, and to some extent Russia—have instead of a maritime lien the civil-law principle of privileged debts. Amongst these in all cases are found claims for salvage, wages, bottomry under certain restrictions, and necessaries. Each of these has a privileged claim against the ship, and in some cases against freight and cargo as well, but it is a matter of very great importance that, except in Belgium, a claim for collision damage (which as we have seen confers a maritime lien, and one of a very high order, in Great Britain) confers no privilege against the wrong-doing ship, whilst in all these countries an owner can get rid of his personal liability by abandoning the ship and freight to his creditor, and so, if the ship is sunk, escape all liability whilst retaining any insurance there may be. This, indeed, was at one time the law of Great Britain; the measure of damage was limited by the value of the *res*; and in the United States at the present time a shipowner can get rid of his liability for damage by abandoning the ship and freight. A different rule prevails in Germany and the Scandinavian states. There claims relating to the ship, unless the owner has specially rendered himself liable, confer no personal claim at all against him. The claim is limited *ab initio* to ship and freight, except in the case of seamen's wages, which do confer a personal claim so far as they have been earned on a voyage or passage completed prior to the loss of the ship. In all maritime states, however, except Spain, a provisional arrest of the ship is allowed, and thus between the privilege accorded to the debt and the power to arrest till bail is given or the ship abandoned to creditors, a condition of things analogous to the maritime lien is established; especially as these claims when the proper legal steps have been taken to render them valid—usually by endorsement on the ship's papers on board, or by registration at her port of registry—attach to the ship and follow her into the hands of a purchaser. They are in fact notice to him of the incumbrance.

*Duration of Lien.*—So long as the party claiming the lien at common law retains the property, the lien continues, notwithstanding the debt in respect of which it is claimed becoming barred by the Statute of Limitations (*Higgins v. Scott*, 1831, 2 B. & Ald. 413). But if he takes proceedings at law to recover the debt, and on a sale of the goods to satisfy the judgment purchases them himself, he so alters the nature of the possession that he loses his lien (*Jacobs v. Latour*, 5 Bing. 130). An equitable lien probably in all cases continues, provided the purchaser of the subject matter has notice of the lien at the time of his purchase. A maritime lien is in no respect subject to the Statute of Limitations, and continues in force notwithstanding a change in the ownership of the property without notice, and is only terminated when it has once attached, by laches on the part of the person claiming it (the "*Kong Magnus*," 1891, P. 223). There is an exception in the case of seamen's wages, where by 4 Anne c. 16 (*Stat. Rev.* 4 & 5 Anne c. 3) all suits for seamen's wages in the Admiralty must be brought within six years.

*Ranking of Maritime Liens.*—There may be several claimants holding maritime and other liens on the same vessel. For example, a foreign vessel comes into collision by her own fault and is damaged and her cargo also; she is assisted into port by salvors and ultimately under a towage agreement, and put into the hands of a shipwright who does necessary repairs. The innocent party to the collision has a maritime lien for his damage, and the seamen for their wages; the cargo owner has a suit *in rem* or a statutory lien for damage, and the

shipwright a possessory lien for the value of his repairs, while the tugs certainly have a right *in rem* and possibly a maritime lien also in the nature of salvage. The value of the property may be insufficient to pay all claims, and it becomes a matter of great consequence to settle whether any, and if so which, have priority over the others, or whether all rank alike and have to divide the proceeds of the property *pro rata* amongst them. The following general rules apply: liens for benefits conferred rank against the fund in the inverse, and those for the reparation of damage sustained in the direct order of their attaching to the *res*; as between the two classes those last mentioned rank before those first mentioned of earlier date; as between liens of the same class and the same date, the first claimant has priority over others who have not taken action. The courts of admiralty, however, allow equitable considerations, and enter into the question of marshalling assets. For example, if one claimant has a lien on two funds, or an effective right of action in addition to his lien, and another claimant has only a lien upon one fund, the first claimant will be obliged to exhaust his second remedy before coming into competition with the second. As regards possessory liens, the shipwright takes the ship as she stands, *i.e.* with her incumbrances, and it appears that the lien for seaman's wages takes precedence of a solicitor's lien for costs, under a charging order made in pursuance of the Solicitors Act 1860, § 28.

Subject to equitable considerations, the true principle appears to be that services rendered under an actual or implied contract, which confer a maritime lien, make the holder of the lien in some sort a proprietor of the vessel, and therefore liable for damage done by her—hence the priority of the damage lien—but, directly it has attached, benefits conferred on the property by enabling it to reach port in safety benefit the holder of the damage lien in common with all other prior holders of maritime liens. It is less easy to see why of two damage liens the earlier should take precedence of the later, except on the principle that the *res* which came into collision the second time is depreciated in value by the amount of the existing lien upon her for the first collision, and where there was more than one damage lien, and also liens for benefits conferred prior to the first collision between the two collisions and subsequent to the second, the court would have to make a special order to meet the peculiar circumstances. The claim of a mortgagee naturally is deferred to all maritime liens, whether they are for benefits conferred on the property in which he is interested or for damage done by it, and also for the same reason to the possessory lien of the shipwright, but both the possessory lien of the shipwright and the claim of the mortgagee take precedence over a claim for necessities, which only confers a statutory lien or a right to proceed *in rem* in certain cases. In other maritime states possessing codes of commercial law, the privileged debts are all set out in order of priority in these codes, though, as has been already pointed out, the lien for damage by collision—the most important in English law—has no counterpart in most of the foreign codes.

*Stoppage in Transitu.*—This is a lien held by an unpaid vendor in certain cases over goods sold after they have passed out of his actual possession. It has been much discussed whether it is an equitable or common-law right or lien. The fact appears to be that it has always been a part of the Law Merchant, which, properly speaking, is itself a part of the common law of England unless inconsistent with it. This particular right was, in the first instance, held by a court of equity to be equitable and not contrary to English law, and by that decision this particular part of the Law Merchant was approved and became part of the common law of England (see per Lord Abinger in *Gibson v. Carruthers*, 8 M. & W., p. 336 et seq.). It may be described as a lien by the Law Merchant, decided by equity to be part of the common law, but in its nature partaking rather of the character of an equitable lien than one at common law. "It is a right which arises solely upon the insolvency of the buyer, and is based on the plain reason of justice and equity that one man's goods shall not be applied to the payment of another man's debts. If, therefore, after the vendor has delivered the goods out of his own possession and put them in the hands of a carrier for delivery to the buyer, he discovers that the buyer is insolvent, he may re-take the goods if he can before they reach the buyer's possession, and thus avoid having his property applied to paying debts due by the buyer to other people" (*Benjamin on Sales*, 2nd ed., 289). This right, though only recognized by English law in 1690, is highly favoured by the courts on account of its intrinsic justice, and extends to quasi-vendors, or persons in the same position, such as consignors who have bought on behalf of a principal and forwarded the goods. It is, however, defeated by a lawful transfer of the document of title to the goods by the vendor to a third person, who takes it *bonâ fide* and for valuable consideration (Factors Act 1889; Sale of Goods Act 1893).

*Assignment or Transfer of Lien.*—A lien being a personal right acquired in respect of personal services, it cannot, as a rule, be assigned or transferred; but here again there are exceptions. The personal representative of the holder of a possessory lien on his decease would probably in all cases be held entitled to it; and it has been held that the lien over a client's papers remains with the firm of solicitors notwithstanding changes in the constitution of the firm (*Gregory v. Cresswell*, 14 L.J. Ch. 300). So also where a solicitor, having a lien on documents for his costs, assigned the debt to his bankers with the benefit of the lien, it was held that the bankers might enforce such lien in equity. But though a tradesman has a lien on the property of his customer for his charges for work done upon it, where the property is delivered to him by a servant acting within the scope of his employment, such lien cannot be transferred to the servant, even if he has paid the money himself; and the lien does not exist at all if the servant was acting without authority in delivering the goods, except where (as in the case of a common carrier) he is bound to receive the goods, in which case he retains his lien for the carriage against the rightful owner. Where, however, there is a lien on property of any sort not in possession, a person acquiring the property with knowledge of the lien takes it subject to such lien. This applies to equitable liens, and cannot apply to those common-law liens in which possession is necessary. It is, however, true that by statute certain common-law liens can be transferred, *e.g.* under the Merchant Shipping Act a master of a ship having a lien upon cargo for his freight can transfer the possession of the cargo to a wharfinger, and with it the lien (Merchant Shipping Act 1894, § 494). In this case, however, though the matter is simplified by the statute, if the wharfinger was constituted the agent or servant of the shipmaster, his possession would be the possession of the shipmaster, and there would be no real transfer of the lien; therefore the common-law doctrine is not altered, only greater facilities for the furtherance of trade are given by the statute, enabling the wharfinger to act in his own name without reference to his principal, who may be at the other side of the world. So also a lien may be retained, notwithstanding that the property passes out of possession, where it has to be deposited in some special place (such as the Custom-House) to comply with the law. Seamen cannot sell or assign or in any way part with their maritime lien for wages (Merchant Shipping Act 1894, § 156), but, nevertheless, with the sanction of the court, a person who pays seamen their wages is entitled to stand in their place and exercise their rights (the *Cornelia Henrietta*, 1866, L.R. 1 Ad. & Ec. 51).

*Waiver.*—Any parting with the possession of goods is in general a waiver of the lien upon them; for example, when a factor having a lien on the goods of his principal gives them to a carrier to be carried at the expense of

his principal, even if undisclosed, he waives his lien, and has no right to stop the goods *in transitu* to recover it; so also where a coach-builder who has a lien on a carriage for repairs allows the owner from time to time to take it out for use without expressly reserving his lien, he has waived it, nor has he a lien for the standage of the carriage except by express agreement, as mere standage does not give a possessory lien. It has even been held that where a portion of goods sold as a whole for a lump sum has been taken away and paid for proportionately, the conversion has taken place and the lien for the residue of the unpaid purchase-money has gone (*Gurr v. Cuthbert*, 1843, 12 L.J. Ex. 309). Again, an acceptance of security for a debt is inconsistent with the existence of a lien, as it substitutes the credit of the owner for the material guarantee of the thing itself, and so acts as a waiver of the lien. For the same reason even an agreement to take security is a waiver of the lien, though the security is not, in fact, given (*Alliance Bank v. Broon*, 11 L.T. 332).

*Sale of Goods under Lien.*—At common law the lien only gives a right to retain the goods, and ultimately to sell by legal process, against the owner; but in certain cases a right has been given by statute to sell without the intervention of legal process, such as the right of an innkeeper to sell the goods of his customer for his unpaid account (Innkeepers Act 1878, § 1), the right of a wharfinger to sell goods entrusted to him by a shipowner with a lien upon them for freight, and also for their own charges (Merchant Shipping Act 1894, §§ 497, 498), and of a railway company to sell goods for their charges (Railway Clauses Act 1845, § 97). Property affected by an equitable lien or a maritime lien cannot be sold by the holder of the lien without the interposition of the court to enforce an order, or judgment of the court. In Admiralty cases, where a sale is necessary, no bail having been given and the property being under arrest, the sale is usually made by the marshal in London, but may be elsewhere on the parties concerned showing that a better price is likely to be obtained.

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

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

599

BRITISH COLONIES.—In those colonies which before the Canadian federation were known as Upper Canada and the Maritime Provinces of British North America, and in the several Australasian states where the English common law is enforced except as modified by colonial statute, the principles of lien, whether by common law or equitable or maritime, discussed above with reference to England, will prevail; but questions not dissimilar to those treated of in reference to the United States may arise where colonies have come to the crown of Great Britain by cession, and where different systems of municipal law are enforced. For example, in Lower Canada the law of France prior to the Revolution occupies the place of the common law in England, but is generally regulated by a code very similar to the Code Napoleon; in Mauritius and its dependencies the Code Napoleon itself is in force except so far as modified by subsequent ordinances. In South Africa, and to some extent in Ceylon and Guiana, Roman-Dutch law is in force; in the island of Trinidad old Spanish law, prior to the introduction of the present civil code of Spain, is the basis of jurisprudence. Each several system of law requires to be studied on the point; but, speaking generally, apart from the possessory lien of workmen and the maritime lien of the vice-admiralty courts, it may be assumed that the rules of the civil law, giving a privilege or priority in certain specified cases rather than a lien as understood in English law, prevail in those colonies where the English law is not in force.

(F. W. RA.)

1 This right, however, is not absolute, but depends on the custom of the port (*Raitt v. Mitchell*, 1815, 4 Camp. 146).



**LIERRE** (Flemish, *Lier*), a town in the province of Antwerp, Belgium; 9 m. S.E. of Antwerp. Pop. (1904) 24,229. It carries on a brisk industry in silk fabrics. Its church of St Gommaire was finished in 1557 and contains three fine glass windows, the gift of the archduke Maximilian, to celebrate his wedding with Mary of Burgundy.



**LIESTAL**, the capital (since 1833) of the half canton of Basel-Stadt in Switzerland. It is a well-built but uninteresting industrial town, situated on the left bank of the Ergolz stream, and is the most populous town in the entire canton of Basel, after Basel itself. By rail it is 9¼ m. S.E. of Basel, and 15¾ m. N.W. of Olten. In the 15th-century town hall (*Rathaus*) is preserved the golden drinking cup of Charles the Bold, duke of Burgundy, which was taken at the battle of Nancy in 1477. In 1900 the population was 5403, all German-speaking and mainly Protestants. The town was sold in 1302 by its lord to the bishop of Basel who, in 1400, sold it to the city of Basel, at whose hands it suffered much in the Peasants' War of 1653, and so consented gladly to the separation of 1833.



**LIEUTENANT**, one who takes the place, office and duty of and acts on behalf of a superior or other person. The word in English preserves the form of the French original (from *lieu*, place, *tenant*, holding), which is the equivalent of the Lat. *locum tenens*, one holding the place of another. The usual English pronunciation appears early, the word being frequently spelled *lieftenant*, *lyeftenant* or *luftenant* in the 14th and 15th centuries. The modern American pronunciation is *lewtenant*, while the German is represented by the present form of the word *Leutnant*. In French history, *lieutenant du roi* (*locum tenens regis*) was a title borne by the officer sent with military powers to represent the king in certain provinces. With wider powers and functions, both civil as well as military, and holding authority throughout an entire province, such a representative of the king was called *lieutenant général du roi*. The first appointment of these officials dates from the reign of Philip IV. the Fair (see [CONSTABLE](#)). In the 16th century the administration of the provinces was in the hands of *gouverneurs*, to whom the *lieutenants du roi* became subordinates. The titles *lieutenant civil* or *criminel* and *lieutenant général de police* have been borne by certain judicial officers in France (see [CHÂTELET](#) and [BAILIFF: Bailli](#)). As the title of the representative of the sovereign, "lieutenant" in English usage appears in the title of the lord lieutenant of Ireland, and of the lords lieutenant of the counties of the United Kingdom (see below).

The most general use of the word is as the name of a grade of naval and military officer. It is common in this application to nearly every navy and army of the present day. In Italy and Spain the first part of the word is omitted, and an Italian and Spanish officer bearing this rank are called *tenente* or *teniente* respectively. In the British and most other navies the lieutenants are the commissioned officers next in rank to commanders, or second class of captains. Originally the lieutenant was a soldier who aided, and in case of need replaced, the captain, who, until the latter half of the 17th century, was not necessarily a seaman in any navy. At first one lieutenant was carried, and only in the largest ships. The number was gradually increased, and the lieutenants formed a numerous corps. At the close of the Napoleonic War in 1815 there were 3211 lieutenants in the British navy. Lieutenants now often qualify for special duties such as navigation, or gunnery, or the management of torpedoes. In the British army a lieutenant is a subaltern officer ranking next below a captain and above a second lieutenant. In the United States of America subalterns are classified as first lieutenants and second lieutenants. In France the two grades are *lieutenant* and *sous-lieutenant*, while in Germany the *Leutnant* is the lower of the two ranks, the higher being *Ober-leutnant* (formerly *Premier-leutnant*). A "captain lieutenant" in the British army was formerly the senior subaltern who virtually commanded the colonel's company or troop, and ranked as junior captain, or "puny captain," as he was called by Cromwell's soldiers.

The lord lieutenant of a county, in England and Wales and in Ireland, is the principal officer of a county. His creation dates from the reign of Henry VIII. (or, according to some, Edward VI.), when the military functions of the sheriff were handed over to him. He was responsible for the efficiency of the militia of the county, and afterwards of the yeomanry and volunteers. He was commander of these forces, whose officers he appointed. By the Regulation of the Forces Act 1871, the jurisdiction, duties and command exercised by the lord lieutenant were vested in the crown, but the power of recommending for first appointments was reserved to the lord lieutenant. By the Territorial and Reserve Forces Act 1907, the lord lieutenant of a county was constituted president of the county association. The office of lord lieutenant is honorary, and is held during the royal pleasure, but virtually for life. Appointment to the office is by letters patent under the great seal. Usually, though not necessarily, the person appointed lord lieutenant is also appointed *custos rotulorum* (*q.v.*). Appointments to the county bench of magistrates are usually made on the recommendation of the lord lieutenant (see [JUSTICE OF THE PEACE](#)).

A deputy lieutenant (denoted frequently by the addition of the letters D.L. after a person's name) is a deputy of a lord lieutenant of a county. His appointment and qualifications previous to 1908 were regulated by the Militia Act 1882. By s. 30 of that act the lieutenant of each county was required from time to time to appoint such properly qualified persons as he thought fit, living within the county, to be deputy lieutenants. At least twenty had to be appointed for each county, if there were so many qualified; if less than that number were qualified, then all the duly qualified persons in the county were to be appointed. The appointments were subject to the sovereign's approval, and a return of all appointments to, and removals from, the office had to be laid before parliament annually. To qualify for the appointment of deputy lieutenant a person had to be (a) a peer of the realm, or the heir-apparent of such a peer, having a place of residence within the county; or (b) have in possession an estate in land in the United Kingdom of the yearly value of not less than £200; or (c) be the heir-

apparent of such a person; or (*d*) have a clear yearly income from personalty within the United Kingdom of not less than £200 (s. 33). If the lieutenant were absent from the United Kingdom, or through illness or other cause were unable to act, the sovereign might authorize any three deputy lieutenants to act as lieutenant (s. 31), or might appoint a deputy lieutenant to act as vice-lieutenant. Otherwise, the duties of the office were practically nominal, except that a deputy lieutenant might attest militia recruits and administer the oath of allegiance to them. The reorganization in 1907 of the forces of the British crown, and the formation of county associations to administer the territorial army, placed increased duties on deputy lieutenants, and it was publicly announced that the king's approval of appointments to that position would only be given in the case of gentlemen who had served for ten years in some force of the crown, or had rendered eminent service in connexion with a county association.

The lord lieutenant of Ireland is the head of the executive in that country. He represents his sovereign and maintains the formalities of government, the business of government being entrusted to the department of his chief secretary, who represents the Irish government in the House of Commons, and may have a seat in the cabinet. The chief secretary occupies an important position, and in every cabinet either the lord lieutenant or he has a seat.

Lieutenant-governor is the title of the governor of an Indian province, in direct subordination to the governor-general in council. The lieutenant-governor comes midway in dignity between the governors of Madras and Bombay, who are appointed from England, and the chief commissioners of smaller provinces. In the Dominion of Canada the governors of provinces also have the title of lieutenant-governor. The representatives of the sovereign in the Isle of Man and the Channel Islands are likewise styled lieutenant-governors.



**LIFE**, the popular name for the activity peculiar to protoplasm (*q.v.*). This conception has been extended by analogy to phenomena different in kind, such as the activities of masses of water or of air, or of machinery, or by another analogy, to the duration of a composite structure, and by imagination to real or supposed phenomena such as the manifestations of incorporeal entities. From the point of view of exact science life is associated with matter, is displayed only by living bodies, by all living bodies, and is what distinguishes living bodies from bodies that are not alive. Herbert Spencer's formula that life is "the continuous adjustment of internal relations to external relations" was the result of a profound and subtle analysis, but omits the fundamental consideration that we know life only as a quality of and in association with living matter.

In developing our conception we must discard from consideration the complexities that arise from the organization of the higher living bodies, the differences between one living animal and another, or between plant and animal. Such differentiations and integrations of living bodies are the subject-matter of discussions on evolution; some will see in the play of circumambient media, natural or supernatural, on the simplest forms of living matter, sufficient explanation of the development of such matter into the highest forms of living organisms; others will regard the potency of such living matter so to develop as a mysterious and peculiar quality that must be added to the conception of life. Choice amongst these alternatives need not complicate investigation of the nature of life. The explanation that serves for the evolution of living matter, the vehicle of life, will serve for the evolution of life. What we have to deal with here is life in its simplest form.

The definition of life must really be a description of the essential characters of life, and we must set out with an investigation of the characters of living substance with the special object of detecting the differences between organisms and unorganized matter, and the differences between dead and living organized matter.

Living substance (see **PROTOPLASM**), as it now exists in all animals and plants, is particulate, consisting of elementary organisms living independently, or grouped in communities, the communities forming the bodies of the higher animals and plants. These small particles or larger communities are subject to accidents, internal or external, which destroy them, immediately or slowly, and thus life ceases; or they may wear out, or become clogged by the products of their own activity. There is no reason to regard the mortality of protoplasm and the consequent limited duration of life as more than the necessary consequence of particulate character of living matter (see **LONGEVITY**).

Protoplasm, the living material, contains only a few elements, all of which are extremely common and none of which is peculiar to it. These elements, however, form compounds characteristic of living substance and for the most part peculiar to it. Proteid, which consists of carbon, hydrogen, nitrogen, oxygen and sulphur, is present in all protoplasm, is the most complex of all organic bodies, and, so far, is known only from organic bodies. A multitude of minor and simpler organic compounds, of which carbohydrates and fats are the best known, occur in different protoplasm in varying forms and proportions, and are much less isolated from the inorganic world. They may be stages in the elaboration or disintegration of protoplasm, and although they were at one time believed to occur only as products of living matter, are gradually being conquered by the synthetic chemist. Finally, protoplasm contains various inorganic substances, such as salts and water, the latter giving it its varying degrees of liquid consistency.

We attain, therefore, our first generalized description of life as the property or peculiar quality of a substance composed of none but the more common elements, but of these elements grouped in various ways to form compounds ranging from proteid, the most complex of known substances to the simplest salts. The living substance, moreover, has its mixture of elaborate and simple compounds associated in a fashion that is peculiar. The older writers have spoken of protoplasm or the cell as being in a sense "manufactured articles"; in the more modern view such a conception is replaced by the statement that protoplasm and the cell have behind them a long historical architecture. Both ideas, or both modes of expressing what is fundamentally the same idea, have this in common, that life is not a sum of the qualities of the chemical elements contained in protoplasm, but a function first of the peculiar architecture of the mixture, and then of the high complexity of the compounds contained in the mixture. The qualities of water are no sum of the qualities of oxygen and hydrogen, and still less can we expect to explain the qualities of life without regard to the immense complexity of the living substance.

We must now examine in more detail the differences which exist or have been alleged to exist between living organisms and inorganic bodies. There is no essential difference in structure. Confusion has arisen in regard to this point from attempts to compare organized bodies with crystals, the comparison having been suggested by the view that as crystals present the highest type of inorganic structure, it was reasonable to compare them with organic matter. Differences between crystals and organized bodies have no bearing on the problem of life, for organic substance must be compared with a liquid rather than with a crystal, and differs in structure no more from inorganic liquids than these do amongst themselves, and less than they differ from crystals. Living matter is a mixture of substances chiefly dissolved in water; the comparison with the crystals has led to a supposed distinction in the mode of growth, crystals growing by the superficial apposition of new particles and living substance by intussusception. But inorganic liquids also grow in the latter mode, as when a soluble substance is added to them.

The phenomena of movement do not supply any absolute distinction. Although these are the most obvious characters of life, they cannot be detected in quiescent seeds, which we know to be alive, and they are displayed in a fashion very like life by inorganic foams brought in contact with liquids of different composition. Irritability, again, although a notable quality of living substance, is not peculiar to it, for many inorganic substances respond to external stimulation by definite changes. Instability, again, which lies at the root of Spencer's definition "continuous adjustment of internal relations to external relations" is displayed by living matter in very varying degrees from the apparent absolute quiescence of frozen seeds to the activity of the central nervous system, whilst there is a similar range amongst inorganic substances.

The phenomena of reproduction present no fundamental distinction. Most living bodies, it is true, are capable of reproduction, but there are many without this capacity, whilst, on the other hand, it would be difficult to draw an effective distinction between that reproduction of simple organisms which consists of a sub-division of their substance with consequent resumption of symmetry by the separate pieces, and the breaking up of a drop of mercury into a number of droplets.

Consideration of the mode of origin reveals a more real if not an absolute distinction. All living substance so far as is known at present (see [BIOGENESIS](#)) arises only from already existing living substance. It is to be noticed, however, that green plants have the power of building up living substance from inorganic material, and there is a certain analogy between the building up of new living material only in association with pre-existing living material, and the greater readiness with which certain inorganic reactions take place if there already be present some trace of the result of the reaction.

601

The real distinction between living matter and inorganic matter is chemical. Living substance always contains proteid, and although we know that proteid contains only common inorganic elements, we know neither how these are combined to form proteid, nor any way in which proteid can be brought into existence except in the presence of previously existing proteid. The central position of the problem of life lies in the chemistry of proteid, and until that has been fully explored, we are unable to say that there is any problem of life behind the problem of proteid.

Comparison of living and lifeless organic matter presents the initial difficulty that we cannot draw an exact line between a living and a dead organism. The higher "warm-blooded" creatures appear to present the simplest case and in their life-history there seems to be a point at which we can say "that which was alive is now dead." We judge from some major arrest of activity, as when the heart ceases to beat. Long after this, however, various tissues remain alive and active, and the event to which we give the name of death is no more than a superficially visible stage in a series of changes. In less highly integrated organisms, such as "cold-blooded" vertebrates, the point of death is less conspicuous, and when we carry our observations further down the scale of animal life, there ceases to be any salient phase in the slow transition from life to death.

The distinction between life and death is made more difficult by a consideration of cases of so-called "arrested vitality." If credit can be given to the stories of Indian fakirs, it appears that human beings can pass voluntarily into a state of suspended animation that may last for weeks. The state of involuntary trance, sometimes mistaken for death, is a similar occurrence. A. Leeuwenhoek, in 1719, made the remarkable discovery, since abundantly confirmed, that many animalculae, notably tardigrades and rotifers, may be completely desiccated and remain in that condition for long periods without losing the power of awaking to active life when moistened with water. W. Preyer has more recently investigated the matter and has given it the name "anabiosis." Later observers have found similar occurrences in the cases of small nematodes, rotifers and bacteria. The capacity of plant seeds to remain dry and inactive for very long periods is still better known. It has been supposed that in the case of the plant seeds and still more in that of the animals, the condition of anabiosis was merely one in which the metabolism was too faint to be perceptible by ordinary methods of observation, but the elaborate experiments of W. Kochs would seem to show that a complete arrest of vital activity is compatible with viability. The categories, "alive" and "dead," are not sufficiently distinct for us to add to our conception of life by comparing them. A living organism usually displays active metabolism of proteid, but the metabolism may slow down, actually cease and yet reawaken; a dead organism is one in which the metabolism has ceased and does not reawaken.

*Origin of Life.*—It is plain that we cannot discuss adequately the origin of life or the possibility of the artificial construction of living matter (see [ABIOTENESIS](#) and [BIOGENESIS](#)) until the chemistry of protoplasm and specially of proteid is more advanced. The investigations of O. Bütschli have shown how a model of protoplasm can be manufactured. Very finely triturated soluble particles are rubbed into a smooth paste with an oil of the requisite consistency. A fragment of such a paste brought into a liquid in which the solid particles are soluble, slowly expands into a honeycomb like foam, the walls of the minute vesicles being films of oil, and the contents being the soluble particles dissolved in droplets of the circumambient liquid. Such a model, properly constructed, that is to say, with the vesicles of the foam microscopic in size, is a marvellous imitation of the appearance of protoplasm, being distinguishable from it only by a greater symmetry. The nicely balanced conditions of solution produce a state of unstable equilibrium, with the result that internal streaming movements and changes of shape and changes of position in the model simulate closely the corresponding manifestations in real protoplasm. The model has no power of recuperation; in a comparatively short time equilibrium is restored and the resemblance with protoplasm disappears. But it suggests a method by which, when the chemistry of protoplasm and proteid is better known, the proper substances which compose protoplasm may be brought together to form a simple kind of protoplasm.

It has been suggested from time to time that conditions very unlike those now existing were necessary for the first appearance of life, and must be repeated if living matter is to be constructed artificially. No support for such a view can be derived from observations of the existing conditions of life. The chemical elements involved are abundant; the physical conditions of temperature pressure and so forth at which living matter is most active, and within the limits of which it is confined, are familiar and almost constant in the world around us. On the other hand, it may be that the initial conditions for the synthesis of proteid are different from those under which proteid and living matter display their activities. E. Pflüger has argued that the analogies between living proteid and the compounds of cyanogen are so numerous that they suggest cyanogen as the starting-point of protoplasm. Cyanogen and its compounds, so far as we know, arise only in a state of incandescent heat. Pflüger suggests that such compounds arose when the surface of the earth was incandescent, and that in the long process of cooling, compounds of cyanogen and hydrocarbons passed into living protoplasm by such processes of transformation and polymerization as are familiar in the chemical groups in question, and by the acquisition of water and oxygen. His theory is in consonance with the interpretation of the structure of protoplasm as having behind it a long historical architecture and leads to the obvious conclusion that if protoplasm be constructed artificially it will be by a series of stages and that the product will be simpler than any of the existing animals or plants.

Until greater knowledge of protoplasm and particularly of proteid has been acquired, there is no scientific room for the suggestion that there is a mysterious factor differentiating living matter from other matter and life from other activities. We have to scale the walls, open the windows, and explore the castle before crying out that it is so marvellous that it must contain ghosts.

As may be supposed, theories of the origin of life apart from doctrines of special creation or of a primitive and slow spontaneous generation are mere fantastic speculations. The most striking of these suggests an extra-terrestrial origin. H. E. Richter appears to have been the first to propound the idea that life came to this planet as cosmic dust or in meteorites thrown off from stars and planets. Towards the end of the 19th century Lord Kelvin (then Sir W. Thomson) and H. von Helmholtz independently raised and discussed the possibility of such an origin of terrestrial life, laying stress on the presence of hydrocarbons in meteoric stones and on the indications of their presence revealed by the spectra of the tails of comets. W. Preyer has criticized such views, grouping them under the phrase "theory of cosmozoa," and has suggested that living matter preceded inorganic matter. Preyer's view, however, enlarges the conception of life until it can be applied to the phenomena of incandescent gases and has no relation to ideas of life derived from observation of the living matter we know.

REFERENCES.—O. Bütschli, *Investigations on Microscopic Foams and Protoplasm* (Eng. trans. by E. A. Minchin, 1894), with a useful list of references; H. von Helmholtz, *Vorträge und Reden*, ii. (1884); W. Kochs, *Allgemeine Naturkunde*, x. 673 (1890); A. Leeuwenhoek, *Epistolae ad Societatem regiam Anglicam* (1719); E. Pflüger, "Über einige Gesetze des Eiweissstoffwechsels," in *Archiv. Ges. Physiol.* liv. 333 (1893); W. Preyer, *Die Hypothesen über den Ursprung des Lebens* (1880); H. E. Richter, *Zur Darwinischen Lehre* (1865); Herbert Spencer, *Principles of Biology*; Max Verworm, *General Physiology* (English trans. by F. S. Lee, 1899), with a very full literature.

(P. C. M.)



**LIFE-BOAT, and LIFE-SAVING SERVICE.** The article on **DROWNING AND LIFE-SAVING** (*q.v.*) deals generally with the means of saving life at sea, but under this heading it is convenient to include the appliances connected specially with the life-boat service. The ordinary open boat is unsuited for life-saving in a stormy sea, and numerous contrivances, in regard to which the lead came from England, have been made for securing the best type of life-boat.

The first life-boat was conceived and designed by Lionel Lukin, a London coach-builder, in 1785. Encouraged by the prince of Wales (George IV.), Lukin fitted up a Norway yawl as a life-boat, took out a patent for it, and wrote a pamphlet descriptive of his "Insubmergible Boat." Buoyancy he obtained by means of a projecting gunwale of cork and air-chambers inside—one of these being at the bow, another at the stern. Stability he secured by a false iron keel. The self-righting and self-emptying principles he seems not to have thought of; at all events he did not compass them. Despite the patronage of the prince, Lukin went to his grave a neglected and disappointed man. But he was not altogether unsuccessful, for, at the request of the Rev Dr Shairp, Lukin fitted up a coble as an "unimmergible" life-boat, which was launched at Bamborough, saved several lives the first year and afterwards saved many lives and much property.

Public apathy in regard to shipwreck was temporally swept away by the wreck of the "Adventure" of Newcastle in 1789. This vessel was stranded only 300 yds. from the shore, and her crew dropped, one by one, into the raging breakers in presence of thousands of spectators, none of whom dared to put off in an ordinary boat to the rescue. An excited meeting among the people of South Shields followed; a committee was formed, and premiums were offered for the best models of a life-boat. This called forth many plans, of which those of William Wouldhave, a painter, and Henry Greathead, a boatbuilder, of South Shields, were selected. The committee awarded the prize to the latter, and, adopting the good points of both models, gave the order for the construction of their boat to Greathead. This boat was rendered buoyant by nearly 7 cwts. of cork, and had very raking stem and stern-posts, with great curvature of keel. It did good service, and Greathead was well rewarded; nevertheless no other life-boat was launched till 1798, when the duke of Northumberland ordered Greathead to build him a life-boat which he endowed. This boat also did good service, and its owner ordered another in 1800 for Oporto. In the same year Mr Cathcart Dempster ordered one for St Andrews, where, two years later, it saved twelve lives. Thus the value of life-boats began to be recognized, and before the end of 1803 Greathead had built thirty-one boats—eighteen for England, five for Scotland and eight for foreign lands. Nevertheless, public interest in life-boats was not thoroughly aroused till 1823.

In that year Sir William Hillary, Bart., stood forth to champion the life-boat cause. Sir William dwelt in the Isle



of Man, and had assisted with his own hand in the saving of three hundred and five lives. In conjunction with two members of parliament—Mr Thomas Wilson and Mr George Hibbert—Hillary founded the “Royal National Institution for the Preservation of Life from Shipwreck.” This, perhaps the grandest of England’s charitable societies, and now named the “Royal National Life-boat Institution,” was founded on the 4th of March 1824. The king patronized it; the archbishop of Canterbury presided at its birth; the most eloquent men in the land—among them Wilberforce—pleaded the cause; nevertheless, the institution began its career with a sum of only £9826. In the first year twelve new life-boats were built and placed at different stations, besides which thirty-nine life-boats had been stationed on the British shores by benevolent individuals and by independent associations over which the institution exercised no control though it often assisted them. In its early years the institution placed the mortar apparatus of Captain Manby at many stations, and provided for the wants of sailors and others saved from shipwreck,—a duty subsequently discharged by the “Shipwrecked Fishermen and Mariners’ Royal Benevolent Society.” At the date of the institution’s second report it had contributed to the saving of three hundred and forty-two lives, either by its own life-saving apparatus or by other means for which it had granted rewards. With fluctuating success, both as regards means and results, the institution continued its good work—saving many lives, and occasionally losing a few brave men in its tremendous battles with the sea. Since the adoption of the self-righting boats, loss of life in the service has been comparatively small and infrequent.

Towards the middle of the 19th century the life-boat cause appeared to lose interest with the British public, though the life-saving work was prosecuted with unremitting zeal, but the increasing loss of life by shipwreck, and a few unusually severe disasters to life-boats, brought about the reorganization of the society in 1850. The Prince Consort became vice-patron of the institution in conjunction with the king of the Belgians, and Queen Victoria, who had been its patron since her accession, became an annual contributor to its funds. In 1851 the duke of Northumberland became president, and from that time forward a tide of prosperity set in, unprecedented in the history of benevolent institutions, both in regard to the great work accomplished and the pecuniary aid received. In 1850 its committee undertook the immediate superintendence of all the life-boat work on the coasts, with the aid of local committees. Periodical inspections, quarterly exercise of crews, fixed rates of payments to coxswains and men, and quarterly reports, were instituted, at the time when the self-righting self-emptying boat came into being. This boat was the result of a hundred-guinea prize, offered by the president, for the best model of a life-boat, with another hundred to defray the cost of a boat built on the model chosen. In reply to the offer no fewer than two hundred and eighty models were sent in, not only from all parts of the United Kingdom, but from France, Germany, Holland and the United States of America. The prize was gained by Mr James Beeching of Great Yarmouth, whose model, slightly modified by Mr James Peake, one of the committee of inspection, was still further improved as time and experience suggested (see below).

The necessity of maintaining a thoroughly efficient life-boat service is now generally recognized by the people not only of Great Britain, but also of those other countries on the European Continent and America which have a seaboard, and of the British colonies, and numerous life-boat services have been founded more or less on the lines of the Royal National Life-boat Institution. The British Institution was again reorganized in 1883; it has since greatly developed both in its life-saving efficiency and financially, and has been spoken of in the highest terms as regards its management by successive governments—a Select Committee of the House of Commons in 1897 reporting to the House that the thanks of the whole community were due to the Institution for its energy and good management. On the death of Queen Victoria in January 1901 she was succeeded as patron of the Institution by Edward VII., who as prince of Wales had been its president for several years. At the close of 1908 the Institution’s fleet consisted of 280 life-boats, and the total number of lives for the saving of which the committee of management had granted rewards since the establishment of the Institution in 1824 was 47,983. At this time there were only seventeen life-boats on the coast of the United Kingdom which did not belong to the Institution. In 1882 the total amount of money received by the Institution from all sources was £57,797, whereas in 1901 the total amount received had increased to £107,293. In 1908 the receipts were £115,303, the expenditure £90,335.

In 1882 the Institution undertook, with the view of diminishing the loss of life among the coast fishermen, to provide the masters and owners of fishing-vessels with trustworthy aneroid barometers, at about a third of the retail price, and in 1883 the privilege was extended to the masters and owners of coasters under 100 tons burden. At the end of 1901 as many as 4417 of these valuable instruments had been supplied. In 1889 the committee of management secured the passing of the Removal of Wrecks Act 1877 Amendment Act, which provides for the removal of wrecks in non-navigable waters which might prove dangerous to life-boat crews and others. Under its provisions numerous highly dangerous wrecks have been removed.

In 1893 the chairman of the Institution moved a resolution in the House of Commons that, in order to decrease the serious loss of life from shipwreck on the coast, the British Government should provide either telephonic or telegraphic communication between all the coast-guard stations and signal stations on the coast of the United Kingdom; and that where there are no coast-guard stations the post offices nearest to the life-boat stations should be electrically connected, the object being to give the earliest possible information to the life-boat authorities at all times, by day and night, when the life-boats are required for service; and further, that a Royal Commission should be appointed to consider the desirability of electrically connecting the rock lighthouses, light-ships, &c., with the shore. The resolution was agreed to without a division, and its intention has been practically carried out, the results obtained having proved most valuable in the saving of life.

On the 1st of January 1898 a pension and gratuity scheme was introduced by the committee of management, under which life-boat coxswains, bowmen and signalmen of long and meritorious service, retiring on account of old age, accident, ill-health or abolition of office, receive special allowances as a reward for their good services. While these payments act as an incentive to the men to discharge their duties satisfactorily, they at the same time assist the committee of management in their effort to obtain the best men for the work. For many years the Institution has given compensation to any who may have received injury while employed in the service, besides granting liberal help to the widows and dependent relatives of any in the service who lose their own lives when endeavouring to rescue others.

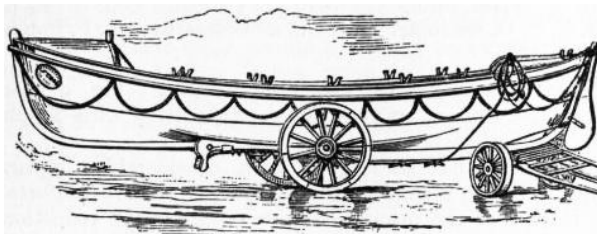


FIG. 1.—The 33-ft., Double-banked, Ten-oared, Self-righting and Self-emptying Life-boat (1881) of the Institution on its Transporting Carriage, ready for launching.

A very marked advance in improvement in design and suitability for service has been made in the life-boat since the reorganization of the Institution in 1883, but principally since 1887, when, as the result of an accident in December 1886 to two self-righting life-boats in Lancashire, twenty-seven out of twenty-nine of the men who manned them were drowned. At this time a permanent technical sub-committee was appointed by the Institution, whose object was, with the assistance of an eminent consulting naval architect—a new post created—and the Institution's official experts, to give its careful attention to the designing of improvements in the life-boat and its equipment, and to the scientific consideration of any inventions or proposals submitted by the public, with a view to adopting them if of practical utility. Whereas in 1881 the self-righting life-boat of that time was looked upon as the Institution's special life-boat, and there were very few life-boats in the Institution's fleet not of that type, at the close of 1901 the life-boats of the Institution included 60 non-self-righting boats of various types, known by the following designations: Steam life-boats 4, Cromer 3, Lamb and White 1, Liverpool 14, Norfolk and Suffolk 19, tubular 1, Watson 18. In 1901 a steam-tug was placed at Padstow for use solely in conjunction with the life-boats on the north coast of Cornwall. The self-righting life-boat of 1901 was a very different boat from that of 1881. The Institution's present policy is to allow the men who man the life-boats, after having seen and tried by deputation the various types, to select that in which they have the most confidence.

The present life-boat of the self-righting type (fig. 2) differs materially from its predecessor, the stability being increased and the righting power greatly improved. The test of efficiency in this last quality was formerly considered sufficient if the boat would quickly right herself in smooth water without her crew and gear, but every self-righting life-boat now built by the Institution will right with her full crew and gear on board, with her sails set and the anchor down. Most of the larger self-righting boats are furnished with "centre-boards" or "drop-keels" of varying size and weight, which can be used at pleasure, and materially add to their weather qualities. The drop-keel was for the first time placed in a life-boat in 1885.

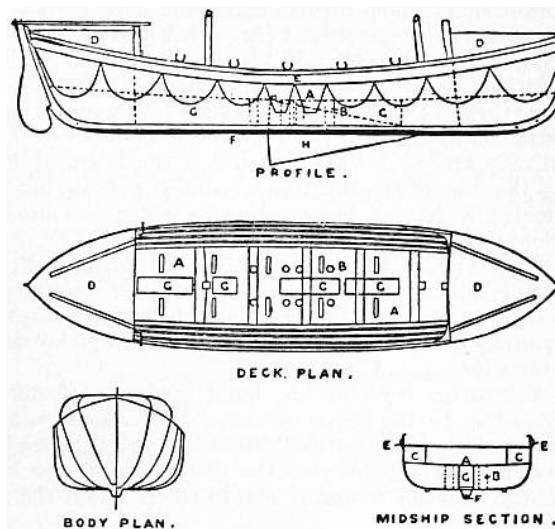


FIG. 2.—Plans, Profile and Section of Modern English Self-righting Life-boat.

- |  |   |
|--|---|
| A, Deck.   | E, Wale, or fender.   |
| B, Relieving valves for automatic discharge of water off deck.                             | F, Iron keel ballast, important in general stability and self-righting. |
| C, Side air-cases above deck.  | G, Water-ballast tanks.   |
| D, End air compartments, usually called "end-boxes," an important factor in self-righting. | H, Drop-keel.   |

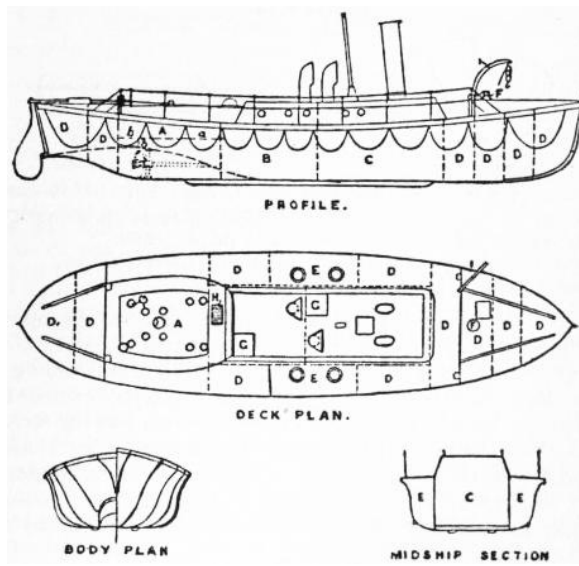


FIG. 3.—Plans, Profile and Section of English Steam Life-boat.

- |                     |  |
|---------------------|--|
| A, Cockpit.         | D, Water-tight compartments.           |
| a, Deck.            | E, Coal-bunkers.                       |
| b, Propeller hatch. | F, Capstan.                            |
| c, Relief valves.   | G, Hatches to engine and boiler rooms. |
| B, Engine-room.     | H, Cable reel.                         |
| C, Boiler-room.     | I, Anchor davit.                       |

Steam was first introduced into a life-boat in 1890, when the Institution, after very full inquiry and consideration, stationed on the coast a steel life-boat, 50 ft. long and 12 ft. beam, and a depth of 3 ft. 6 in., propelled by a turbine wheel driven by engines developing 170 horse-power. It had been previously held by all competent judges that a mechanically-propelled life-boat, suitable for service in heavy weather, was a problem surrounded by so many and great difficulties that even the most sanguine experts dared not hope for an early solution of it. This type of boat (fig. 3) has proved very useful. It is, however, fully recognized that boats of this description can necessarily be used at only a very limited number of stations, and where there is a harbour which never dries out. The highest speed attained by the first hydraulic steam life-boat was rather more than 9 knots, and that secured in the latest 9½ knots. In 1909 the fleet of the Institution included 4 steam life-boats and 8 motor life-boats. The experiments with motor life-boats in previous years had proved successful.

The other types of pulling and sailing life-boats are all non-self-righting, and are specially suitable for the requirements of the different parts of the coast on which they are placed. Their various qualities will be understood by a glance at the illustrations (figs. 4, 5, 6, 7 and 8).

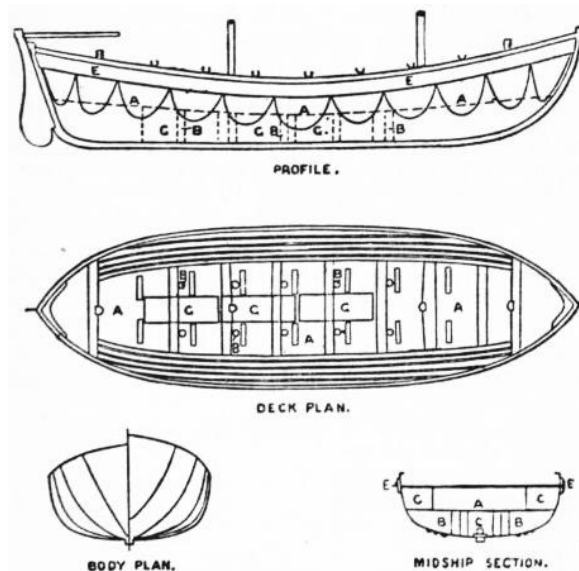


FIG. 4.—Plans, Profile and Section of Cromer Type of Life-boat.

- |  |                               |
|--|-------------------------------|
| A, Deck.   | C, Side air-cases above deck. |
| B, Relieving valves for automatic discharge of water off deck. | E, Wale, or fender.           |
|  | G, Water-ballast tanks.       |

The Institution continues to build life-boats of different sizes according to the requirements of the various points of the coast at which they are placed, but of late years the tendency has been generally to increase the dimensions of the boats. This change of policy is mainly due to the fact that the small coasters and fishing-boats have in great measure disappeared, their places being taken by steamers and steam trawlers. The cost of the building and equipping of pulling and sailing life-boats has materially increased, more especially since 1898, the

increase being mainly due to improvements and the seriously augmented charges for materials and labour. In 1881 the average cost of a fully-equipped life-boat and carriage was £650, whereas at the end of 1901 it amounted to £1000, the average annual cost of maintaining a station having risen to about £125.

The *transporting-carriage* continues to be a most important part of the equipment of life-boats, generally of the self-righting type, and is indispensable where it is necessary to launch the boats at any point not in the immediate vicinity of the boat-house. It is not, however, usual to supply carriages to boats of larger dimensions than 37 ft. in length by 9 ft. beam, those in excess as regards length and beam being either launched by means of special slipways or kept afloat. The transporting-carriage of to-day has been rendered particularly useful at places where the beach is soft, sandy or shingly, by the introduction in 1888 of Tipping's sand-plates. They are composed of an endless plateway or jointed wheel tyre fitted to the main wheels of the carriage, thereby enabling the boat to be transferred with rapidity and with greatly decreased labour over beach and soft sand. Further efficiency in launching has also been attained at many stations by the introduction in 1890 of pushing-poles, attached to the transporting-carriages, and of horse launching-poles, first used in 1892. Fig. 9 gives a view of the modern transporting-carriage fitted with Tipping's sand- or wheel-plates.

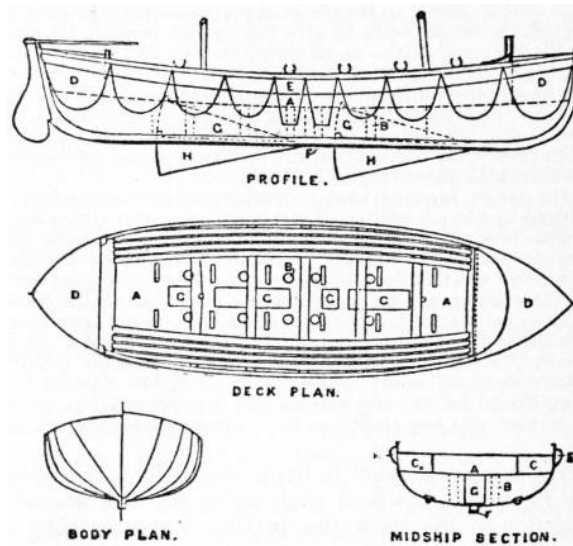


FIG. 5.—Plans, Profile and Section of Liverpool Type of Life-boat. A, B, C, E, G, as in fig. 3; D, end air-compartments; F, iron keel; H, drop-keels.

The *life-belt* has since 1898 been considerably improved, being now less cumbersome than formerly, and more comfortable. The feature of the principal improvement is the reduction in length of the corks under the arms of the wearer and the rounding-off of the upper portions, the result being that considerably more freedom is provided for the arms. The maximum extra buoyancy has thereby been reduced from 25 lb to 22 lb, which is more than sufficient to support a man heavily clothed with his head and shoulders above the water, or to enable him to support another person besides himself. Numerous life-belts of very varied descriptions, and made of all sorts of materials, have been patented, but it is generally agreed that for life-boat work the cork life-belt of the Institution has not yet been equalled.

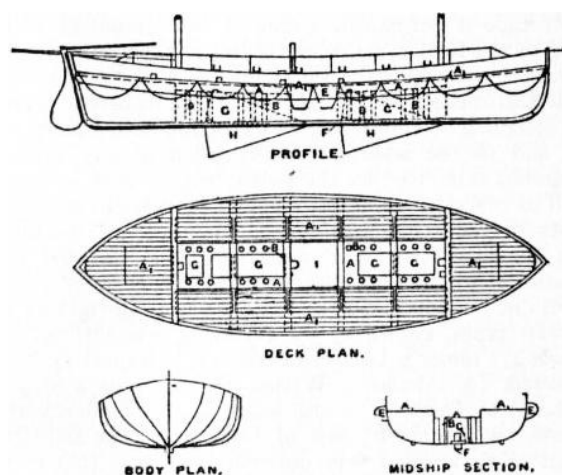


FIG. 6.—Plans, Profile and Section of Norfolk and Suffolk Type of Life-boat. A, B, E, F, G, H, as in fig. 4; A, side deck; I, cable-well.

*Life-saving rafts, seats for ships' decks, dresses, buoys, belts, &c.*, have been produced in all shapes and sizes, but apparently nothing indispensable has as yet been brought out. Those interested in life-saving appliances were hopeful that the Paris Exhibition of 1900 would have produced some life-saving invention which might prove a benefit to the civilized world, but so lacking in real merit were the life-saving exhibits that the jury of experts were unable to award to any of the 435 competitors the Andrew Pollok prize of £4000 for the best method or device for saving life from shipwreck.

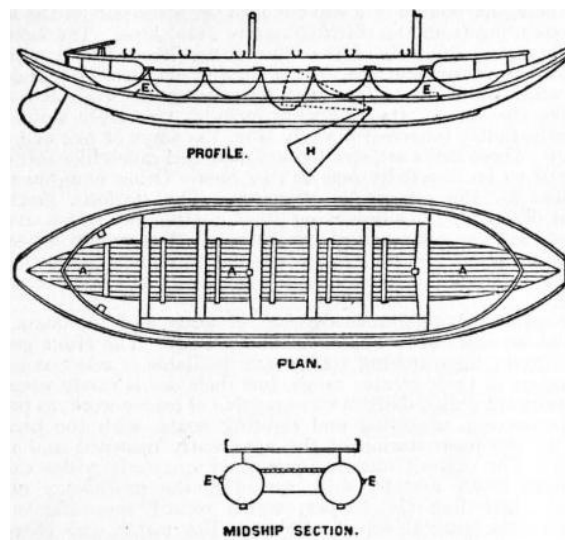


FIG. 7.—Plan, Profile and Section of Tubular Type of Life-boat. A, deck; E, wale, or fender; H, drop-keel.

The *rocket apparatus*, which in the United Kingdom is under the management of the coast-guard, renders excellent service in life-saving. This, next to the life-boat, is the most important and successful means by which shipwrecked persons are rescued on the British shores. Many vessels are cast every year on the rocky parts of the coasts, under cliffs, where no life-boat could be of service. In such places the rocket alone is available.

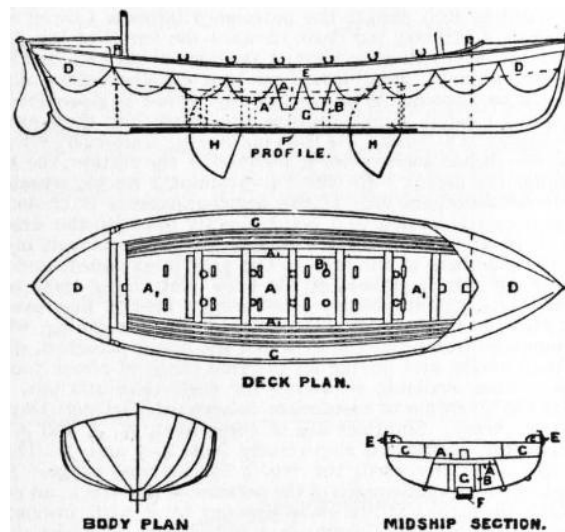


FIG. 8.—Plans, Profile and Section of Watson Type of Life-boat. Lettering as in fig. 5, but C, side air-cases above deck and thwarts.

The rocket apparatus consists of five principal parts, viz. the rocket, the rocket-line, the whip, the hawser and the sling life-buoy. The mode of working it is as follows. A rocket, having a light line attached to it, is fired over the wreck. By means of this line the wrecked crew haul out the whip, which is a double or endless line, rove through a block with a tail attached to it. The tail-block, having been detached from the rocket-line, is fastened to a mast, or other portion of the wreck, high above the water. By means of the whip the rescuers haul off the hawser, to which is hung the travelling or sling life-buoy. When one end of the hawser has been made fast to the mast, about 18 in. *above* the whip, and its other end to tackle fixed to an anchor on shore, the life-buoy is run out by the rescuers, and the shipwrecked persons, getting into it one at a time, are hauled ashore. Sometimes, in cases of urgency, the life-buoy is worked by means of the whip alone, without the hawser. Captain G. W. Manby, F.R.S., in 1807 invented, or at least introduced, the mortar apparatus, on which the system of the rocket apparatus, which superseded it in England, is founded. Previously, however, in 1791, the idea of throwing a rope from a wreck to the shore by means of a shell from a mortar had occurred to Serjeant Bell of the Royal Artillery, and about the same time, to a Frenchman named La Fère, both of whom made successful experiments with their apparatus. In the same year (1807) a rocket was proposed by Mr Trengrouse of Helston in Cornwall, also a hand and lead line as means of communicating with vessels in distress. The *heaving-cane* was a fruit of the latter suggestion. In 1814 forty-five mortar stations were established, and Manby received £2000, in addition to previous grants, in acknowledgment of the good service rendered by his invention. Mr John Dennett of Newport, Isle of Wight, introduced the rocket, which was afterwards extensively used. In 1826 four places in the Isle of Wight were supplied with Dennett's rockets, but it was not till after government had taken the apparatus under its own control, in 1855, that the rocket invented by Colonel Boxer was adopted. Its peculiar characteristic lies in the combination of two rockets in one case, one being a continuation of the other, so that, after the first compartment has carried the machine to its full elevation, the second gives it an additional impetus whereby a great increase of range is obtained.

(R. M. B.; C. D.)

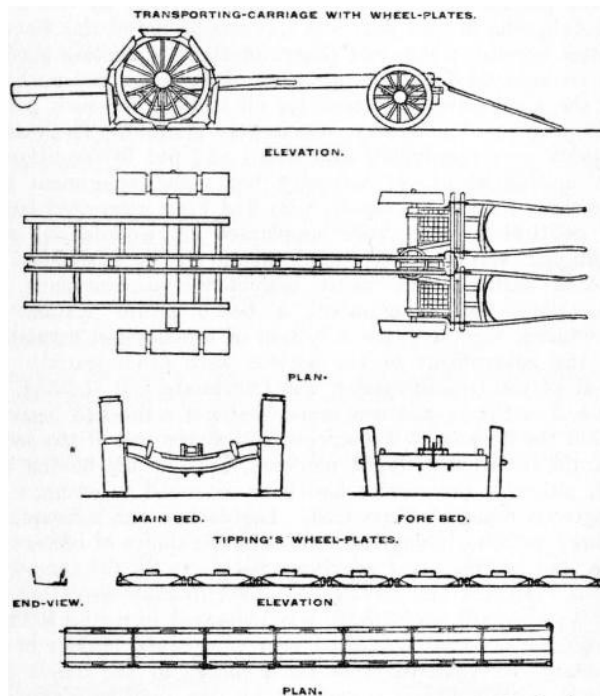


FIG. 9.—Life-boat Transporting-Carriage with Tipping's Wheel-Plates.

UNITED STATES.—In the extent of coast line covered, magnitude of operations and the extraordinary success which has crowned its efforts, the life-saving service of the United States is not surpassed by any other institution of its kind in the world. Notwithstanding the exposed and dangerous nature of the coasts flanking and stretching between the approaches to the principal seaports, and the immense amount of shipping concentrating upon them, the loss of life among a total of 121,459 persons imperilled by marine casualty within the scope of the operations of the service from its organization in 1871 to the 30th of June 1907, was less than 1%, and even this small proportion is made up largely of persons washed overboard immediately upon the striking of vessels and before any assistance could reach them, or lost in attempts to land in their own boats, and people thrown into the sea by the capsizing of small craft. In the scheme of the service, next in importance to the saving of life is the saving of property from marine disaster, for which no salvage or reward is allowed. During the period named vessels and cargoes to the value of nearly two hundred million dollars were saved, while only about a quarter as much was lost.

The first government life-saving stations were plain boat-houses erected on the coast of New Jersey in 1848, each equipped with a fisherman's surf-boat and a mortar and life-car with accessories. Prior to this time, as early as 1789, a benevolent organization known as the Massachusetts Humane Society had erected rude huts along the coast of that state, followed by a station at Cohasset in 1807 equipped with a boat for use by volunteer crews. Others were subsequently added. Between 1849 and 1870 this society secured appropriations from Congress aggregating \$40,000. It still maintains sixty-nine stations on the Massachusetts coast. The government service was extended in 1849 to the coast of Long Island, and in 1850 one station was placed on the Rhode Island coast. In 1854 the appointment of keepers for the New Jersey and Long Island stations, and a superintendent for each of these coasts, was authorized by law. Volunteer crews were depended upon until 1870, when Congress authorized crews at each alternate station for the three winter months.

The present system was inaugurated in 1871 by Sumner I. Kimball, who in that year was appointed chief of the Revenue Cutter Service, which had charge of the few existing stations. He recommended an appropriation of \$200,000 and authority for the employment of crews for all stations for such periods as were deemed necessary, which were granted. The existing stations were thoroughly overhauled and put in condition for the housing of crews; necessary boats and equipment were furnished; incapable keepers, who had been appointed largely for political reasons, were supplanted by experienced men; additional stations were established; all were manned by capable surfmen; the merit system for appointments and promotions was inaugurated; a beach patrol system was introduced, together with a system of signals; and regulations for the government of the service were promulgated. The result of the transformation was immediate and striking. At the end of the year it was found that not a life had been lost within the domain of the service; and at the end of the second year the record was almost identical, but one life having been lost, although the service had been extended to embrace the dangerous coast of Cape Cod. Legislation was subsequently secured, totally eliminating politics in the choice of officers and men, and making other provisions necessary for the completion of the system. The service continued to grow in extent and importance until, in 1878, it was separated from the Revenue Cutter Service and organized into a separate bureau of the Treasury, its administration being placed in the hands of a general superintendent appointed by the president and confirmed by the senate, his term of office being limited only by the will of the president. Mr Kimball was appointed to the position, which he still held in 1909.

The service embraces thirteen districts, with 280 stations located at selected points upon the sea and lake coasts. Nine districts on the Atlantic and Gulf coasts contain 201 stations, including nine houses of refuge on the Florida coast, each in charge of a keeper only, without crews; three districts on the Great Lakes contain 61 stations, including one at the falls of the Ohio river, Louisville, Kentucky; and one district on the Pacific coast contains 18 stations, including one at Nome, Alaska.

The general administration of the service is conducted by a general superintendent; an inspector of life-saving stations and two superintendents of construction of life-saving stations detailed from the Revenue Cutter Service; a district superintendent for each district; and assistant inspectors of stations, also detailed from the Revenue Cutter Service "to perform such duties in connexion with the conduct of the service as the general superintendent may require." There is also an advisory board on life-saving appliances consisting of experts, to consider devices and inventions submitted by the general superintendent.

Station crews are composed of a keeper and from six to eight surfmen, with an additional man during the winter months at most of the stations on the Atlantic coast. The surfmen are reenlisted from year to year during good behaviour, subject to a thorough physical examination. The keepers are also subject to annual physical examinations after attaining the age of fifty-five. Stations on the Atlantic and Gulf coasts are manned from August 1st to May 31st. On the lakes the active season covers the period of navigation, from about April 1st to early in December. The falls station at Louisville, and all stations on the Pacific coast, are in commission continuously. One station, located in Dorchester Bay, an expanse of water within Boston harbour, where numerous yachts rendezvous and many accidents occur, which, with the one at Louisville are, believed to be the only floating life-saving stations in the world, is manned from May 1st to November 15th. Its equipment includes a steam tug and two gasoline launches, the latter being harboured in a slip cut into the after-part of the station and extending from the stern to nearly amidships. The Louisville stations guard the falls of the Ohio river, where life is much endangered from accidents to vessels passing over the falls and small craft which are liable to be drawn into the chutes while attempting to cross the river. Its equipment includes two river skiffs which can be instantly launched directly from the ways at one end of the station. These skiffs are small boats modelled much like surf-boats, designed to be rowed by one or two men. Other equipments are provided for the salvage of property. The stations, located as near as practicable to a launching place, contain as a rule convenient quarters for the residence of the keeper and crew and a boat and apparatus room. In some instances the dwelling- and boat-house are built separately. Each station has a look-out tower for the day watch.

The principal apparatus consists of surf- and life-boats, Lyle gun and breeches-buoy apparatus and life-car. The Hunt gun and Cunningham line-carrying rocket are available at selected stations on account of their greater range, but their use is rarely necessary. The crews are drilled daily in some portion of rescue work, as practice in manœuvring, upsetting and righting boats, with the breeches-buoy, in the resuscitation of the apparently drowned and in signalling. The district officers upon their quarterly visits examine the crews orally and by drill, recording the proficiency of each member, including the keeper, which record accompanies their report to the general superintendent. For watch and patrol the day of twenty-four hours is divided into periods of four or five hours each. Day watches are stood by one man in the look-out tower or at some other point of vantage, while two men are assigned to each night watch between sunset and sunrise. One of the men remains on watch at the station, dividing his time between the beach look-out and visits to the telephone at specified intervals to receive messages, the service telephone system being extended from station to station nearly throughout the service, with watch telephones at half-way points. The other man patrols the beach to the end of his beat and returns, when he takes the look-out and his watchmate patrols in the opposite direction. A like patrol and watch is maintained in thick or stormy weather in the daytime. Between adjacent stations a record of the patrol is made by the exchange of brass checks; elsewhere the patrolman carries a watchman's clock, on the dial of which he records the time of his arrival at the keypost which marks the end of his beat. On discovering a vessel standing into danger the patrolman burns a Coston signal, which emits a brilliant red flare, to warn the vessel of her danger. The number of vessels thus warned averages about two hundred in each year, whereby great losses are averted, the extent of which can never be known. When a stranded vessel is discovered, the patrolman's Coston signal apprises the crew that they are seen and assistance is at hand. He then notifies his station, by telephone if possible. When such notice is received at the station, the keeper determines the means with which to attempt a rescue, whether by boat or beach-apparatus. If the beach-apparatus is chosen, the apparatus cart is hauled to a point directly opposite the wreck by horses, kept at most of the stations during the inclement months, or by the members of the crew. The gear is unloaded, and while being set up—the members of the crew performing their several allotted parts simultaneously—the keeper fires a line over the wreck with the Lyle gun, a small bronze cannon weighing, with its 18 lb elongated iron projectile to which the line is attached, slightly more than 200 lb, and having an extreme range of about 700 yds., though seldom available at wrecks for more than 400 yds. This gun was the invention of Lieutenant (afterwards Colonel) David A. Lyle, U.S. Army. Shot lines are of three sizes,  $\frac{1}{32}$ ,  $\frac{7}{32}$  and  $\frac{9}{32}$  of an inch diameter, designated respectively Nos. 4, 7 and 9. The two larger are ordinarily used, the No. 4 for extreme range. A line having been fired within reach of the persons on the wreck, an endless rope rove through a tail-block is sent out by it with instructions, printed in English and French on a tally-board, to make the tail fast to a mast or other elevated portion of the wreck. This done, a 3-in. hawser is bent on to the whip and hauled off to the wreck, to be made fast a little above the tail-block, after which the shore end is hauled taut over a crotch by means of tackle attached to a sand anchor. From this hawser the breeches-buoy or life-car is suspended and drawn between the ship and shore of the endless whip-line. The life-car can also be drawn like a boat between ship and shore without the use of a hawser. The breeches-buoy is a cork life-buoy to which is attached a pair of short canvas breeches, the whole suspended from a traveller block by suitable lanyards. It usually carries one person at a time, although two have frequently been brought ashore together. The life-car, first introduced in 1848, is a boat of corrugated iron with a convex iron cover, having a hatch in the top for the admission of passengers, which can be fastened either from within or without, and a few perforations to admit air, with raised edges to exclude water. At wreck operations during the night the shore is illuminated by powerful acetylene (calcium carbide) lights. If any of the rescued persons are frozen, as often happens, or are injured or sick, first aid and simple remedies are furnished them. Dry clothing, supplied by the Women's National Relief Association, is also furnished to survivors, which the destitute are allowed to keep.

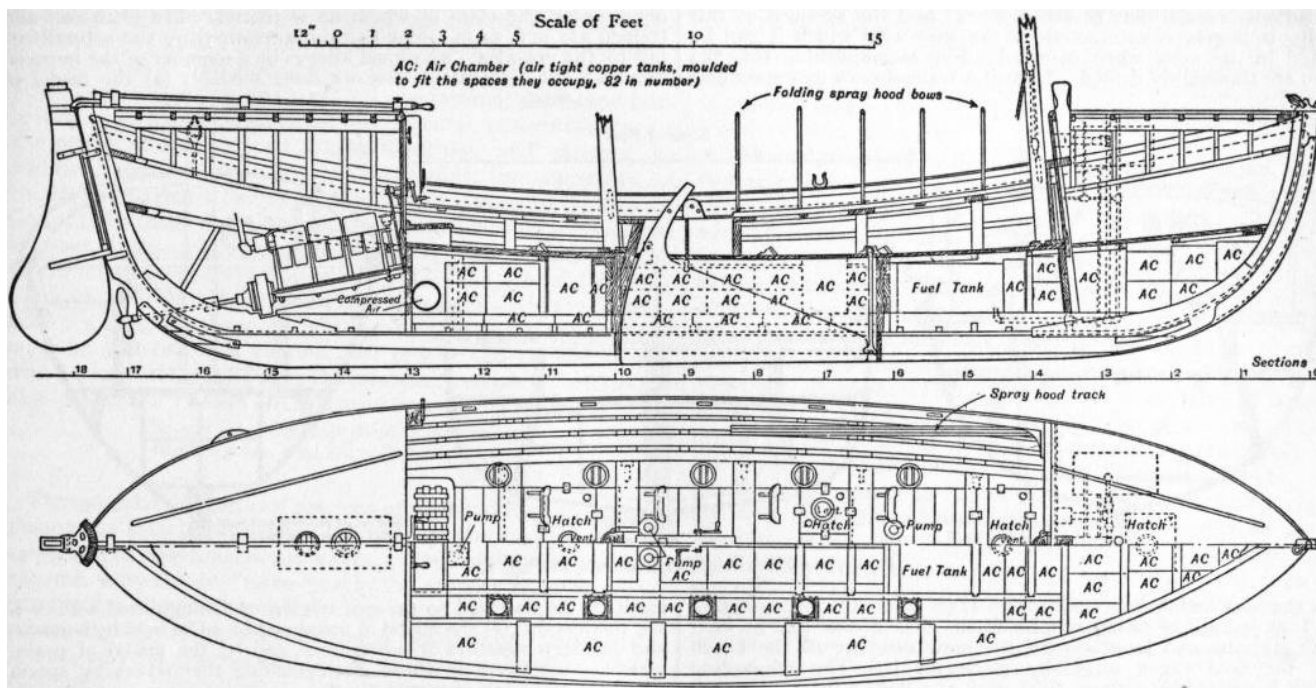
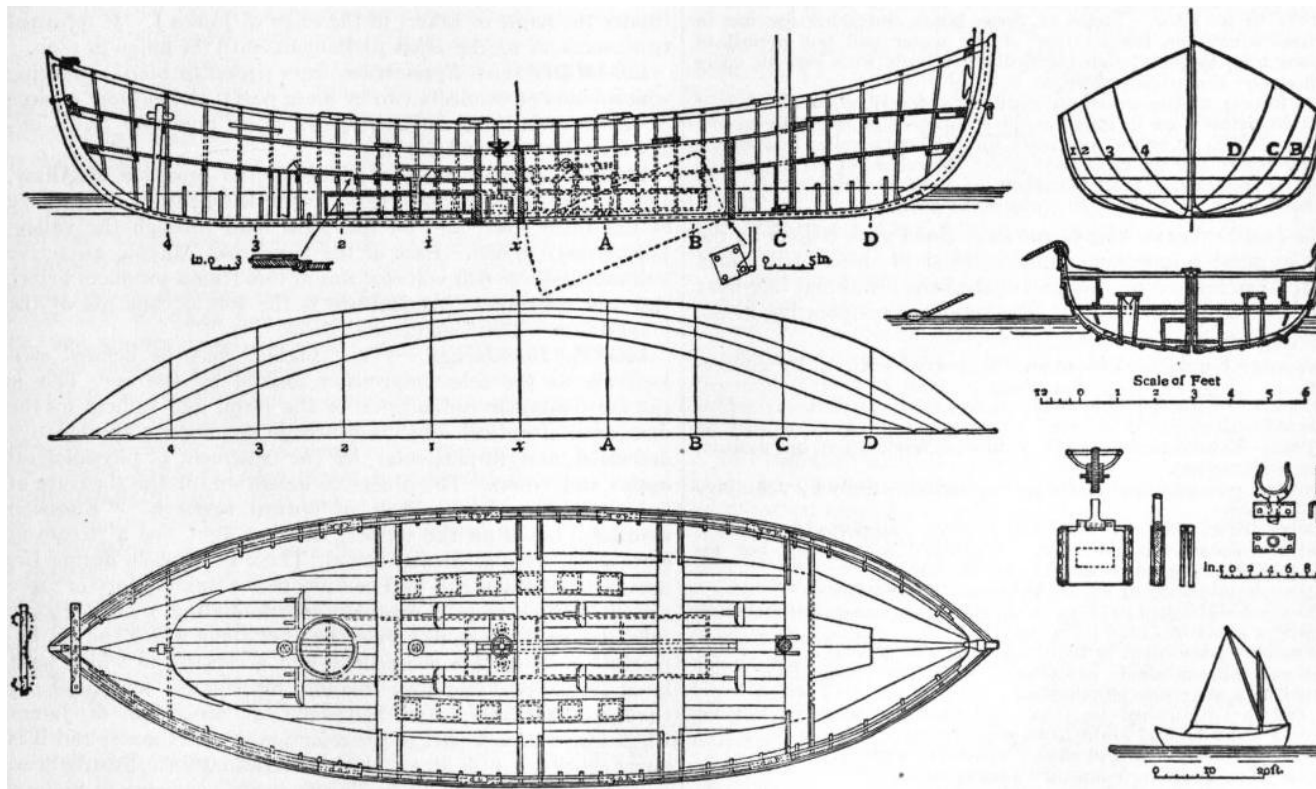


FIG. 10.—American Power Life-boat.

Several types of light open surf-boats are used, adapted to the special requirements of the different localities and occasions. They are built of cedar, from 23 to 27 ft. long, and are provided with end air chambers and longitudinal air cases on each side under the thwarts.



Self-righting and self-bailing life-boats, patterned after those used in England and other countries, have heretofore been used at most of the Lake stations and at points on the ocean coast where they can be readily launched from ways. Most of these boats, however, have now been transformed into power boats without the sacrifice of any of their essential qualities. The installation of power is effected by introducing a 25 H.P. four-cycle gasoline motor, weighing with its fittings, tanks, &c., about 800 lb. The engine is installed in the after air chamber, with the starting crank, reversing clutches, &c., recessed into the bulkhead to protect them from accidents. These boats attain a speed of from 7 to 9 m. an hour, and have proved extremely efficient. A new power life-boat (fig. 10) on somewhat improved lines, 36 ft. in length, and equipped with a 35-40 H.P. gasoline engine, promises to prove still more efficient. A number of surf-boats have also been equipped with gasoline engines of from 5 to 7 H.P., for light and quick work, with very satisfactory results.



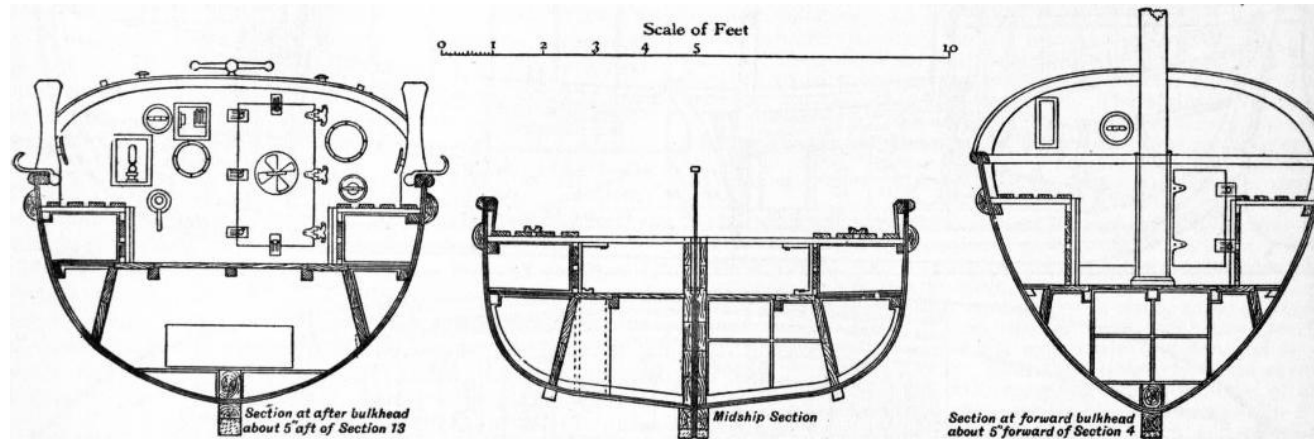


FIG. 12.—Details of boat shown in Fig. 10.

A distinctively American life-boat extensively used is the Beebe-McLellan self-bailing boat (fig. 11), which for all round life-saving work is held in the highest esteem. It possesses all the qualities of the self-righting and self-bailing life-boats in use in all life-saving institutions, except that of self-righting; and the sacrifice of this quality is largely counteracted by the ease with which it can be righted by its crew when capsized. For accomplishing this the crews are thoroughly drilled. In drill a trained crew can upset and right the boat and resume their places at the oars in twenty seconds. The boat is built of cedar, weighs about 1200 lb, and can be used at all stations and launched by the crew directly off the beach from the boat-wagon especially made for it. The self-bailing quality is secured by a water-tight deck at a level a little above the load water line with relieving tubes fitted with valves through which any water shipped runs back into the sea by gravity. Air cases along the sides under the thwarts, inclining towards the middle of the boat, minimize the quantity of water taken in, and the water-ballast tank in the bottom increases the stability by the weight of the water which can be admitted by opening the valve. When transported along the land it is empty. The Beebe-McLellan boat is 25 ft. long, 7 ft. beam, and will carry 12 to 15 persons in addition to its crew. Some of these boats, intended for use in localities where the temperature of the water will not permit of frequent upsetting and righting drills, are built with end air cases which render them self-righting.

In addition to the principal appliances described, a number of minor importance are included in the equipment of every life-saving station, such as launching carriages for life-boats, roller boat-skids, heaving sticks and all necessary tools. Members of all life-saving crews are required on all occasions of boat practice or duty at wrecks to wear life-belts of the prescribed pattern.

(A. T. T.)

*Life-boat Service in other Countries.*—Good work is done by the life-boat service in other countries, most of these institutions having been formed on the lines of the Royal National Life-boat Institution of Great Britain. The services are operating in the following countries:—

*Belgium.*—Established in 1838. Supported entirely by government.

*Denmark.*—Established in 1848. Government service.

*Sweden.*—Established in 1856. Government service.

*France.*—Established in 1865. Voluntary association, but assisted by the government.

*Germany.*—Established in 1885. Supported entirely by voluntary contributions.

*Turkey (Black Sea).*—Established in 1868. Supported by dues.

*Russia.*—Established in 1872. Voluntary association, but receiving an annual grant from the government.

*Italy.*—Established in 1879. Voluntary association.

*Spain.*—Established in 1880. Voluntary association, but receiving annually a grant of £1440 from government.

*Canada.*—Established in 1880. Government service.

*Holland.*—Established in 1884. Voluntary association, but assisted by a government subsidy.

*Norway.*—Established in 1891. Voluntary association, but receiving a small annual grant from government.

*Portugal.*—Established in 1898. Voluntary society.

*India (East Coast).*—Voluntary association.

*Australia (South).*—Voluntary association.

*New Zealand.*—Voluntary association.

*Japan.*—The National Life-boat Institution of Japan was founded in 1889. It is a voluntary society, assisted by government. Its affairs are managed by a president and a vice-president, supported by a very influential council. The head office is at Tōkyō; there are numerous branches with local committees. The Imperial government contributes an annual subsidy of 20,000 yen (£2000). The members of the Institution consist of three classes—honorary, ordinary and sub-ordinary, the amount contributed by the member determining the class in which he is placed. The chairman and council are not, as in Great Britain, appointed by the subscribers, but by the president, who must always be a member of the imperial family. The Institution bestows three medals: (a) the medal of merit, to be awarded to persons rendering distinguished service to the Institution; (b) the medal of membership, to be held by honorary and ordinary members or subscribers; and (c) the medal of praise, which is bestowed on those distinguishing themselves by special service in the work of rescue.



**LIFFORD**, the county town of Co. Donegal, Ireland, on the left bank of the Foyle. Pop. (1901) 446. The county gaol, court house and infirmary are here, but the town is practically a suburb of Strabane, across the river, in Co. Londonderry. Lifford, formerly called Ballyduff, was a chief stronghold of the O'Donnells of Tyrconnell. It was incorporated as a borough (under the name of Liffer) in the reign of James I. It returned two members to the Irish parliament until the union in 1800.



**LIGAMENT** (Lat. *ligamentum*, from *ligare*, to bind), anything which binds or connects two or more parts; in anatomy a piece of tissue connecting different parts of an organism (see [CONNECTIVE TISSUES](#) and [JOINTS](#)).



**LIGAO**, a town near the centre of the province of Albay, Luzon, Philippine Islands, close to the left bank of a tributary of the Bicol river, and on the main road through the valley. Pop. (1903) 17,687. East of the town rises Mayón, an active volcano, and the rich volcanic soil in this region produces hemp, rice and coco-nuts. Agriculture is the sole occupation of the inhabitants. Their language is Bicol.



**LIGHT.** *Introduction.*—§ 1. "Light" may be defined subjectively as the sense-impression formed by the eye. This is the most familiar connotation of the term, and suffices for the discussion of optical subjects which do not require an objective definition, and, in particular, for the treatment of physiological optics and vision. The objective definition, or the "nature of light," is the *ultima Thule* of optical research. "Emission theories," based on the supposition that light was a stream of corpuscles, were at first accepted. These gave place during the opening decades of the 19th century to the "undulatory or wave theory," which may be regarded as culminating in the "elastic solid theory"—so named from the lines along which the mathematical investigation proceeded—and according to which light is a transverse vibratory motion propagated longitudinally through the aether. The mathematical researches of James Clerk Maxwell have led to the rejection of this theory, and it is now held that light is identical with electromagnetic disturbances, such as are generated by oscillating electric currents or moving magnets. Beyond this point we cannot go at present. To quote Arthur Schuster (*Theory of Optics*, 1904), "So long as the character of the displacements which constitute the waves remains undefined we cannot pretend to have established a theory of light." It will thus be seen that optical and electrical phenomena are co-ordinating as a phase of the physics of the "aether," and that the investigation of these sciences culminates in the derivation of the properties of this conceptual medium, the existence of which was called into being as an instrument of research.<sup>1</sup> The methods of the elastic-solid theory can still be used with advantage in treating many optical phenomena, more especially so long as we remain ignorant of fundamental matters concerning the origin of electric and magnetic strains and stresses; in addition, the treatment is more intelligible, the researches on the electromagnetic theory leading in many cases to the derivation of differential equations which express quantitative relations between diverse phenomena, although no precise meaning can be attached to the symbols employed. The school following Clerk Maxwell and Heinrich Hertz has certainly laid the foundations of a complete theory of light and electricity, but the methods must be adopted with caution, lest one be constrained to say with Ludwig Boltzmann as in the introduction to his *Vorlesungen über Maxwell's Theorie der Elektrizität und des Lichtes*:—

"So soll ich denn mit saurem Schweiss  
Euch lehren, was ich selbst nicht weiss."  
GOETHE, *Faust*.

The essential distinctions between optical and electromagnetic phenomena may be traced to differences in the lengths of light-waves and of electromagnetic waves. The aether can probably transmit waves of any wave-length, the velocity of longitudinal propagation being about  $3.10^{10}$  cms. per second. The shortest waves, discovered by Schumann and accurately measured by Lyman, have a wave-length of 0.0001 mm.; the ultra-violet, recognized by their action on the photographic plate or by their promoting fluorescence, have a wave-length of 0.0002 mm.; the eye recognizes vibrations of a wave-length ranging from about 0.0004 mm. (violet) to about 0.0007 (red); the infra-red rays, recognized by their heating power or by their action on phosphorescent bodies, have a wave-length of 0.001 mm.; and the longest waves present in the radiations of a luminous source are the residual rays ("*Rest-strahlen*") obtained by repeated reflections from quartz (.0085 mm.), from fluorite (0.056 mm.), and from sylvite (0.06 mm.). The research-field of optics includes the investigation of the rays which we have just enumerated. A delimitation may then be made, inasmuch as luminous sources yield no other

radiations, and also since the next series of waves, the electromagnetic waves, have a minimum wave-length of 6 mm.

§ 2. The commonest subjective phenomena of light are colour and visibility, *i.e.* why are some bodies visible and others not, or, in other words, what is the physical significance of the words “transparency,” “colour” and “visibility.” What is ordinarily understood by a *transparent* substance is one which transmits all the rays of white light without appreciable absorption—that some absorption does occur is perceived when the substance is viewed through a sufficient thickness. *Colour* is due to the absorption of certain rays of the spectrum, the unabsorbed rays being transmitted to the eye, where they occasion the sensation of colour (see [COLOUR](#); [ABSORPTION OF LIGHT](#)). Transparent bodies are seen partly by reflected and partly by transmitted light, and opaque bodies by absorption. Refraction also influences visibility. Objects immersed in a liquid of the same refractive index and dispersion would be invisible; for example, a glass rod can hardly be seen when immersed in Canada balsam; other instances occur in the petrological examination of rock-sections under the microscope. In a complex rock-section the boldness with which the constituents stand out are measures of the difference between their refractive indices and the refractive index of the mounting medium, and the more nearly the indices coincide the less defined become the boundaries, while the interior of the mineral may be most advantageously explored. Lord Rayleigh has shown that transparent objects can only be seen when non-uniformly illuminated, the differences in the refractive indices of the substance and the surrounding medium becoming inoperative when the illumination is uniform on all sides. R. W. Wood has performed experiments which confirm this view.

The analysis of white light into the spectrum colours, and the reformation of the original light by transmitting the spectrum through a reversed prism, proved, to the satisfaction of Newton and subsequent physicists until late in the 19th century, that the various coloured rays were present in white light, and that the action of the prism was merely to sort out the rays. This view, which suffices for the explanation of most phenomena, has now been given up, and the modern view is that the prism or grating really does *manufacture* the colours, as was held previously to Newton. It appears that white light is a sequence of irregular wave trains which are analysed into series of more regular trains by the prism or grating in a manner comparable with the analytical resolution presented by Fourier’s theorem. The modern view points to the *mathematical* existence of waves of all wave-lengths in white light, the Newtonian view to the *physical* existence. Strictly, the term “monochromatic” light is only applicable to light of a single wave-length (which can have no actual existence), but it is commonly used to denote light which cannot be analysed by the instruments at our disposal; for example, with low-power instruments the light emitted by sodium vapour would be regarded as homogeneous or monochromatic, but higher power instruments resolve this light into two components of different wave-lengths, each of which is of a higher degree of homogeneity, and it is not impossible that these rays may be capable of further analysis.

§ 3. *Divisions of the Subject.*—In the early history of the science of light or optics a twofold division was adopted: *Catoptrics* (from Gr. κάτοπτρον, a mirror), embracing the phenomena of reflection, *i.e.* the formation of images by mirrors; and *Dioptrics* (Gr. διά, through), embracing the phenomena of refraction, *i.e.* the bending of a ray of light when passing obliquely through the surface dividing two media.<sup>2</sup> A third element, *Chromatics* (Gr. χρώμα, colour), was subsequently introduced to include phenomena involving colour transformations, such as the iridescence of mother-of-pearl, feathers, soap-bubbles, oil floating on water, &c. This classification has been discarded (although the terms, particularly “dioptric” and “chromatic,” have survived as adjectives) in favour of a twofold division: geometrical optics and physical optics. *Geometrical optics* is a mathematical development (mainly effected by geometrical methods) of three laws assumed to be rigorously true: (1) the law of rectilinear propagation, viz. that light travels in straight lines or *rays* in any homogeneous medium; (2) the law of reflection, viz. that the incident and reflected rays at any point of a surface are equally inclined to, and coplanar with, the normal to the surface at the point of incidence; and (3) the law of refraction, viz. that the incident and refracted rays at a surface dividing two media make angles with the normal to the surface at the point of incidence whose sines are in a ratio (termed the “refractive index”) which is constant for every particular pair of media, and that the incident and refracted rays are coplanar with the normal. *Physical optics*, on the other hand, has for its ultimate object the elucidation of the question: what is light? It investigates the nature of the rays themselves, and, in addition to determining the validity of the axioms of geometrical optics, embraces phenomena for the explanation of which an expansion of these assumptions is necessary.

Of the subordinate phases of the science, “physiological optics” is concerned with the phenomena of vision, with the eye as an optical instrument, with colour-perception, and with such allied subjects as the appearance of the eyes of a cat and the luminosity of the glow-worm and firefly; “meteorological optics” includes phenomena occasioned by the atmosphere, such as the rainbow, halo, corona, mirage, twinkling of stars and colour of the sky, and also the effects of atmospheric dust in promoting such brilliant sunsets as were seen after the eruption of Krakatoa; “magneto-optics” investigates the effects of electricity and magnetism on optical properties; “photo-chemistry,” with its more practical development photography, is concerned with the influence of light in effecting chemical action; and the term “applied optics” may be used to denote, on the one hand, the experimental investigation of material for forming optical systems, *e.g.* the study of glasses with a view to the formation of a glass of specified optical properties (with which may be included such matters as the transparency of rock-salt for the infra-red and of quartz for the ultra-violet rays), and, on the other hand, the application of geometrical and physical investigations to the construction of optical instruments.

610

§ 4. *Arrangement of the Subject.*—The following three divisions of this article deal with: (I.) the history of the science of light; (II.) the nature of light; (III.) the velocity of light; but a summary (which does not aim at scientific precision) may here be given to indicate to the reader the inter-relation of the various optical phenomena, those phenomena which are treated in separate articles being shown in larger type.

The simplest subjective phenomena of light are [COLOUR](#) and intensity, the measurement of the latter being named [PHOTOMETRY](#). When light falls on a medium, it may be returned by [REFLECTION](#) or it may suffer [ABSORPTION](#); or it may be transmitted and undergo [REFRACTION](#), and, if the light be composite, [DISPERSION](#); or, as in the case of oil films on water, brilliant colours are seen, an effect which is due to [INTERFERENCE](#). Again, if the rays be transmitted in two directions, as with certain crystals, “double refraction” (see [REFRACTION](#), [DOUBLE](#)) takes place, and the emergent rays have undergone [POLARIZATION](#). A [SHADOW](#) is cast by light falling on an opaque object, the complete theory of which involves the phenomenon of [DIFFRACTION](#). Some substances have the property of transforming luminous radiations, presenting the phenomena of [CALORESCENCE](#), [FLUORESCENCE](#) and [PHOSPHORESCENCE](#). An optical system is composed of any number of [MIRRORS](#) or [LENSES](#), or of both. If light falling on a system be not brought to

a focus, *i.e.* if all the emergent rays be not concurrent, we are presented with a CAUSTIC and an ABERRATION. An optical instrument is simply the setting up of an optical system, the TELESCOPE, MICROSCOPE, OBJECTIVE, optical LANTERN, CAMERA LUCIDA, CAMERA OBSCURA and the KALEIDOSCOPE are examples; instruments serviceable for simultaneous vision with both eyes are termed BINOCULAR INSTRUMENTS; the STEREOSCOPE may be placed in this category; the optical action of the Zoétrope, with its modern development the CINEMATOGRAPH, depends upon the physiological persistence of VISION. Meteorological optical phenomena comprise the CORONA, HALO, MIRAGE, RAINBOW, colour of SKY and TWILIGHT, and also astronomical refraction (see REFRACTION, ASTRONOMICAL); the complete theory of the corona involves DIFFRACTION, and atmospheric DUST also plays a part in this group of phenomena.

## I. HISTORY

§ 1. There is reason to believe that the ancients were more familiar with optics than with any other branch of physics; and this may be due to the fact that for a knowledge of external things man is indebted to the sense of vision in a far greater degree than to other senses. That light travels in straight lines—or, in other words, that an object is seen in the direction in which it really lies—must have been realized in very remote times. The antiquity of mirrors points to some acquaintance with the phenomena of reflection, and Layard's discovery of a convex lens of rock-crystal among the ruins of the palace of Nimrud implies a knowledge of the burning and magnifying powers of this instrument. The Greeks were acquainted with the fundamental law of reflection, *viz.* the equality of the angles of incidence and reflection; and it was Hero of Alexandria who proved that the path of the ray is the least possible. The lens, as an instrument for magnifying objects or for concentrating rays to effect combustion, was also known. Aristophanes, in the *Clouds* (*c.* 424 B.C.), mentions the use of the burning-glass to destroy the writing on a waxed tablet; much later, Pliny describes such glasses as solid balls of rock-crystal or glass, or hollow glass balls filled with water, and Seneca mentions their use by engravers. A treatise on optics (Κατοπτρικά), assigned to Euclid by Proclus and Marinus, shows that the Greeks were acquainted with the production of images by plane, cylindrical and concave and convex spherical mirrors, but it is doubtful whether Euclid was the author, since neither this work nor the *Optiká*, a work treating of vision and also assigned to him by Proclus and Marinus, is mentioned by Pappus, and more particularly since the demonstrations do not exhibit the precision of his other writings.

Reflection, or catoptrics, was the key-note of their explanations of optical phenomena; it is to the reflection of solar rays by the air that Aristotle ascribed twilight, and from his observation of the colours formed by light falling on spray, he attributes the rainbow to reflection from drops of rain. Although certain elementary phenomena of refraction had also been noted—such as the apparent bending of an oar at the point where it met the water, and the apparent elevation of a coin in a basin by filling the basin with water—the quantitative law of refraction was unknown; in fact, it was not formulated until the beginning of the 17th century. The analysis of white light into the continuous spectrum of rainbow colours by transmission through a prism was observed by Seneca, who regarded the colours as fictitious, placing them in the same category as the iridescent appearance of the feathers on a pigeon's neck.

§ 2. The aversion of the Greek thinkers to detailed experimental inquiry stultified the progress of the science; instead of acquiring facts necessary for formulating scientific laws and correcting hypotheses, the Greeks devoted their intellectual energies to philosophizing on the nature of light itself. In their search for a theory the Greeks were mainly concerned with vision—in other words, they sought to determine how an object was seen, and to what its colour was due. Emission theories, involving the conception that light was a stream of concrete particles, were formulated. The Pythagoreans assumed that vision and colour were caused by the bombardment of the eye by minute particles projected from the surface of the object seen. The Platonists subsequently introduced three elements—a stream of particles emitted by the eye (their "divine fire"), which united with the solar rays, and, after the combination had met a stream from the object, returned to the eye and excited vision.

In some form or other the emission theory—that light was a longitudinal propulsion of material particles—dominated optical thought until the beginning of the 19th century. The authority of the Platonists was strong enough to overcome Aristotle's theory that light was an activity (ἐνέργεια) of a medium which he termed the *pellucid* (διαφανές); about two thousand years later Newton's exposition of his corpuscular theory overcame the undulatory hypotheses of Descartes and Huygens; and it was only after the acquisition of new experimental facts that the labours of Thomas Young and Augustin Fresnel indubitably established the wave-theory.

§ 3. The experimental study of refraction, which had been almost entirely neglected by the early Greeks, received more attention during the opening centuries of the Christian era. Cleomedes, in his *Cyclical Theory of Meteors*, *c.* A.D. 50, alludes to the apparent bending of a stick partially immersed in water, and to the rendering visible of coins in basins by filling up with water; and also remarks that the air may refract the sun's rays so as to render that luminary visible, although actually it may be below the horizon. The most celebrated of the early writers on optics is the Alexandrian Ptolemy (2nd century). His writings on light are believed to be preserved in two imperfect Latin manuscripts, themselves translations from the Arabic. The subjects discussed include the nature of light and colour; the formation of images by various types of mirrors, refractions at the surface of glass and of water, with tables of the angle of refraction corresponding to given angles of incidence for rays passing from air to glass and from air to water; and also astronomical refractions, *i.e.* the apparent displacement of a heavenly body due to the refraction of light in its passage through the atmosphere. The authenticity of these manuscripts has been contested: the *Almagest* contains no mention of the *Optics*, nor is the subject of astronomical refractions noticed, but the strongest objection, according to A. de Morgan, is the fact that their author was a poor geometer.

§ 4. One of the results of the decadence of the Roman empire was the suppression of the academies, and few additions were made to scientific knowledge on European soil until the 13th century. Extinguished in the West, the spirit of research was kindled in the East. The accession of the Arabs to power and territory in the 7th century was followed by the acquisition of the literary stores of Greece, and during the following five centuries the Arabs, both by their preservation of existing works and by their original discoveries (which, however, were but few), took a permanent place in the history of science. Pre-eminent among Arabian scientists is Alhazen, who flourished in the 11th century. Primarily a mathematician and astronomer, he also investigated a wide range of optical phenomena. He examined the anatomy of the eye, and the functions of its several parts in promoting vision; and explained how it is that we see one object with two eyes, and then not by a single ray or beam as had

been previously held, but by two cones of rays proceeding from the object, one to each eye. He attributed vision to emanations from the body seen; and on his authority the Platonic theory fell into disrepute. He also discussed the magnifying powers of lenses; and it may be that his writings on this subject inspired the subsequent invention of spectacles. Astronomical observations led to the investigation of refraction by the atmosphere, in particular, astronomical refraction; he explained the phenomenon of twilight, and showed a connexion between its duration and the height of the atmosphere. He also treated *optical deceptions*, both in direct vision and in vision by reflected and refracted light, including the phenomenon known as the *horizontal moon*, i.e. the apparent increase in the diameter of the sun or moon when near the horizon. This appearance had been explained by Ptolemy on the supposition that the diameter was actually increased by refraction, and his commentator Theon endeavoured to explain why an object appears larger when viewed under water. But actual experiment showed that the diameter did not increase. Alhazen gave the correct explanation, which, however, Friar Bacon attributes to Ptolemy. We judge of distance by comparing the angle under which an object is seen with its supposed distance, so that if two objects be seen under nearly equal angles and one be supposed to be more distant than the other, then the former will be supposed to be the larger. When near the horizon the sun or moon, conceived as very distant, are intuitively compared with terrestrial objects, and therefore they appear larger than when viewed at elevations.

§ 5. While the Arabs were acting as the custodians of scientific knowledge, the institutions and civilizations of Europe were gradually crystallizing. Attacked by the Mongols and by the Crusaders, the Bagdad caliphate disappeared in the 13th century. At that period the Arabic commentaries, which had already been brought to Europe, were beginning to exert great influence on scientific thought; and it is probable that their rarity and the increasing demand for the originals and translations led to those forgeries which are of frequent occurrence in the literature of the middle ages. The first treatise on optics written in Europe was admitted by its author Vitello or Vitellio, a native of Poland, to be based on the works of Ptolemy and Alhazen. It was written in about 1270, and first published in 1572, with a Latin translation of Alhazen's treatise, by F. Risner, under the title *Thesaurus opticae*. Its tables of refraction are more accurate than Ptolemy's; the author follows Alhazen in his investigation of lenses, but his determinations of the foci and magnifying powers of spheres are inaccurate. He attributed the twinkling of stars to refraction by moving air, and observed that the scintillation was increased by viewing through water in gentle motion; he also recognized that both reflection and refraction were instrumental in producing the rainbow, but he gave no explanation of the colours.

The *Perspectiva Communis* of John Peckham, archbishop of Canterbury, being no more than a collection of elementary propositions containing nothing new, we have next to consider the voluminous works of Vitellio's illustrious contemporary, Roger Bacon. His writings on light, *Perspectiva* and *Specula mathematica*, are included in his *Opus majus*. It is conceivable that he was acquainted with the nature of the images formed by light traversing a small orifice—a phenomenon noticed by Aristotle, and applied at a later date to the construction of the camera obscura. The invention of the magic lantern has been ascribed to Bacon, and his statements concerning spectacles, the telescope, and the microscope, if not based on an experimental realization of these instruments, must be regarded as masterly conceptions of the applications of lenses. As to the nature of light, Bacon adhered to the theory that objects are rendered visible by emanations from the eye.

The history of science, and more particularly the history of inventions, constantly confronts us with the problem presented by such writings as Friar Bacon's. Rarely has it been given to one man to promote an entirely new theory or to devise an original instrument; it is more generally the case that, in the evolution of a single idea, there comes some stage which arrests our attention, and to which we assign the dignity of an "invention." Furthermore, the obscurity that surrounds the early history of spectacles, the magic lantern, the telescope and the microscope, may find a partial solution in the spirit of the middle ages. The natural philosopher who was bold enough to present to a prince a pair of spectacles or a telescope would be in imminent danger of being regarded in the eyes of the church as a powerful and dangerous magician; and it is conceivable that the maker of such an instrument would jealously guard the secret of its actual construction, however much he might advertise its potentialities.<sup>3</sup>

§ 6. The awakening of Europe, which first manifested itself in Italy, England and France, was followed in the 16th century by a period of increasing intellectual activity. The need for experimental inquiry was realized, and a tendency to dispute the dogmatism of the church and to question the theories of the established schools of philosophy became apparent. In the science of optics, Italy led the van, the foremost pioneers being Franciscus Maurolycus (1494-1575) of Messina, and Giambattista della Porta (1538-1615) of Naples. A treatise by Maurolycus entitled *Photismi de Lumine et Umbra prospectivum radorum incidentium facientes* (1575), contains a discussion of the measurement of the intensity of light—an early essay in photometry; the formation of circular patches of light by small holes of any shape, with a correct explanation of the phenomenon; and the optical relations of the parts of the eye, maintaining that the crystalline humour acts as a lens which focuses images on the retina, explaining short- and long-sight (myopia and hyper-metropia), with the suggestion that the former may be corrected by concave, and the latter by convex, lenses. He observed the spherical aberration due to elements beyond the axis of a lens, and also the caustics of refraction (diacaustics) by a sphere (seen as the bright boundaries of the luminous patches formed by receiving the transmitted light on a screen), which he correctly regarded as determined by the intersections of the refracted rays. His researches on refraction were less fruitful; he assumed the angles of incidence and refraction to be in the constant ratio of 8 to 5, and the rainbow, in which he recognized four colours, orange, green, blue and purple, to be formed by rays reflected in the drops along the sides of an octagon. Porta's fame rests chiefly on his *Magia naturalis sive de miraculis rerum naturalium*, of which four books were published in 1558, the complete work of twenty books appearing in 1589. It attained great popularity, perhaps by reason of its astonishing medley of subjects—pyrotechnics and perfumery, animal reproduction and hunting, alchemy and optics,—and it was several times reprinted, and translated into English (with the title *Natural Magick*, 1658), German, French, Spanish, Hebrew and Arabic. The work contains an account of the camera obscura, with the invention of which the author has sometimes been credited; but, whoever the inventor, Porta was undoubtedly responsible for improving and popularizing that instrument, and also the magic lantern. In the same work practical applications of lenses are suggested, combinations comparable with telescopes are vaguely treated and spectacles are discussed. His *De Refractione, optices parte* (1593) contains an account of binocular vision, in which are found indications of the principle of the stereoscope.

§ 7. The empirical study of lenses led, in the opening decade of the 17th century, to the emergence of the

telescope from its former obscurity. The first form, known as the Dutch or Galileo telescope, consisted of a convex and a concave lens, a combination which gave erect images; the later form, now known as the “Keplerian” or “astronomical” telescope (in contrast with the earlier or “terrestrial” telescope) consisted of two convex lenses, which gave inverted images. With the microscope, too, advances were made, and it seems probable that the compound type came into common use about this time. These single instruments were followed by the invention of binoculars, *i.e.* instruments which permitted simultaneous vision with both eyes. There is little doubt that the experimental realization of the telescope, opening up as it did such immense fields for astronomical research, stimulated the study of lenses and optical systems. The investigations of Maurolycus were insufficient to explain the theory of the telescope, and it was Kepler who first determined the principle of the Galilean telescope in his *Dioptrice* (1611), which also contains the first description of the astronomical or Keplerian telescope, and the demonstration that rays parallel to the axis of a plano-convex lens come to a focus at a point on the axis distant twice the radius of the curved surface of the lens, and, in the case of an equally convex lens, at an axial point distant only once the radius. He failed, however, to determine accurately the case for unequally convex lenses, a problem which was solved by Bonaventura Cavalieri, a pupil of Galileo.

Early in the 17th century great efforts were made to determine the law of refraction. Kepler, in his *Prolegomena ad Vitellionem* (1604), assiduously, but unsuccessfully, searched for the law, and can only be credited with twenty-seven empirical rules, really of the nature of approximations, which he employed in his theory of lenses. The true law—that the ratio of the sines of the angles of incidence and refraction is constant—was discovered in 1621 by Willebrord Snell (1591-1626); but was published for the first time after his death, and with no mention of his name, by Descartes. Whereas in Snell’s manuscript the law was stated in the form of the ratio of certain lines, trigonometrically interpretable as a ratio of cosecants, Descartes expressed the law in its modern trigonometrical form, *viz.* as the ratio of the sines. It may be observed that the modern form was independently obtained by James Gregory and published in his *Optica promota* (1663). Armed with the law of refraction, Descartes determined the geometrical theory of the primary and secondary rainbows, but did not mention how far he was indebted to the explanation of the primary bow by Antonio de Dominis in 1611; and, similarly, in his additions to the knowledge of the telescope the influence of Galileo is not recorded.

§ 8. In his metaphysical speculations on the system of nature, Descartes formulated a theory of light at variance with the generally accepted emission theory and showing some resemblance to the earlier views of Aristotle, and, in a smaller measure, to the modern undulatory theory. He imagined light to be a pressure transmitted by an infinitely elastic medium which pervades space, and colour to be due to rotatory motions of the particles of this medium. He attempted a mechanical explanation of the law of refraction, and came to the conclusion that light passed more readily through a more highly refractive medium. This view was combated by Pierre de Fermat (1601-1665), who, from the principle known as the “law of least time,” deduced the converse to be the case, *i.e.* that the velocity varied inversely with the refractive index. In brief, Fermat’s argument was as follows: Since nature performs her operations by the most direct routes or shortest paths, then the path of a ray of light between any two points must be such that the time occupied in the passage is a minimum. The rectilinear propagation and the law of reflection obviously agree with this principle, and it remained to be proved whether the law of refraction tallied.

Although Fermat’s premiss is useless, his inference is invaluable, and the most notable application of it was made in about 1824 by Sir William Rowan Hamilton, who merged it into his conception of the “characteristic function,” by the help of which all optical problems, whether on the corpuscular or on the undulator theory, are solved by one common process. Hamilton was in possession of the germs of this grand theory some years before 1824, but it was first communicated to the Royal Irish Academy in that year, and published in imperfect instalments some years later. The following is his own description of it. It is of interest as exhibiting the origin of Fermat’s deduction, its relation to contemporary and subsequent knowledge, and its connexion with other analytical principles. Moreover, it is important as showing Hamilton’s views on a very singular part of the more modern history of the science to which he contributed so much.

“Those who have meditated on the beauty and utility, in theoretical mechanics, of the general method of Lagrange, who have felt the power and dignity of that central dynamical theorem which he deduced, in the *Mécanique analytique* ..., must feel that mathematical optics can only then attain a coordinate rank with mathematical mechanics ..., when it shall possess an appropriate method, and become the unfolding of a central idea.... It appears that if a general method in deductive optics can be attained at all, it must flow from some law or principle, itself of the highest generality, and among the highest results of induction.... [This] must be the principle, or law, called usually the Law of Least Action; suggested by questionable views, but established on the widest induction, and embracing every known combination of media, and every straight, or bent, or curved line, ordinary or extraordinary, along which light (whatever light may be) extends its influence successively in space and time: namely, that this linear path of light, from one point to another, is always found to be such that, if it be compared with the other infinitely various lines by which in thought and in geometry the same two points might be connected, a certain integral or sum, called often *Action*, and depending by fixed rules on the length, and shape, and position of the path, and on the media which are traversed by it, is less than all the similar integrals for the other neighbouring lines, or, at least, possesses, with respect to them, a certain *stationary* property. From this Law, then, which may, perhaps, be named the LAW OF STATIONARY ACTION, it seems that we may most fitly and with best hope set out, in the synthetic or deductive process and in the search of a mathematical method.

“Accordingly, from this known law of least or stationary action I deduced (long since) another connected and coextensive principle, which may be called by analogy the LAW OF VARYING ACTION, and which seems to offer naturally a method such as we are seeking; the one law being as it were the last step in the ascending scale of induction, respecting linear paths of light, while the other law may usefully be made the first in the descending and deductive way.

“The former of these two laws was discovered in the following manner. The elementary principle of straight rays showed that light, under the most simple and usual circumstances, employs the direct, and therefore the shortest, course to pass from one point to another. Again, it was a very early discovery (attributed by Laplace to Ptolemy), that, in the case of a plane mirror, the bent line formed by the incident and reflected rays is shorter than any other bent line having the same extremities, and having its point of bending on the mirror. These facts were thought by some to be instances and results of the simplicity and economy of nature; and Fermat, whose researches on maxima and minima are claimed by the Continental mathematicians as the germ of the differential calculus, sought anxiously to trace some similar economy in the more complex case of refraction. He believed that by a metaphysical or cosmological necessity, arising from the simplicity of the universe, light always takes

the course which it can traverse in the shortest time. To reconcile this metaphysical opinion with the law of refraction, discovered experimentally by Snellius, Fermat was led to suppose that the two lengths, or *indices*, which Snellius had measured on the incident ray prolonged and on the refracted ray, and had observed to have one common projection on a refracting plane, are inversely proportional to the two successive velocities of the light before and after refraction, and therefore that the velocity of light is diminished on entering those denser media in which it is observed to approach the perpendicular; for Fermat believed that the time of propagation of light along a line bent by refraction was represented by the sum of the two products, of the incident portion multiplied by the index of the first medium and of the refracted portion multiplied by the index of the second medium; because he found, by his mathematical method, that this sum was less, in the case of a plane refractor, than if light went by any other than its actual path from one given point to another, and because he perceived that the supposition of a velocity inversely as the index reconciled his mathematical discovery of the minimum of the foregoing sum with his cosmological principle of least time. Descartes attacked Fermat's opinions respecting light, but Leibnitz zealously defended them; and Huygens was led, by reasonings of a very different kind, to adopt Fermat's conclusions of a velocity inversely as the index, and of a *minimum time* of propagation of light, in passing from one given point to another through an ordinary refracting plane. Newton, however, by his theory of emission and attraction, was led to conclude that the velocity of light was *directly*, not *inversely*, as the index, and that it was *increased* instead of being *diminished* on entering a denser medium; a result incompatible with the theorem of the shortest time in refraction. This theorem of shortest time was accordingly abandoned by many, and among the rest by Maupertuis, who, however, proposed in its stead, as a new cosmological principle, that *celebrated law of least action* which has since acquired so high a rank in mathematical physics, by the improvements of Euler and Lagrange."

§ 9. The second half of the 17th century witnessed developments in the practice and theory of optics which equal in importance the mathematical, chemical and astronomical acquisitions of the period. Original observations were made which led to the discovery, in an embryonic form, of new properties of light, and the development of mathematical analysis facilitated the quantitative and theoretical investigation of these properties. Indeed, mathematical and physical optics may justly be dated from this time. The phenomenon of *diffraction*, so named by Grimaldi, and by Newton *inflection*, which may be described briefly as the spreading out, or deviation, from the strictly rectilinear path of light passing through a small aperture or beyond the edge of an opaque object, was discovered by the Italian Jesuit, Francis Maria Grimaldi (1619-1663), and published in his *Physico-Mathesis de Lumine* (1665); at about the same time Newton made his classical investigation of the spectrum or the band of colours formed when light is transmitted through a prism,<sup>4</sup> and studied *interference* phenomena in the form of the colours of thin and thick plates, and in the form now termed *Newton's rings*; *double refraction*, in the form of the dual images of a single object formed by a rhomb of Iceland spar, was discovered by Bartholinus in 1670; Huygens's examination of the transmitted beams led to the discovery of an absence of symmetry now called *polarization*; and the finite velocity of light was deduced in 1676 by Ole Roemer from the comparison of the observed and computed times of the eclipses of the moons of Jupiter.

These discoveries had a far-reaching influence upon the theoretical views which had been previously held: for instance, Newton's recombination of the spectrum by means of a second (inverted) prism caused the rejection of the earlier view that the prism actually manufactured the colours, and led to the acceptance of the theory that the colours were physically present in the white light, the function of the prism being merely to separate the physical mixture; and Roemer's discovery of the finite velocity of light introduced the necessity of considering the momentum of the particles which, on the accepted emission theory, composed the light. Of greater moment was the controversy concerning the emission or corpuscular theory championed by Newton and the undulatory theory presented by Huygens (see section II. of this article). In order to explain the colours of thin plates Newton was forced to abandon some of the original simplicity of his theory; and we may observe that by postulating certain motions for the Newtonian corpuscles all the phenomena of light can be explained, these motions aggregating to a transverse displacement, translated longitudinally, and the corpuscles, at the same time, becoming otiose and being replaced by a medium in which the vibration is transmitted. In this way the Newtonian theory may be merged into the undulatory theory. Newton's results are collected in his *Opticks*, the first edition of which appeared in 1704. Huygens published his theory in his *Traité de lumière* (1690), where he explained reflection, refraction and double refraction, but did not elucidate the formation of shadows (which was readily explicable on the Newtonian hypothesis) or polarization; and it was this inability to explain polarization which led to Newton's rejection of the wave theory. The authority of Newton and his masterly exposition of the corpuscular theory sustained that theory until the beginning of the 19th century, when it succumbed to the assiduous skill of Young and Fresnel.

§ 10. Simultaneously with this remarkable development of theoretical and experimental optics, notable progress was made in the construction of optical instruments. The increased demand for telescopes, occasioned by the interest in observational astronomy, led to improvements in the grinding of lenses (the primary aim being to obtain forms in which spherical aberration was a minimum), and also to the study of achromatism, the principles of which followed from Newton's analysis and synthesis of white light. Kepler's supposition that lenses having the form of surfaces of revolution of the conic sections would bring rays to a focus without spherical aberration was investigated by Descartes, and the success of the latter's demonstration led to the grinding of ellipsoidal and hyperboloidal lenses, but with disappointing results.<sup>5</sup> The grinding of spherical lenses was greatly improved by Huygens, who also attempted to reduce chromatic aberration in the refracting telescope by introducing a stop (*i.e.* by restricting the aperture of the rays); to the same experimenter are due compound eye-pieces, the invention of which had been previously suggested by Eustachio Divini. The so-called Huygenian eye-piece is composed of two plano-convex lenses with their plane faces towards the eye; the field-glass has a focal length three times that of the eye-glass, and the distance between them is twice the focal length of the eye-glass. Huygens observed that spherical aberration was diminished by making the deviations of the rays at the two lenses equal, and Ruggiero Giuseppe Boscovich subsequently pointed out that the combination was achromatic. The true development, however, of the achromatic refracting telescope, which followed from the introduction of compound object-glasses giving no dispersion, dates from about the middle of the 18th century. The difficulty of obtaining lens systems in which aberrations were minimized, and the theory of Newton that colour production invariably attended refraction, led to the manufacture of improved specula which permitted the introduction of reflecting telescopes. The idea of this type of instrument had apparently occurred to Marin Mersenne in about 1640, but the first reflector of note was described in 1663 by James Gregory in his *Optica promota*; a second type was invented by Newton, and a third in 1672 by Cassegrain. Slight improvements were made in the microscope, although the achromatic type did not appear until about 1820, some sixty years after John Dollond

had determined the principle of the achromatic telescope (see [ABERRATION](#), [TELESCOPE](#), [MICROSCOPE](#), [BINOCULAR INSTRUMENT](#)).

§ 11. Passing over the discovery by Ehrenfried Walther Tschirnhausen (1651-1708) of the caustics produced by reflection ("catacaustics") and his experiments with large reflectors and refractors (for the manufacture of which he established glass-works in Italy); James Bradley's discovery in 1728 of the "aberration of light," with the subsequent derivation of the velocity of light, the value agreeing fairly well with Roemer's estimate; the foundation of scientific photometry by Pierre Bouguer in an essay published in 1729 and expanded in 1760 into his *Traité d'optique sur la graduation de la lumière*; the publication of John Henry Lambert's treatise on the same subject, entitled *Photometria, sive de Mensura et Gradibus Luminis, Colorum et Umbrae* (1760); and the development of the telescope and other optical instruments, we arrive at the closing decades of the 18th century. During the forty years 1780 to 1820 the history of optics is especially marked by the names of Thomas Young and Augustin Fresnel, and in a lesser degree by Arago, Malus, Sir William Herschel, Fraunhofer, Wollaston, Biot and Brewster.

Although the corpuscular theory had been disputed by Benjamin Franklin, Leonhard Euler and others, the authority of Newton retained for it an almost general acceptance until the beginning of the 19th century, when Young and Fresnel instituted their destructive criticism. Basing his views on the earlier undulatory theories and diffraction phenomena of Grimaldi and Hooke, Young accepted the Huygenian theory, assuming, from a false analogy with sound waves, that the wave-disturbance was longitudinal, and ignoring the suggestion made by Hooke in 1672 that the direction of the vibration might be transverse, *i.e.* at right angles to the direction of the rays. As with Huygens, Young was unable to explain diffraction correctly, or polarization. But the assumption enabled him to establish the principle of interference,<sup>6</sup> one of the most fertile in the science of physical optics. The undulatory theory was also accepted by Fresnel who, perceiving the inadequacy of the researches of Huygens and Young, showed in 1818 by an analysis which, however, is not quite free from objection, that, by assuming that every element of a wave-surface could act as a source of secondary waves or wavelets, the diffraction bands were due to the interference of the secondary waves formed by each element of a primary wave falling upon the edge of an obstacle or aperture. One consequence of Fresnel's theory was that the bands were independent of the nature of the diffracting edge—a fact confirmed by experiment and therefore invalidating Young's theory that the bands were produced by the interference between the primary wave and the wave reflected from the edge of the obstacle. Another consequence, which was first mathematically deduced by Poisson and subsequently confirmed by experiment, is the paradoxical phenomenon that a small circular disk illuminated by a point source casts a shadow having a bright centre.

§ 12. The undulatory theory reached its zenith when Fresnel explained the complex phenomena of polarization, by adopting the conception of Hooke that the vibrations were transverse, and not longitudinal.<sup>7</sup> Polarization by double refraction had been investigated by Huygens, and the researches of Wollaston and, more especially, of Young, gave such an impetus to the study that the Institute of France made double refraction the subject of a prize essay in 1812. E. L. Malus (1775-1812) discovered the phenomenon of polarization by reflection about 1808 and investigated metallic reflection; Arago discovered circular polarization in quartz in 1811, and, with Fresnel, made many experimental investigations, which aided the establishment of the Fresnel-Arago laws of the interference of polarized beams; Biot introduced a reflecting polariscope, investigated the colours of crystalline plates and made many careful researches on the rotation of the plane of polarization; Sir David Brewster made investigations over a wide range, and formulated the law connecting the angle of polarization with the refractive index of the reflecting medium. Fresnel's theory was developed in a strikingly original manner by Sir William Rowan Hamilton, who interpreted from Fresnel's analytical determination of the geometrical form of the wave-surface in biaxial crystals the existence of two hitherto unrecorded phenomena. At Hamilton's instigation Humphrey Lloyd undertook the experimental search, and brought to light the phenomena of external and internal conical refraction.

The undulatory vibration postulated by Fresnel having been generally accepted as explaining most optical phenomena, it became necessary to determine the mechanical properties of the aether which transmits this motion. Fresnel, Neumann, Cauchy, MacCullagh, and, especially, Green and Stokes, developed the "elastic-solid theory." By applying the theory of elasticity they endeavoured to determine the constants of a medium which could transmit waves of the nature of light. Many different allocations were suggested (of which one of the most recent is Lord Kelvin's "contractile aether," which, however, was afterwards discarded by its author), and the theory as left by Green and Stokes has merits other than purely historical. At a later date theories involving an action between the aether and material atoms were proposed, the first of any moment being J. Boussinesq's (1867). C. Christiansen's investigation of anomalous dispersion in 1870, and the failure of Cauchy's formula (founded on the elastic-solid theory) to explain this phenomenon, led to the theories of W. Sellmeier (1872), H. von Helmholtz (1875), E. Ketteler (1878), E. Lommel (1878) and W. Voigt (1883). A third class of theory, to which the present-day theory belongs, followed from Clerk Maxwell's analytical investigations in electromagnetics. Of the greatest exponents of this theory we may mention H. A. Lorentz, P. Drude and J. Larmor, while Lord Rayleigh has, with conspicuous brilliancy, explained several phenomena (*e.g.* the colour of the sky) on this hypothesis.

For a critical examination of these theories see section II. of this article; reference may also be made to the *British Association Reports*: "On Physical Optics," by Humphrey Lloyd (1834), p. 35; "On Double Refraction," by Sir G. G. Stokes (1862), p. 253; "On Optical Theories," by R. T. Glazebrook (1885), p. 157.

§ 13. *Recent Developments.*—The determination of the velocity of light (see section III. of this article) may be regarded as definitely settled, a result contributed to by A. H. L. Fizeau (1849), J. B. L. Foucault (1850, 1862), A. Cornu (1874), A. A. Michelson (1880), James Young and George Forbes (1882), Simon Newcomb (1880-1882) and Cornu (1900). The velocity in moving media was investigated theoretically by Fresnel; and Fizeau (1859), and Michelson and Morley (1886) showed experimentally that the velocity was increased in running water by an amount agreeing with Fresnel's formula, which was based on the hypothesis of a stationary aether. The optics of moving media have also been investigated by Lord Rayleigh, and more especially by H. A. Lorentz, who also assumed a stationary aether. The relative motion of the earth and the aether has an important connexion with the phenomenon of the aberration of light, and has been treated with masterly skill by Joseph Larmor and others (see [AETHER](#)). The relation of the earth's motion to the intensities of terrestrial sources of light was investigated theoretically by Fizeau, but no experimental inquiry was made until 1903, when Nordmeyer obtained negative



results, which were confirmed by the theoretical investigations of A. A. Bucherer and H. A. Lorentz.

Experimental photometry has been greatly developed since the pioneer work of Bouguer and Lambert and the subsequent introduction of the photometers of Ritchie, Rumford, Bunsen and Wheatstone, followed by Swan's in 1859, and O. R. Lummer and E. Brodhun's instrument (essentially the same as Swan's) in 1889. This expansion may largely be attributed to the increase in the number of artificial illuminants—especially the many types of filament- and arc-electric lights, and the incandescent gas light. Colour photometry has also been notably developed, especially since the enunciation of the "Purkinje phenomenon" in 1825. Sir William Abney has contributed much to this subject, and A. M. Meyer has designed a photometer in which advantage is taken of the phenomenon of contrast colours. "Flicker photometry" may be dated from O. N. Rood's investigations in 1893, and the same principle has been applied by Haycraft and Whitman. These questions—colour and flicker photometry—have important affinities to colour perception and the persistence of vision (see [VISION](#)). The spectrophotometer, devised by De Witt Bristol Brace in 1899, which permits the comparison of similarly coloured portions of the spectra from two different sources, has done much valuable work in the determination of absorptive powers and extinction coefficients. Much attention has also been given to the preparation of a standard of intensity, and many different sources have been introduced (see [PHOTOMETRY](#)). Stellar photometry, which was first investigated instrumentally with success by Sir John Herschel, was greatly improved by the introduction of Zöllner's photometer, E. C. Pickering's meridian photometer and C. Pritchard's wedge photometer. Other methods of research in this field are by photography—photographic photometry—and radiometric method (see [PHOTOMETRY, CELESTIAL](#)).

The earlier methods for the experimental determination of refractive indices by measuring the deviation through a solid prism of the substance in question or, in the case of liquids, through a hollow prism containing the liquid, have been replaced in most accurate work by other methods. The method of total reflection, due originally to Wollaston, has been put into a very convenient form, applicable to both solids and liquids, in the Pulfrich refractometer (see [REFRACTION](#)). Still more accurate methods, based on interference phenomena, have been devised. Jamin's interference refractometer is one of the earlier forms of such apparatus; and Michelson's interferometer is one of the best of later types (see [INTERFERENCE](#)). The variation of refractive index with density has been the subject of much experimental and theoretical inquiry. The empirical rule of Gladstone and Dale was often at variance with experiment, and the mathematical investigations of H. A. Lorentz of Leiden and L. Lorenz of Copenhagen on the electromagnetic theory led to a more consistent formula. The experimental work has been chiefly associated with the names of H. H. Landolt and J. W. Brühl, whose results, in addition to verifying the Lorenz-Lorentz formula, have established that this function of the refractive index and density is a colligative property of the molecule, *i.e.* it is calculable additively from the values of this function for the component atoms, allowance being made for the mode in which they are mutually combined (see [CHEMISTRY, PHYSICAL](#)). The preparation of lenses, in which the refractive index decreases with the distance from the axis, by K. F. J. Exner, H. F. L. Matthiessen and Schott, and the curious results of refraction by non-homogeneous media, as realized by R. Wood may be mentioned (see [MIRAGE](#)).

The spectrum of white light produced by prismatic refraction has engaged many investigators. The infra-red or heat waves were discovered by Sir William Herschel, and experiments on the actinic effects of the different parts of the spectrum on silver salts by Scheele, Senebier, Ritter, Seebeck and others, proved the increased activity as one passed from the red to the violet and the ultra-violet. Wollaston also made many investigations in this field, noticing the dark lines—the "Fraunhofer lines"—which cross the solar spectrum, which were further discussed by Brewster and Fraunhofer, who thereby laid the foundations of modern spectroscopy. Mention may also be made of the investigations of Lord Rayleigh and Arthur Schuster on the resolving power of prisms (see [DIFFRACTION](#)), and also of the modern view of the function of the prism in analysing white light. The infra-red and ultra-violet rays are of especial interest since, although not affecting vision after the manner of ordinary light, they possess very remarkable properties. Theoretical investigation on the undulatory theory of the law of reflection shows that a surface, too rough to give any trace of regular reflection with ordinary light, may regularly reflect the long waves, a phenomenon experimentally realized by Lord Rayleigh. Long waves—the so-called "residual rays" or "*Rest-strahlen*"—have also been isolated by repeated reflections from quartz surfaces of the light from zirconia raised to incandescence by the oxyhydrogen flame (E. F. Nichols and H. Rubens); far longer waves were isolated by similar reflections from fluorite (56  $\mu$ ) and sylvite (61  $\mu$ ) surfaces in 1899 by Rubens and E. Aschkinass. The short waves—ultra-violet rays—have also been studied, the researches of E. F. Nichols on the transparency of quartz to these rays, which are especially present in the radiations of the mercury arc, having led to the introduction of lamps made of fused quartz, thus permitting the convenient study of these rays, which, it is to be noted, are absorbed by ordinary clear glass. Recent researches at the works of Schott and Genossen, Jena, however, have resulted in the production of a glass transparent to the ultra-violet.

Dispersion, *i.e.* that property of a substance which consists in having a different refractive index for rays of different wave-lengths, was first studied in the form known as "ordinary dispersion" in which the refrangibility of the ray increased with the wave-length. Cases had been observed by Fox Talbot, Le Roux, and especially by Christiansen (1870) and A. Kundt (1871-1872) where this normal rule did not hold; to such phenomena the name "anomalous dispersion" was given, but really there is nothing anomalous about it at all, ordinary dispersion being merely a particular case of the general phenomenon. The Cauchy formula, which was founded on the elastic-solid theory, did not agree with the experimental facts, and the germs of the modern theory, as was pointed out by Lord Rayleigh in 1900, were embodied in a question proposed by Clerk Maxwell for the Mathematical Tripos examination for 1869. The principle, which occurred simultaneously to W. Sellmeier (who is regarded as the founder of the modern theory) and had been employed about 1850 by Sir G. G. Stokes to explain absorption lines, involves an action between the aether and the molecules of the dispersing substance. The mathematical investigation is associated with the names of Sellmeier, Hermann Helmholtz, Eduard Ketteler, P. Drude, H. A. Lorentz and Lord Rayleigh, and the experimental side with many observers—F. Paschen, Rubens and others; absorbing media have been investigated by A. W. Pflüger, a great many aniline dyes by K. Stöckl, and sodium vapour by R. W. Wood. Mention may also be made of the beautiful experiments of Christiansen (1884) and Lord Rayleigh on the colours transmitted by white powders suspended in liquids of the same refractive index. If, for instance, benzol be gradually added to finely powdered quartz, a succession of beautiful colours—red, yellow, green and finally blue—is transmitted, or, under certain conditions, the colours may appear at once, causing the mixture to flash like a fiery opal. Absorption, too, has received much attention; the theory has been especially elaborated by M. Planck, and the experimental investigation has been prosecuted from the

Interference phenomena have been assiduously studied. The experiments of Young, Fresnel, Lloyd, Fizeau and Foucault, of Fresnel and Arago on the measurement of refractive indices by the shift of the interference bands, of H. F. Talbot on the "Talbot bands" (which he insufficiently explained on the principle of interference, it being shown by Sir G. B. Airy that diffraction phenomena supervene), of Baden-Powell on the "Powell bands," of David Brewster on "Brewster's bands," have been developed, together with many other phenomena—Newton's rings, the colours of thin, thick and mixed plates, &c.—in a striking manner, one of the most important results being the construction of interferometers applicable to the determination of refractive indices and wave-lengths, with which the names of Jamin, Michelson, Fabry and Perot, and of Lummer and E. Gehrcke are chiefly associated. The mathematical investigations of Fresnel may be regarded as being completed by the analysis chiefly due to Airy, Stokes and Lord Rayleigh. Mention may be made of Sir G. G. Stokes' attribution of the colours of iridescent crystals to periodic twinning; this view has been confirmed by Lord Rayleigh (*Phil. Mag.*, 1888) who, from the purity of the reflected light, concluded that the laminae were equidistant by the order of a wave-length. Prior to 1891 only interference between waves proceeding in the same direction had been studied. In that year Otto H. Wiener obtained, on a film 1/20th of a wave-length in thickness, photographic impressions of the stationary waves formed by the interference of waves proceeding in opposite directions, and in 1892 Drude and Nernst employed a fluorescent film to record the same phenomenon. This principle is applied in the Lippmann colour photography, which was suggested by W. Zenker, realized by Gabriel Lippmann, and further investigated by R. G. Neuhauss, O. H. Wiener, H. Lehmann and others.

Great progress has been made in the study of diffraction, and "this department of optics is precisely the one in which the wave theory has secured its greatest triumphs" (Lord Rayleigh). The mathematical investigations of Fresnel and Poisson were placed on a dynamical basis by Sir G. G. Stokes; and the results gained more ready interpretation by the introduction of "Babinet's principle" in 1837, and Cornu's graphic methods in 1874. The theory also gained by the researches of Fraunhofer, Airy, Schwerd, E. Lommel and others. The theory of the concave grating, which resulted from H. A. Rowland's classical methods of ruling lines of the necessary nature and number on curved surfaces, was worked out by Rowland, E. Mascart, C. Runge and others. The resolving power and the intensity of the spectra have been treated by Lord Rayleigh and Arthur Schuster, and more recently (1905), the distribution of light has been treated by A. B. Porter. The theory of diffraction is of great importance in designing optical instruments, the theory of which has been more especially treated by Ernst Abbe (whose theory of microscopic vision dates from about 1870) by the scientific staff at the Zeiss works, Jena, by Rayleigh and others. The theory of coronae (as diffraction phenomena) was originally due to Young, who, from the principle involved, devised the *erimeter* for measuring the diameters of very small objects; and Sir G. G. Stokes subsequently explained the appearances presented by minute opaque particles borne on a transparent plate. The polarization of the light diffracted at a slit was noted in 1861 by Fizeau, whose researches were extended in 1892 by H. Du Bois, and, for the case of gratings, by Du Bois and Rubens in 1904. The diffraction of light by small particles was studied in the form of very fine chemical precipitates by John Tyndall, who noticed the polarization of the beautiful cerulean blue which was transmitted. This subject—one form of which is presented in the blue colour of the sky—has been most auspiciously treated by Lord Rayleigh on both the elastic-solid and electromagnetic theories. Mention may be made of R. W. Wood's experiments on thin metal films which, under certain conditions, originate colour phenomena inexplicable by interference and diffraction. These colours have been assigned to the principle of optical resonance, and have been treated by Kossonogov (*Phys. Zeit.*, 1903). J. C. Maxwell Garnett (*Phil. Trans.* vol. 203) has shown that the colours of coloured glasses are due to ultra-microscopic particles, which have been directly studied by H. Siedentopf and R. Zsigmondy under limiting oblique illumination.

Polarization phenomena may, with great justification, be regarded as the most engrossing subject of optical research during the 19th century; the assiduity with which it was cultivated in the opening decades of that century received a great stimulus when James Nicol devised in 1828 the famous "Nicol prism," which greatly facilitated the determination of the plane of vibration of polarized light, and the facts that light is polarized by reflection, repeated refractions, double refraction and by diffraction also contributed to the interest which the subject excited. The rotation of the plane of polarization by quartz was discovered in 1811 by Arago; if white light be used the colours change as the Nicol rotates—a phenomenon termed by Biot "rotatory dispersion." Fresnel regarded rotatory polarization as compounded from right- and left-handed (dextro- and laevo-) circular polarizations; and Fresnel, Cornu, Dove and Cotton effected their experimental separation. Legrand des Cloizeaux discovered the enormously enhanced rotatory polarization of cinnabar, a property also possessed—but in a lesser degree—by the sulphates of strychnine and ethylene diamine. The rotatory power of certain liquids was discovered by Biot in 1815; and at a later date it was found that many solutions behaved similarly. A. Schuster distinguishes substances with regard to their action on polarized light as follows: substances which act in the isotropic state are termed *photogyric*; if the rotation be associated with crystal structure, *crystallogyric*; if the rotation be due to a magnetic field, *magnetogyric*; for cases not hitherto included the term *allogyric* is employed, while optically inactive substances are called *isogyric*. The theory of photogyric and crystallogyric rotation has been worked out on the elastic-solid (MacCullagh and others) and on the electromagnetic hypotheses (P. Drude, Cotton, &c.). Allogyricism is due to a symmetry of the molecule, and is a subject of the greatest importance in modern (and, more especially, organic) chemistry (see [STEREISOIMERISM](#)).

The optical properties of metals have been the subject of much experimental and theoretical inquiry. The explanations of MacCullagh and Cauchy were followed by those of Beer, Eisenlohr, Lundquist, Ketteler and others; the refractive indices were determined both directly (by Kundt) and indirectly by means of Brewster's law; and the reflecting powers from  $\lambda = 251 \mu\mu$  to  $\lambda = 1500 \mu\mu$  were determined in 1900-1902 by Rubens and Hagen. The correlation of the optical and electrical constants of many metals has been especially studied by P. Drude (1900) and by Rubens and Hagen (1903).

The transformations of luminous radiations have also been studied. John Tyndall discovered calorescence. Fluorescence was treated by John Herschel in 1845, and by David Brewster in 1846, the theory being due to Sir G. G. Stokes (1852). More recent studies have been made by Lommel, E. L. Nichols and Merritt (*Phys. Rev.*, 1904), and by Millikan who discovered polarized fluorescence in 1895. Our knowledge of phosphorescence was greatly improved by Becquerel, and Sir James Dewar obtained interesting results in the course of his low temperature researches (see [LIQUID GASES](#)). In the theoretical and experimental study of radiation enormous

progress has been recorded. The pressure of radiation, the necessity of which was demonstrated by Clerk Maxwell on the electromagnetic theory, and, in a simpler manner, by Joseph Larmor in his article [RADIATION](#) in these volumes, has been experimentally determined by E. F. Nichols and Hull, and the tangential component by J. H. Poynting. With the theoretical and practical investigation the names of Balfour Stewart, Kirchhoff, Stefan, Bartoli, Boltzmann, W. Wien and Larmor are chiefly associated. Magneto-optics, too, has been greatly developed since Faraday's discovery of the rotation of the plane of polarization by the magnetic field. The rotation for many substances was measured by Sir William H. Perkin, who attempted a correlation between rotation and composition. Brace effected the analysis of the beam into its two circularly polarized components, and in 1904 Mills measured their velocities. The Kerr effect, discovered in 1877, and the Zeeman effect (1896) widened the field of research, which, from its intimate connexion with the nature of light and electromagnetics, has resulted in discoveries of the greatest importance.

§ 14. *Optical Instruments*.—Important developments have been made in the construction and applications of optical instruments. To these three factors have contributed. The mathematician has quantitatively analysed the phenomena observed by the physicist, and has inductively shown what results are to be expected from certain optical systems. A consequence of this was the detailed study, and also the preparation, of glasses of diverse properties; to this the chemist largely contributed, and the manufacture of the so-called *optical glass* (see [GLASS](#)) is possibly the most scientific department of glass manufacture. The mathematical investigations of lenses owe much to Gauss, Helmholtz and others, but far more to Abbe, who introduced the method of studying the aberrations separately, and applied his results with conspicuous skill to the construction of optical systems. The development of Abbe's methods constitutes the main subject of research of the present-day optician, and has brought about the production of telescopes, microscopes, photographic lenses and other optical apparatus to an unprecedented pitch of excellence. Great improvements have been effected in the stereoscope. Binocular instruments with enhanced stereoscopic vision, an effect achieved by increasing the distance between the object glasses, have been introduced. In the study of diffraction phenomena, which led to the technical preparation of gratings, the early attempts of Fraunhofer, Nobert and Lewis Morris Rutherford, were followed by H. A. Rowland's ruling of plane and concave gratings which revolutionized spectroscopic research, and, in 1898, by Michelson's invention of the echelon grating. Of great importance are interferometers, which permit extremely accurate determinations of refractive indices and wave-lengths, and Michelson, from his classical evaluation of the standard metre in terms of the wave-lengths of certain of the cadmium rays, has suggested the adoption of the wave-length of one such ray as a standard with which national standards of length should be compared. Polarization phenomena, and particularly the rotation of the plane of polarization by such substances as sugar solutions, have led to the invention and improvements of polarimeters. The polarized light employed in such instruments is invariably obtained by transmission through a fixed Nicol prism—the polarizer—and the deviation is measured by the rotation of a second Nicol—the analyser. The early forms, which were termed "light and shade" polarimeters, have been generally replaced by "half-shade" instruments. Mention may also be made of the microscopic examination of objects in polarized light, the importance of which as a method of crystallographic and petrological research was suggested by Nicol, developed by Sorby and greatly expanded by Zirkel, Rosenbusch and others.

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## II. NATURE OF LIGHT

1. *Newton's Corpuscular Theory*.—Until the beginning of the 19th century physicists were divided between two different views concerning the nature of optical phenomena. According to the one, luminous bodies emit extremely small corpuscles which can freely pass through transparent substances and produce the sensation of light by their impact against the retina. This *emission* or *corpuscular theory* of light was supported by the

authority of Isaac Newton,<sup>8</sup> and, though it has been entirely superseded by its rival, the *wave-theory*, it remains of considerable historical interest.

2. *Explanation of Reflection and Refraction.*—Newton supposed the light-corpuscles to be subjected to attractive and repulsive forces exerted at very small distances by the particles of matter. In the interior of a homogeneous body a corpuscle moves in a straight line as it is equally acted on from all sides, but it changes its course at the boundary of two bodies, because, in a thin layer near the surface there is a resultant force in the direction of the normal. In modern language we may say that a corpuscle has at every point a definite potential energy, the value of which is constant throughout the interior of a homogeneous body, and is even equal in all bodies of the same kind, but changes from one substance to another. If, originally, while moving in air, the corpuscles had a definite velocity  $v_0$ , their velocity  $v$  in the interior of any other substance is quite determinate. It is given by the equation  $\frac{1}{2}mv^2 - \frac{1}{2}mv_0^2 = A$ , in which  $m$  denotes the mass of a corpuscle, and  $A$  the excess of its potential energy in air over that in the substance considered.

A ray of light falling on the surface of separation of two bodies is reflected according to the well-known simple law, if the corpuscles are acted on by a sufficiently large force directed towards the first medium. On the contrary, whenever the field of force near the surface is such that the corpuscles can penetrate into the interior of the second body, the ray is refracted. In this case the law of Snellius can be deduced from the consideration that the projection  $w$  of the velocity on the surface of separation is not altered, either in direction or in magnitude. This obviously requires that the plane passing through the incident and the refracted rays be normal to the surface, and that, if  $\alpha_1$  and  $\alpha_2$  are the angles of incidence and of refraction,  $v_1$  and  $v_2$  the velocities of light in the two media,

$$\sin \alpha_1 / \sin \alpha_2 = w/v_1 : w/v_2 = v_2/v_1. \quad (1)$$

The ratio is constant, because, as has already been observed,  $v_1$  and  $v_2$  have definite values.

As to the unequal refrangibility of differently coloured light, Newton accounted for it by imagining different kinds of corpuscles. He further carefully examined the phenomenon of total reflection, and described an interesting experiment connected with it. If one of the faces of a glass prism receives on the inside a beam of light of such obliquity that it is totally reflected under ordinary circumstances, a marked change is observed when a second piece of glass is made to approach the reflecting face, so as to be separated from it only by a very thin layer of air. The reflection is then found no longer to be total, part of the light finding its way into the second piece of glass. Newton concluded from this that the corpuscles are attracted by the glass even at a certain small measurable distance.

618

3. *New Hypotheses in the Corpuscular Theory.*—The preceding explanation of reflection and refraction is open to a very serious objection. If the particles in a beam of light all moved with the same velocity and were acted on by the same forces, they all ought to follow exactly the same path. In order to understand that part of the incident light is reflected and part of it transmitted, Newton imagined that each corpuscle undergoes certain alternating changes; he assumed that in some of its different “phases” it is more apt to be reflected, and in others more apt to be transmitted. The same idea was applied by him to the phenomena presented by very thin layers. He had observed that a gradual increase of the thickness of a layer produces periodic changes in the intensity of the reflected light, and he very ingeniously explained these by his theory. It is clear that the intensity of the transmitted light will be a minimum if the corpuscles that have traversed the front surface of the layer, having reached that surface while in their phase of easy transmission, have passed to the opposite phase the moment they arrive at the back surface. As to the nature of the alternating phases, Newton (*Opticks*, 3rd ed., 1721, p. 347) expresses himself as follows:—“Nothing more is requisite for putting the Rays of Light into Fits of easy Reflexion and easy Transmission than that they be small Bodies which by their attractive Powers, or some other Force, stir up Vibrations in what they act upon, which Vibrations being swifter than the Rays, overtake them successively, and agitate them so as by turns to increase and decrease their Velocities, and thereby put them into those Fits.”

4. *The Corpuscular Theory and the Wave-Theory compared.*—Though Newton introduced the notion of periodic changes, which was to play so prominent a part in the later development of the wave-theory, he rejected this theory in the form in which it had been set forth shortly before by Christiaan Huygens in his *Traité de la lumière* (1690), his chief objections being: (1) that the rectilinear propagation had not been satisfactorily accounted for; (2) that the motions of heavenly bodies show no sign of a resistance due to a medium filling all space; and (3) that Huygens had not sufficiently explained the peculiar properties of the rays produced by the double refraction in Iceland spar. In Newton’s days these objections were of much weight.

Yet his own theory had many weaknesses. It explained the propagation in straight lines, but it could assign no cause for the equality of the speed of propagation of all rays. It adapted itself to a large variety of phenomena, even to that of double refraction (Newton says [*ibid.*]:—“... the unusual Refraction of Iceland Crystal looks very much as if it were perform’d by some kind of attractive virtue lodged in certain Sides both of the Rays, and of the Particles of the Crystal.”), but it could do so only at the price of losing much of its original simplicity.

In the earlier part of the 19th century, the corpuscular theory broke down under the weight of experimental evidence, and it received the final blow when J. B. L. Foucault proved by direct experiment that the velocity of light in water is not greater than that in air, as it should be according to the formula (1), but less than it, as is required by the wave-theory.

5. *General Theorems on Rays of Light.*—With the aid of suitable assumptions the Newtonian theory can accurately trace the course of a ray of light in any system of isotropic bodies, whether homogeneous or otherwise; the problem being equivalent to that of determining the motion of a material point in a space in which its potential energy is given as a function of the coordinates. The application of the dynamical principles of “least and of varying action” to this latter problem leads to the following important theorems which William Rowan Hamilton made the basis of his exhaustive treatment of systems of rays.<sup>9</sup> The total energy of a corpuscle is supposed to have a given value, so that, since the potential energy is considered as known at every point, the velocity  $v$  is so likewise.

(a) The path along which light travels from a point A to a point B is determined by the condition that for this line the integral  $\int v ds$ , in which  $ds$  is an element of the line, be a minimum (provided A and B be not too near

each other). Therefore, since  $v = \mu v_0$ , if  $v_0$  is the velocity of light *in vacuo* and  $\mu$  the index of refraction, we have for every variation of the path the points A and B remaining fixed,

$$\delta f \mu ds = 0. \tag{2}$$

(b) Let the point A be kept fixed, but let B undergo an infinitely small displacement  $BB'$  ( $= q$ ) in a direction making an angle  $\theta$  with the last element of the ray AB. Then, comparing the new ray  $AB'$  with the original one, it follows that

$$\delta f \mu ds = \mu_B q \cos \theta, \tag{3}$$

where  $\mu_B$  is the value of  $\mu$  at the point B.

6. *General Considerations on the Propagation of Waves.*—“Waves,” *i.e.* local disturbances of equilibrium travelling onward with a certain speed, can exist in a large variety of systems. In a theory of these phenomena, the state of things at a definite point may in general be defined by a certain directed or vector quantity  $\mathbf{P}$ ,<sup>10</sup> which is zero in the state of equilibrium, and may be called the disturbance (for example, the velocity of the air in the case of sound vibrations, or the displacement of the particles of an elastic body from their positions of equilibrium). The components  $\mathbf{P}_x, \mathbf{P}_y, \mathbf{P}_z$  of the disturbance in the directions of the axes of coordinates are to be considered as functions of the coordinates  $x, y, z$  and the time  $t$ , determined by a set of partial differential equations, whose form depends on the nature of the problem considered. If the equations are homogeneous and linear, as they always are for sufficiently small disturbances, the following theorems hold.

(a) Values of  $\mathbf{P}_x, \mathbf{P}_y, \mathbf{P}_z$  (expressed in terms of  $x, y, z, t$ ) which satisfy the equations will do so still after multiplication by a common arbitrary constant.

(b) Two or more solutions of the equations may be combined into a new solution by addition of the values of  $\mathbf{P}_x$ , those of  $\mathbf{P}_y$ , &c., *i.e.* by compounding the vectors  $\mathbf{P}$ , such as they are in each of the particular solutions.

In the application to light, the first proposition means that the phenomena of propagation, reflection, refraction, &c., can be produced in the same way with strong as with weak light. The second proposition contains the principle of the “superposition” of different states, on which the explanation of all phenomena of interference is made to depend.

In the simplest cases (monochromatic or homogeneous light) the disturbance is a simple harmonic function of the time (“simple harmonic vibrations”), so that its components can be represented by

$$\mathbf{P}_x = a_1 \cos (nt + f_1), \mathbf{P}_y = a_2 \cos (nt + f_2), \mathbf{P}_z = a_3 \cos (nt + f_3).$$

The “phases” of these vibrations are determined by the angles  $nt + f_1$ , &c., or by the times  $t + f_1/n$ , &c. The “frequency”  $n$  is constant throughout the system, while the quantities  $f_1, f_2, f_3$ , and perhaps the “amplitudes”  $a_1, a_2, a_3$  change from point to point. It may be shown that the end of a straight line representing the vector  $\mathbf{P}$ , and drawn from the point considered, in general describes a certain ellipse, which becomes a straight line, if  $f_1 = f_2 = f_3$ . In this latter case, to which the larger part of this article will be confined, we can write in vector notation

$$\mathbf{P} = \mathbf{A} \cos (nt + f), \tag{4}$$

where  $\mathbf{A}$  itself is to be regarded as a vector.

We have next to consider the way in which the disturbance changes from point to point. The most important case is that of plane waves with constant amplitude  $\mathbf{A}$ . Here  $f$  is the same at all points of a plane (“wave-front”) of a definite direction, but changes as a linear function as we pass from one such wave-front to the next. The axis of  $x$  being drawn at right angles to the wave-fronts, we may write  $f = f_0 - kx$ , where  $f_0$  and  $k$  are constants, so that (4) becomes

$$P = A \cos (nt - kx + f_0). \tag{5}$$

This expression has the period  $2\pi/n$  with respect to the time and the period  $2\pi/k$  with respect to  $x$ , so that the “time of vibration” and the “wave-length” are given by  $T = 2\pi/n, \lambda = 2\pi/k$ . Further, it is easily seen that the phase belonging to certain values of  $x$  and  $t$  is equal to that which corresponds to  $x + \Delta x$  and  $t + \Delta t$  provided  $\Delta x = (n/k) \Delta t$ . Therefore the phase, or the disturbance itself, may be said to be propagated in the direction normal to the wave-fronts with a velocity (velocity of the waves)  $v = n/k$ , which is connected with the time of vibration and the wave-length by the relation

$$\lambda = vT. \tag{6}$$

In isotropic bodies the propagation can go on in all directions with the same velocity. In anisotropic bodies (crystals), with which the theory of light is largely concerned, the problem is more complicated. As a general rule we can say that, for a given direction of the wave-fronts, the vibrations must have a determinate direction, if the propagation is to take place according to the simple formula given above. It is to be understood that for a given direction of the waves there may be two or even more directions of vibration of the kind, and that in such a case there are as many different velocities, each belonging to one particular direction of vibration.

7. *Wave-surface.*—After having found the values of  $v$  for a particular frequency and different directions of the wave-normal, a very instructive graphical representation can be employed.

Let ON be a line in any direction, drawn from a fixed point O, OA a length along this line equal to the velocity  $v$  of waves having ON for their normal, or, more generally, OA, OA', &c., lengths equal to the velocities  $v, v',$  &c., which such waves have according to their direction of vibration, Q, Q', &c., planes perpendicular to ON through A, A', &c. Let this construction be repeated for all directions of ON, and let W be the surface that is touched by all the planes Q, Q', &c. It is clear that if this surface, which is called the “wave-surface,” is known, the velocity of propagation of plane waves of any chosen direction is given by the length of the perpendicular from the centre O on a tangent plane in the given direction. It must be kept in mind that, in general, each tangent plane corresponds to one definite direction of vibration. If this direction is assigned in each point of the wave-surface, the diagram contains all the information which we can desire concerning the propagation of plane waves of the frequency that has been chosen.

The plane Q employed in the above construction is the position after unit of time of a wave-front perpendicular to ON and originally passing through the point O. The surface W itself is often considered as the locus of all points that are reached in unit of time by a disturbance starting from O and spreading towards all sides. Admitting the validity of this view, we can determine in a similar way the locus of the points reached in some infinitely short time dt, the wave-surface, as we may say, or the "elementary wave," corresponding to this time. It is similar to W, all dimensions of the latter surface being multiplied by dt. It may be noticed that in a heterogeneous medium a wave of this kind has the same form as if the properties of matter existing at its centre extended over a finite space.

8. *Theory of Huygens.*—Huygens was the first to show that the explanation of optical phenomena may be made to depend on the wave-surface, not only in isotropic bodies, in which it has a spherical form, but also in crystals, for one of which (Iceland spar) he deduced the form of the surface from the observed double refraction. In his argument Huygens availed himself of the following principle that is justly named after him: Any point that is reached by a wave of light becomes a new centre of radiation from which the disturbance is propagated towards all sides. On this basis he determined the progress of light-waves by a construction which, under a restriction to be mentioned in § 13, applied to waves of any form and to all kinds of transparent media. Let  $\sigma$  be the surface (wave-front) to which a definite phase of vibration has advanced at a certain time t, dt an infinitely small increment of time, and let an elementary wave corresponding to this interval be described around each point P of  $\sigma$ . Then the envelope  $\sigma'$  of all these elementary waves is the surface reached by the phase in question at the time t + dt, and by repeating the construction all successive positions of the wave-front can be found.

Huygens also considered the propagation of waves that are laterally limited, by having passed, for example, through an opening in an opaque screen. If, in the first wave-front  $\sigma$ , the disturbance exists only in a certain part bounded by the contour s, we can confine ourselves to the elementary waves around the points of that part, and to a portion of the new wave-front  $\sigma'$  whose boundary passes through the points where  $\sigma'$  touches the elementary waves having their centres on s. Taking for granted Huygens's assumption that a sensible disturbance is only found in those places where the elementary waves are touched by the new wave-front, it may be inferred that the lateral limits of the beam of light are determined by lines, each element of which joins the centre P of an elementary wave with its point of contact P' with the next wave-front. To lines of this kind, whose course can be made visible by using narrow pencils of light, the name of "rays" is to be given in the wave-theory. The disturbance may be conceived to travel along them with a velocity  $u = PP'/dt$ , which is therefore called the "ray-velocity."

The construction shows that, corresponding to each direction of the wave-front (with a determinate direction of vibration), there is a definite direction and a definite velocity of the ray. Both are given by a line drawn from the centre of the wave-surface to its point of contact with a tangent plane of the given direction. It will be convenient to say that this line and the plane are conjugate with each other. The rays of light, curved in non-homogeneous bodies, are always straight lines in homogeneous substances. In an isotropic medium, whether homogeneous or otherwise, they are normal to the wave-fronts, and their velocity is equal to that of the waves.

By applying his construction to the reflection and refraction of light, Huygens accounted for these phenomena in isotropic bodies as well as in Iceland spar. It was afterwards shown by Augustin Fresnel that the double refraction in biaxial crystals can be explained in the same way, provided the proper form be assigned to the wave-surface.

In any point of a bounding surface the normals to the reflected and refracted waves, whatever be their number, always lie in the plane passing through the normal to the incident waves and that to the surface itself. Moreover, if  $\alpha_1$  is the angle between these two latter normals, and  $\alpha_2$  the angle between the normal to the boundary and that to any one of the reflected and refracted waves, and  $v_1, v_2$  the corresponding wave-velocities, the relation

$$\sin \alpha_1 / \sin \alpha_2 = v_1 / v_2 \quad (7)$$

is found to hold in all cases. These important theorems may be proved independently of Huygens's construction by simply observing that, at each point of the surface of separation, there must be a certain connexion between the disturbances existing in the incident, the reflected, and the refracted waves, and that, therefore, the lines of intersection of the surface with the positions of an incident wave-front, succeeding each other at equal intervals of time dt, must coincide with the lines in which the surface is intersected by a similar series of reflected or refracted wave-fronts.

In the case of isotropic media, the ratio (7) is constant, so that we are led to the law of Snellius, the index of refraction being given by

$$\mu = v_1 / v_2 \quad (8)$$

(cf. equation 1).

9. *General Theorems on Rays, deduced from Huygens's Construction.*—(a) Let A and B be two points arbitrarily chosen in a system of transparent bodies, ds an element of a line drawn from A to B, u the velocity of a ray of light coinciding with ds. Then the integral  $\int u^{-1} ds$ , which represents the time required for a motion along the line with the velocity u, is a minimum for the course actually taken by a ray of light (unless A and B be too far apart). This is the "principle of least time" first formulated by Pierre de Fermat for the case of two isotropic substances. It shows that the course of a ray of light can always be inverted.

(b) Rays of light starting in all directions from a point A and travelling onward for a definite length of time, reach a surface  $\sigma$ , whose tangent plane at a point B is conjugate, in the medium surrounding B, with the last element of the ray AB.

(c) If all rays issuing from A are concentrated at a point B, the integral  $\int u^{-1} ds$  has the same value for each of them.

(d) In case (b) the variation of the integral caused by an infinitely small displacement q of B, the point A remaining fixed, is given by  $\delta \int u^{-1} ds = q \cos \theta / v_B$ . Here  $\theta$  is the angle between the displacement q and the normal to the surface  $\sigma$ , in the direction of propagation,  $v_B$  the velocity of a plane wave tangent to this surface.

In the case of isotropic bodies, for which the relation (8) holds, we recover the theorems concerning the integral  $\int \mu ds$  which we have deduced from the emission theory (§ 5).

10. *Further General Theorems.*—(a) Let  $V_1$  and  $V_2$  be two planes in a system of isotropic bodies, let rectangular axes of coordinates be chosen in each of these planes, and let  $x_1, y_1$  be the coordinates of a point A in  $V_1$ , and  $x_2, y_2$  those of a point B in  $V_2$ . The integral  $\int \mu ds$ , taken for the ray between A and B, is a function of  $x_1, y_1, x_2, y_2$  and, if  $\xi_1$  denotes either  $x_1$  or  $y_1$ , and  $\xi_2$  either  $x_2$  or  $y_2$ , we shall have

$$\frac{\partial^2}{\partial \xi_1 \partial \xi_2} \int \mu ds = \frac{\partial^2}{\partial \xi_2 \partial \xi_1} \int \mu ds.$$

On both sides of this equation the first differentiation may be performed by means of the formula (3). The second differentiation admits of a geometrical interpretation, and the formula may finally be employed for proving the following theorem:

Let  $\omega_1$  be the solid angle of an infinitely thin pencil of rays issuing from A and intersecting the plane  $V_2$  in an element  $\sigma_2$  at the point B. Similarly, let  $\omega_2$  be the solid angle of a pencil starting from B and falling on the element  $\sigma_1$  of the plane  $V_1$  at the point A. Then, denoting by  $\mu_1$  and  $\mu_2$  the indices of refraction of the matter at the points A and B, by  $\theta_1$  and  $\theta_2$  the sharp angles which the ray AB at its extremities makes with the normals to  $V_1$  and  $V_2$ , we have

$$\mu_1^2 \sigma_1 \omega_1 \cos \theta_1 = \mu_2^2 \sigma_2 \omega_2 \cos \theta_2.$$

(b) There is a second theorem that is expressed by exactly the same formula, if we understand by  $\sigma_1$  and  $\sigma_2$  elements of surface that are related to each other as an object and its optical image—by  $\omega_1, \omega_2$  the infinitely small openings, at the beginning and the end of its course, of a pencil of rays issuing from a point A of  $\sigma_1$  and coming together at the corresponding point B of  $\sigma_2$ , and by  $\theta_1, \theta_2$  the sharp angles which one of the rays makes with the normals to  $\sigma_1$  and  $\sigma_2$ . The proof may be based upon the first theorem. It suffices to consider the section  $\sigma$  of the pencil by some intermediate plane, and a bundle of rays starting from the points of  $\sigma_1$  and reaching those of  $\sigma_2$  after having all passed through a point of that section  $\sigma$ .

620

(c) If in the last theorem the system of bodies is symmetrical around the straight line AB, we can take for  $\sigma_1$  and  $\sigma_2$  circular planes having AB as axis. Let  $h_1$  and  $h_2$  be the radii of these circles, *i.e.* the linear dimensions of an object and its image,  $\varepsilon_1$  and  $\varepsilon_2$  the infinitely small angles which a ray R going from A to B makes with the axis at these points. Then the above formula gives  $\mu_1 h_1 \varepsilon_1 = \mu_2 h_2 \varepsilon_2$ , a relation that was proved, for the particular case  $\mu_1 = \mu_2$  by Huygens and Lagrange. It is still more valuable if one distinguishes by the algebraic sign of  $h_2$  whether the image is direct or inverted, and by that of  $\varepsilon_2$  whether the ray R on leaving A and on reaching B lies on opposite sides of the axis or on the same side.

The above theorems are of much service in the theory of optical instruments and in the general theory of radiation.

11. *Phenomena of Interference and Diffraction.*—The impulses or motions which a luminous body sends forth through the universal medium or aether, were considered by Huygens as being without any regular succession; he neither speaks of vibrations, nor of the physical cause of the colours. The idea that monochromatic light consists of a succession of simple harmonic vibrations like those represented by the equation (5), and that the sensation of colour depends on the frequency, is due to Thomas Young<sup>11</sup> and Fresnel,<sup>12</sup> who explained the phenomena of interference on this assumption combined with the principle of super-position. In doing so they were also enabled to determine the wave-length, ranging from 0.000076 cm. at the red end of the spectrum to 0.000039 cm. for the extreme violet and, by means of the formula (6), the number of vibrations per second. Later investigations have shown that the infra-red rays as well as the ultra-violet ones are of the same physical nature as the luminous rays, differing from these only by the greater or smaller length of their waves. The wave-length amounts to 0.006 cm. for the least refrangible infra-red, and is as small as 0.00001 cm. for the extreme ultra-violet.

Another important part of Fresnel's work is his treatment of diffraction on the basis of Huygens's principle. If, for example, light falls on a screen with a narrow slit, each point of the slit is regarded as a new centre of vibration, and the intensity at any point behind the screen is found by compounding with each other the disturbances coming from all these points, due account being taken of the phases with which they come together (see [DIFFRACTION](#); [INTERFERENCE](#)).

12. *Results of Later Mathematical Theory.*—Though the theory of diffraction developed by Fresnel, and by other physicists who worked on the same lines, shows a most beautiful agreement with observed facts, yet its foundation, Huygens's principle, cannot, in its original elementary form, be deemed quite satisfactory. The general validity of the results has, however, been confirmed by the researches of those mathematicians (Siméon Denis Poisson, Augustin Louis Cauchy, Sir G. G. Stokes, Gustav Robert Kirchhoff) who investigated the propagation of vibrations in a more rigorous manner. Kirchhoff<sup>13</sup> showed that the disturbance at any point of the aether inside a closed surface which contains no ponderable matter can be represented as made up of a large number of parts, each of which depends upon the state of things at one point of the surface. This result, the modern form of Huygens's principle, can be extended to a system of bodies of any kind, the only restriction being that the source of light be not surrounded by the surface. Certain causes capable of producing vibrations can be imagined to be distributed all over this latter, in such a way that the disturbances to which they give rise in the enclosed space are exactly those which are brought about by the real source of light.<sup>14</sup> Another interesting result that has been verified by experiment is that, whenever rays of light pass through a focus, the phase undergoes a change of half a period. It must be added that the results alluded to in the above, though generally presented in the terms of some particular form of the wave theory, often apply to other forms as well.

13. *Rays of Light.*—In working out the theory of diffraction it is possible to state exactly in what sense light may be said to travel in straight lines. Behind an opening *whose width is very large in comparison with the wave-length* the limits between the illuminated and the dark parts of space are approximately determined by rays passing along the borders.

This conclusion can also be arrived at by a mode of reasoning that is independent of the theory of diffraction.<sup>15</sup> If linear differential equations admit a solution of the form (5) with  $\mathbf{A}$  constant, they can also be satisfied by making  $\mathbf{A}$  a function of the coordinates, such that, in a wave-front, it changes very little over a distance equal to the wave-length  $\lambda$ , and that it is constant along each line conjugate with the wave-fronts. In cases of this kind the disturbance may truly be said to travel along lines of the said direction, and an observer who is unable to discern

lengths of the order of  $\lambda$ , and who uses an opening of much larger dimensions, may very well have the impression of a cylindrical beam with a sharp boundary.

A similar result is found for curved waves. If the additional restriction is made that their radii of curvature be very much larger than the wave-length, Huygens's construction may confidently be employed. The amplitudes all along a ray are determined by, and proportional to, the amplitude at one of its points.

14. *Polarized Light*.—As the theorems used in the explanation of interference and diffraction are true for all kinds of vibratory motions, these phenomena can give us no clue to the special kind of vibrations in light-waves. Further information, however, may be drawn from experiments on plane polarized light. The properties of a beam of this kind are completely known when the position of a certain plane passing through the direction of the rays, and *in* which the beam is said to be polarized, is given. "This plane of polarization," as it is called, coincides with the plane of incidence in those cases where the light has been polarized by reflection on a glass surface under an angle of incidence whose tangent is equal to the index of refraction (Brewster's law).

The researches of Fresnel and Arago left no doubt as to the direction of the vibrations in polarized light with respect to that of the rays themselves. In isotropic bodies at least, the vibrations are exactly transverse, *i.e.* perpendicular to the rays, either in the plane of polarization or at right angles to it. The first part of this statement also applies to unpolarized light, as this can always be dissolved into polarized components.

Much experimental work has been done on the production of polarized rays by double refraction and on the reflection of polarized light, either by isotropic or by anisotropic transparent bodies, the object of inquiry being in the latter case to determine the position of the plane of polarization of the reflected rays and their intensity.

In this way a large amount of evidence has been gathered by which it has been possible to test different theories concerning the nature of light and that of the medium through which it is propagated. A common feature of nearly all these theories is that the aether is supposed to exist not only in spaces void of matter, but also in the interior of ponderable bodies.

15. *Fresnel's Theory*.—Fresnel and his immediate successors assimilated the aether to an elastic solid, so that the velocity of propagation of transverse vibrations could be determined by the formula  $v = \sqrt{K/\rho}$ , where  $K$  denotes the modulus of rigidity and  $\rho$  the density. According to this equation the different properties of various isotropic transparent bodies may arise from different values of  $K$ , of  $\rho$ , or of both. It has, however, been found that if both  $K$  and  $\rho$  are supposed to change from one substance to another, it is impossible to obtain the right reflection formulae. Assuming the constancy of  $K$  Fresnel was led to equations which agreed with the observed properties of the reflected light, if he made the further assumption (to be mentioned in what follows as "Fresnel's assumption") that the vibrations of plane polarized light are perpendicular to the plane of polarization.

Let the indices  $p$  and  $n$  relate to the two principal cases in which the incident (and, consequently, the reflected) light is polarized in the plane of incidence, or normally to it, and let positive directions  $h$  and  $h'$  be chosen for the disturbance (at the surface itself) in the incident and for that in the reflected beam, in such a manner that, by a common rotation,  $h$  and the incident ray prolonged may be made to coincide with  $h'$  and the reflected ray. Then, if  $\alpha_1$  and  $\alpha_2$  are the angles of incidence and refraction, Fresnel shows that, in order to get the reflected disturbance, the incident one must be multiplied by

$$\alpha_p = -\sin(\alpha_1 - \alpha_2) / \sin(\alpha_1 + \alpha_2) \quad (9)$$

in the first, and by

$$\alpha_n = \tan(\alpha_1 - \alpha_2) / \tan(\alpha_1 + \alpha_2) \quad (10)$$

in the second principal case.

As to double refraction, Fresnel made it depend on the unequal elasticity of the aether in different directions. He came to the conclusion that, for a given direction of the waves, there are two possible directions of vibration (§ 6), lying in the wave-front, at right angles to each other, and he determined the form of the wave-surface, both in uniaxial and in biaxial crystals.

Though objections may be urged against the dynamic part of Fresnel's theory, he admirably succeeded in adapting it to the facts.

16. *Electromagnetic Theory*.—We here leave the historical order and pass on to Maxwell's theory of light.

James Clerk Maxwell, who had set himself the task of mathematically working out Michael Faraday's views, and who, both by doing so and by introducing many new ideas of his own, became the founder of the modern science of electricity,<sup>16</sup> recognized that, at every point of an electromagnetic field, the state of things can be defined by two vector quantities, the "electric force"  $\mathbf{E}$  and the "magnetic force"  $\mathbf{H}$ , the former of which is the force acting on unit of electricity and the latter that which acts on a magnetic pole of unit strength. In a non-conductor (dielectric) the force  $\mathbf{E}$  produces a state that may be described as a displacement of electricity from its position of equilibrium. This state is represented by a vector  $\mathbf{D}$  ("dielectric displacement") whose magnitude is measured by the quantity of electricity reckoned per unit area which has traversed an element of surface perpendicular to  $\mathbf{D}$  itself. Similarly, there is a vector quantity  $\mathbf{B}$  (the "magnetic induction") intimately connected with the magnetic force  $\mathbf{H}$ . Changes of the dielectric displacement constitute an electric current measured by the rate of change of  $\mathbf{D}$ , and represented in vector notation by

$$\mathbf{C} = \dot{\mathbf{D}} \quad (11)$$

Periodic changes of  $\mathbf{D}$  and  $\mathbf{B}$  may be called "electric" and "magnetic vibrations." Properly choosing the units, the axes of coordinates (in the first proposition also the positive direction of  $s$  and  $n$ ), and denoting components of vectors by suitable indices, we can express in the following way the fundamental propositions of the theory.

(a) Let  $s$  be a closed line,  $\sigma$  a surface bounded by it,  $n$  the normal to  $\sigma$ . Then, for all bodies,

$$\int \mathbf{H}_s ds = \frac{1}{c} \int \mathbf{C}_n d\sigma, \quad \int \mathbf{E}_s ds = -\frac{1}{c} \frac{d}{dt} \int \mathbf{B}_n d\sigma,$$



where the constant  $c$  means the ratio between the electro-magnet and the electrostatic unit of electricity.

From these equations we can deduce:

( $\alpha$ ) For the interior of a body, the equations

$$\frac{\partial \mathbf{H}_z}{\partial y} - \frac{\partial \mathbf{H}_y}{\partial z} = \frac{1}{c} \mathbf{C}_x, \quad \frac{\partial \mathbf{H}_x}{\partial z} - \frac{\partial \mathbf{H}_z}{\partial x} = \frac{1}{c} \mathbf{C}_y, \quad \frac{\partial \mathbf{H}_y}{\partial x} - \frac{\partial \mathbf{H}_x}{\partial y} = \frac{1}{c} \mathbf{C}_z \quad (12)$$

$$\frac{\partial \mathbf{E}_z}{\partial y} - \frac{\partial \mathbf{E}_y}{\partial z} = -\frac{1}{c} \frac{\partial \mathbf{B}_z}{\partial t}, \quad \frac{\partial \mathbf{E}_x}{\partial z} - \frac{\partial \mathbf{E}_z}{\partial x} = -\frac{1}{c} \frac{\partial \mathbf{B}_y}{\partial t}, \quad \frac{\partial \mathbf{E}_y}{\partial x} - \frac{\partial \mathbf{E}_x}{\partial y} = -\frac{1}{c} \frac{\partial \mathbf{B}_z}{\partial t}; \quad (13)$$

( $\beta$ ) For a surface of separation, the continuity of the tangential components of  $\mathbf{E}$  and  $\mathbf{H}$ ;

( $\gamma$ ) The solenoidal distribution of  $\mathbf{C}$  and  $\mathbf{B}$ , and in a dielectric that of  $\mathbf{D}$ . A solenoidal distribution of a vector is one corresponding to that of the velocity in an incompressible fluid. It involves the continuity, at a surface, of the normal component of the vector.

( $b$ ) The relation between the electric force and the dielectric displacement is expressed by

$$\mathbf{D}_x = \varepsilon_1 \mathbf{E}_x, \quad \mathbf{D}_y = \varepsilon_2 \mathbf{E}_y, \quad \mathbf{D}_z = \varepsilon_3 \mathbf{E}_z, \quad (14)$$

the constants  $\varepsilon_1, \varepsilon_2, \varepsilon_3$  (dielectric constants) depending on the properties of the body considered. In an isotropic medium they have a common value  $\varepsilon$ , which is equal to unity for the free aether, so that for this medium  $\mathbf{D} = \mathbf{E}$ .

( $c$ ) There is a relation similar to (14) between the magnetic force and the magnetic induction. For the aether, however, and for all ponderable bodies with which this article is concerned, we may write  $\mathbf{B} = \mathbf{H}$ .

It follows from these principles that, in an isotropic dielectric, transverse electric vibrations can be propagated with a velocity

$$v = c / \sqrt{\varepsilon}. \quad (15)$$

Indeed, all conditions are satisfied if we put

$$\begin{aligned} \mathbf{D}_x &= 0, \quad \mathbf{D}_y = a \cos n(t - xv^{-1} + l), \quad \mathbf{D}_z = 0, \\ \mathbf{H}_x &= 0, \quad \mathbf{H}_y = 0, \quad \mathbf{H}_z = avc^{-1} \cos n(t - xv^{-1} + l) \end{aligned} \quad (16)$$

For the free aether the velocity has the value  $c$ . Now it had been found that the ratio  $c$  between the two units of electricity agrees within the limits of experimental errors with the numerical value of the velocity of light in aether. (The mean result of the most exact determinations<sup>17</sup> of  $c$  is  $3,001 \cdot 10^{10}$  cm./sec., the largest deviations being about  $0,008 \cdot 10^{10}$ , and Cornu<sup>18</sup> gives  $3,001 \cdot 10^{10} \pm 0,003 \cdot 10^{10}$  as the most probable value of the velocity of light.) By this Maxwell was led to suppose that light consists of transverse electromagnetic disturbances. On this assumption, the equations (16) represent a beam of plane polarized light. They show that, in such a beam, there are at the same time electric and magnetic vibrations, both transverse, and at right angles to each other.

It must be added that the electromagnetic field is the seat of two kinds of energy distinguished by the names of electric and magnetic energy, and that, according to a beautiful theorem due to J. H. Poynting,<sup>19</sup> the energy may be conceived to flow in a direction perpendicular both to the electric and to the magnetic force. The amounts per unit of volume of the electric and the magnetic energy are given by the expressions

$$\frac{1}{2} (\mathbf{E}_x \mathbf{D}_x + \mathbf{E}_y \mathbf{D}_y + \mathbf{E}_z \mathbf{D}_z), \quad (17)$$

and

$$\frac{1}{2} (\mathbf{H}_x \mathbf{B}_x + \mathbf{H}_y \mathbf{B}_y + \mathbf{H}_z \mathbf{B}_z) = \frac{1}{2} \mathbf{H}^2, \quad (18)$$

whose mean values for a full period are equal in every beam of light.

The formula (15) shows that the index of refraction of a body is given by  $\sqrt{\varepsilon}$ , a result that has been verified by Ludwig Boltzmann's measurements<sup>20</sup> of the dielectric constants of gases. Thus Maxwell's theory can assign the true cause of the different optical properties of various transparent bodies. It also leads to the reflection formulae (9) and (10), provided the electric vibrations of polarized light be supposed to be perpendicular to the plane of polarization, which implies that the magnetic vibrations are parallel to that plane.

Following the same assumption Maxwell deduced the laws of double refraction, which he ascribes to the inequality of  $\varepsilon_1, \varepsilon_2, \varepsilon_3$ . His results agree with those of Fresnel and the theory has been confirmed by Boltzmann,<sup>21</sup> who measured the three coefficients in the case of crystallized sulphur, and compared them with the principal indices of refraction. Subsequently the problem of crystalline reflection has been completely solved and it has been shown that, in a crystal, Poynting's flow of energy has the direction of the rays as determined by Huygens's construction.

Two further verifications must here be mentioned. In the first place, though we shall speak almost exclusively of the propagation of light in transparent dielectrics, a few words may be said about the optical properties of conductors. The simplest assumption concerning the electric current  $\mathbf{C}$  in a metallic body is expressed by the equation  $\mathbf{C} = \sigma \mathbf{E}$ , where  $\sigma$  is the coefficient of conductivity. Combining this with his other formulae (we may say with (12) and (13)), Maxwell found that there must be an absorption of light, a result that can be readily understood since the motion of electricity in a conductor gives rise to a development of heat. But, though Maxwell accounted in this way for the fundamental fact that metals are opaque bodies, there remained a wide divergence between the values of the coefficient of absorption as directly measured and as calculated from the electrical conductivity; but in 1903 it was shown by E. Hagen and H. Rubens<sup>22</sup> that the agreement is very satisfactory in the case of the extreme infra-red rays.

In the second place, the electromagnetic theory requires that a surface struck by a beam of light shall experience a certain pressure. If the beam falls normally on a plane disk, the pressure is normal too; its total amount is given by  $c^{-1}(i_1 + i_2 - i_3)$ , if  $i_1, i_2$  and  $i_3$  are the quantities of energy that are carried forward per unit of

time by the incident, the reflected, and the transmitted light. This result has been quantitatively verified by E. F. Nicholls and G. F. Hull.<sup>23</sup>

Maxwell's predictions have been splendidly confirmed by the experiments of Heinrich Hertz<sup>24</sup> and others on electromagnetic waves; by diminishing the length of these to the utmost, some physicists have been able to reproduce with them all phenomena of reflection, refraction (single and double), interference, and polarization.<sup>25</sup> A table of the wave-lengths observed in the aether now has to contain, besides the numbers given in § 11, the lengths of the waves produced by electromagnetic apparatus and extending from the long waves used in wireless telegraphy down to about 0.6 cm.

17. *Mechanical Models of the Electromagnetic Medium.*—From the results already enumerated, a clear idea can be formed of the difficulties which were encountered in the older form of the wave-theory. Whereas, in Maxwell's theory, longitudinal vibrations are excluded *ab initio* by the solenoidal distribution of the electric current, the elastic-solid theory had to take them into account, unless, as was often done, one made them disappear by supposing them to have a very great velocity of propagation, so that the aether was considered to be practically incompressible. Even on this assumption, however, much in Fresnel's theory remained questionable. Thus George Green,<sup>26</sup> who was the first to apply the theory of elasticity in an unobjectionable manner, arrived on Fresnel's assumption at a formula for the reflection coefficient  $A_n$  sensibly differing from (10).

In the theory of double refraction the difficulties are no less serious. As a general rule there are in an anisotropic elastic solid three possible directions of vibration (§ 6), at right angles to each other, for a given direction of the waves, but none of these lies in the wave-front. In order to make two of them do so and to find Fresnel's form for the wave-surface, new hypotheses are required. On Fresnel's assumption it is even necessary, as was observed by Green, to suppose that in the absence of all vibrations there is already a certain state of pressure in the medium.

If we adhere to Fresnel's assumption, it is indeed scarcely possible to construct an elastic model of the electromagnetic medium. It may be done, however, if the velocities of the particles in the model are taken to represent the magnetic force  $\mathbf{H}$ , which, of course, implies that the vibrations of the particles are parallel to the plane of polarization, and that the magnetic energy is represented by the kinetic energy in the model. Considering further that, in the case of two bodies connected with each other, there is continuity of  $\mathbf{H}$  in the electromagnetic system, and continuity of the velocity of the particles in the model, it becomes clear that the representation of  $\mathbf{H}$  by that velocity must be on the same scale in all substances, so that, if  $\xi$ ,  $\eta$ ,  $\zeta$  are the displacements of a particle and  $g$  a universal constant, we may write

$$\mathbf{H}_x = g \frac{\partial \xi}{\partial t}, \quad \mathbf{H}_y = g \frac{\partial \eta}{\partial t}, \quad \mathbf{H}_z = g \frac{\partial \zeta}{\partial t}. \tag{19}$$

By this the magnetic energy per unit of volume becomes

$$\frac{1}{2} g^2 \left\{ \left( \frac{\partial \xi}{\partial t} \right)^2 + \left( \frac{\partial \eta}{\partial t} \right)^2 + \left( \frac{\partial \zeta}{\partial t} \right)^2 \right\},$$

and since this must be the kinetic energy of the elastic medium, the density of the latter must be taken equal to  $g^2$ , so that it must be the same in all substances.

It may further be asked what value we have to assign to the potential energy in the model, which must correspond to the electric energy in the electromagnetic field. Now, on account of (11) and (19), we can satisfy the equations (12) by putting  $\mathbf{D}_x = gc (\partial \zeta / \partial y - \partial \eta / \partial z)$ , &c., so that the electric energy (17) per unit of volume becomes

$$\frac{1}{2} g^2 c^2 \left\{ \frac{1}{\epsilon_1} \left( \frac{\partial \zeta}{\partial y} - \frac{\partial \eta}{\partial z} \right)^2 + \frac{1}{\epsilon_2} \left( \frac{\partial \xi}{\partial z} - \frac{\partial \zeta}{\partial x} \right)^2 + \frac{1}{\epsilon_3} \left( \frac{\partial \eta}{\partial x} - \frac{\partial \xi}{\partial y} \right)^2 \right\}.$$

This, therefore, must be the potential energy in the model.

It may be shown, indeed, that, if the aether has a uniform constant density, and is so constituted that in any system, whether homogeneous or not, its potential energy per unit of volume can be represented by an expression of the form

$$\frac{1}{2} \left\{ L \left( \frac{\partial \zeta}{\partial y} - \frac{\partial \eta}{\partial z} \right)^2 + M \left( \frac{\partial \xi}{\partial z} - \frac{\partial \zeta}{\partial x} \right)^2 + N \left( \frac{\partial \eta}{\partial x} - \frac{\partial \xi}{\partial y} \right)^2 \right\}, \tag{20}$$

where  $L$ ,  $M$ ,  $N$  are coefficients depending on the physical properties of the substance considered, the equations of motion will exactly correspond to the equations of the electromagnetic field.

18. *Theories of Neumann, Green, and MacCullagh.*—A theory of light in which the elastic aether has a uniform density, and in which the vibrations are supposed to be parallel to the plane of polarization, was developed by Franz Ernst Neumann,<sup>27</sup> who gave the first deduction of the formulas for crystalline reflection. Like Fresnel, he was, however, obliged to introduce some illegitimate assumptions and simplifications. Here again Green indicated a more rigorous treatment.

By specializing the formula for the potential energy of an anisotropic body he arrives at an expression which, if some of his coefficients are made to vanish and if the medium is supposed to be incompressible, differs from (20) only by the additional terms

$$2 \left\{ L \left( \frac{\partial \zeta}{\partial y} \frac{\partial \eta}{\partial z} - \frac{\partial \eta}{\partial y} \frac{\partial \zeta}{\partial z} \right) + M \left( \frac{\partial \xi}{\partial z} \frac{\partial \zeta}{\partial x} - \frac{\partial \zeta}{\partial z} \frac{\partial \xi}{\partial x} \right) + N \left( \frac{\partial \eta}{\partial x} \frac{\partial \xi}{\partial y} - \frac{\partial \xi}{\partial x} \frac{\partial \eta}{\partial y} \right) \right\}. \tag{21}$$

If  $\xi$ ,  $\eta$ ,  $\zeta$  vanish at infinite distance the integral of this expression over all space is zero, when  $L$ ,  $M$ ,  $N$  are constants, and the same will be true when these coefficients change from point to point, provided we add to (21) certain terms containing the differential coefficients of  $L$ ,  $M$ ,  $N$ , the physical meaning of these terms being that, besides the ordinary elastic forces, there is some extraneous force (called into play by the displacement) acting on all those elements of volume where  $L$ ,  $M$ ,  $N$  are not constant. We may conclude from this that all phenomena can be explained if we admit the existence of this latter force, which, in the case of two contingent bodies, reduces to a surface-action on their common boundary.

James MacCullagh<sup>28</sup> avoided this complication by simply assuming an expression of the form (20) for the potential energy. He thus established a theory that is perfectly consistent in itself, and may be said to have foreshadowed the electromagnetic theory as regards the form of the equations for transparent bodies. Lord Kelvin afterwards interpreted MacCullagh's assumption by supposing the only action which is called forth by a displacement to consist in certain couples acting on the elements of volume and proportional to the components  $\frac{1}{2} \{(\partial\zeta/\partial y) - (\partial\eta/\partial z)\}$ , &c., of their rotation from the natural position. He also showed<sup>29</sup> that this "rotational elasticity" can be produced by certain hidden rotations going on in the medium.

We cannot dwell here upon other models that have been proposed, and most of which are of rather limited applicability. A mechanism of a more general kind ought, of course, to be adapted to what is known of the molecular constitution of bodies, and to the highly probable assumption of the perfect permeability for the aether of all ponderable matter, an assumption by which it has been possible to escape from one of the objections raised by Newton (§ 4) (see [AETHER](#)).

The possibility of a truly satisfactory model certainly cannot be denied. But it would, in all probability, be extremely complicated. For this reason many physicists rest content, as regards the free aether, with some such general form of the electromagnetic theory as has been sketched in § 16.

19. *Optical Properties of Ponderable Bodies. Theory of Electrons.*—If we want to form an adequate representation of optical phenomena in ponderable bodies, the conceptions of the molecular and atomistic theories naturally suggest themselves. Already, in the elastic theory, it had been imagined that certain material particles are set vibrating by incident waves of light. These particles had been supposed to be acted on by an elastic force by which they are drawn back towards their positions of equilibrium, so that they can perform free vibrations of their own, and by a resistance that can be represented by terms proportional to the velocity in the equations of motion, and may be physically understood if the vibrations are supposed to be converted in one way or another into a disorderly heat-motion. In this way it had been found possible to explain the phenomena of dispersion and (selective) absorption, and the connexion between them (anomalous dispersion).<sup>30</sup> These ideas have been also embodied into the electromagnetic theory. In its more recent development the extremely small, electrically charged particles, to which the name of "electrons" has been given, and which are supposed to exist in the interior of all bodies, are considered as forming the connecting links between aether and matter, and as determining by their arrangement and their motion all optical phenomena that are not confined to the free aether.<sup>31</sup>

It has thus become clear why the relations that had been established between optical and electrical properties have been found to hold only in some simple cases (§ 16). In fact it cannot be doubted that, for rapidly alternating electric fields, the formulae expressing the connexion between the motion of electricity and the electric force take a form that is less simple than the one previously admitted, and is to be determined in each case by elaborate investigation. However, the general boundary conditions given in § 16 seem to require no alteration. For this reason it has been possible, for example, to establish a satisfactory theory of metallic reflection, though the propagation of light in the interior of a metal is only imperfectly understood.

One of the fundamental propositions of the theory of electrons is that an electron becomes a centre of radiation whenever its velocity changes either in direction or in magnitude. Thus the production of Röntgen rays, regarded as consisting of very short and irregular electromagnetic impulses, is traced to the impacts of the electrons of the cathode-rays against the anti-cathode, and the lines of an emission spectrum indicate the existence in the radiating body of as many kinds of regular vibrations, the knowledge of which is the ultimate object of our investigations about the structure of the spectra. The shifting of the lines caused, according to Doppler's law, by a motion of the source of light, may easily be accounted for, as only general principles are involved in the explanation. To a certain extent we can also elucidate the changes in the emission that are observed when the radiating source is exposed to external magnetic forces ("Zeeman-effect"; see [MAGNETO-OPTICS](#)).

20. *Various Kinds of Light-motion.*—(a) If the disturbance is represented by

$$\mathbf{P}_x = 0, \mathbf{P}_y = a \cos (nt - kx + f), \mathbf{P}_z = a' \cos (nt - kx + f),$$

so that the end of the vector  $\mathbf{P}$  describes an ellipse in a plane perpendicular to the direction of propagation, the light is said to be elliptically, or in special cases circularly, polarized. Light of this kind can be dissolved in many different ways into plane polarized components.

There are cases in which plane waves must be elliptically or circularly polarized in order to show the simple propagation of phase that is expressed by formulae like (5). Instances of this kind occur in bodies having the property of rotating the plane of polarization, either on account of their constitution, or under the influence of a magnetic field. For a given direction of the wave-front there are in general two kinds of elliptic vibrations, each having a definite form, orientation, and direction of motion, and a determinate velocity of propagation. All that has been said about Huygens's construction applies to these cases.

(b) In a perfect spectroscopie a sharp line would only be observed if an endless regular succession of simple harmonic vibrations were admitted into the instrument. In any other case the light will occupy a certain extent in the spectrum, and in order to determine its distribution we have to decompose into simple harmonic functions of the time the components of the disturbance, at a point of the slit for instance. This may be done by means of Fourier's theorem.

An extreme case is that of the unpolarized light emitted by incandescent solid bodies, consisting of disturbances whose variations are highly irregular, and giving a continuous spectrum. But even with what is commonly called homogeneous light, no perfectly sharp line will be seen. There is no source of light in which the vibrations of the particles remain for ever undisturbed, and a particle will never emit an endless succession of uninterrupted vibrations, but at best a series of vibrations whose form, phase and intensity are changed at irregular intervals. The result must be a broadening of the spectral line.

In cases of this kind one must distinguish between the velocity of propagation of the phase of regular vibrations and the velocity with which the said changes travel onward (see below, iii. *Velocity of Light*).

(c) In a train of plane waves of definite frequency the disturbance is represented by means of goniometric functions of the time and the coordinates. Since the fundamental equations are linear, there are also solutions in which one or more of the coordinates occur in an exponential function. These solutions are of interest because

the motions corresponding to them are widely different from those of which we have thus far spoken. If, for example, the formulae contain the factor

$$e^{-rx} \cos (nt - sy + l),$$

with the positive constant  $r$ , the disturbance is no longer periodic with respect to  $x$ , but steadily diminishes as  $x$  increases. A state of things of this kind, in which the vibrations rapidly die away as we leave the surface, exists in the air adjacent to the face of a glass prism by which a beam of light is totally reflected. It furnishes us an explanation of Newton's experiment mentioned in § 2.

(H. A. L.)

### III. VELOCITY OF LIGHT

The fact that light is propagated with a definite speed was first brought out by Ole Roemer at Paris, in 1676, through observations of the eclipses of Jupiter's satellites, made in different relative positions of the Earth and Jupiter in their respective orbits. It is possible in this way to determine the time required for light to pass across the orbit of the earth. The dimensions of this orbit, or the distance of the sun, being taken as known, the actual speed of light could be computed. Since this computation requires a knowledge of the sun's distance, which has not yet been acquired with certainty, the actual speed is now determined by experiments made on the earth's surface. Were it possible by any system of signals to compare with absolute precision the times at two different stations, the speed could be determined by finding how long was required for light to pass from one station to another at the greatest visible distance. But this is impracticable, because no natural agent is under our control by which a signal could be communicated with a greater velocity than that of light. It is therefore necessary to reflect a ray back to the point of observation and to determine the time which the light requires to go and come. Two systems have been devised for this purpose. One is that of Fizeau, in which the vital appliance is a rapidly revolving toothed wheel; the other is that of Foucault, in which the corresponding appliance is a mirror revolving on an axis in, or parallel to, its own plane.

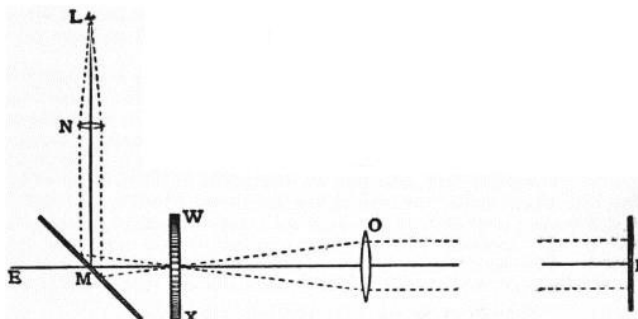


FIG. 1.

The principle underlying Fizeau's method is shown in the accompanying figs. 1 and 2. Fig. 1 shows the course of a ray of light which, emanating from a luminous point  $L$ , strikes the plane surface of a plate of glass  $M$  at an angle of about  $45^\circ$ . A fraction of the light is reflected from the two surfaces of the glass to a distant reflector  $R$ , the plane of which is at right angles to the course of the ray. The latter is thus reflected back on its own course and, passing through the glass  $M$  on its return, reaches a point  $E$  behind the glass. An observer with his eye at  $E$  looking through the glass sees the return ray as a distant luminous point in the reflector  $R$ , after the light has passed over the course in both directions.

In actual practice it is necessary to interpose the object glass of a telescope at a point  $O$ , at a distance from  $M$  nearly equal to its focal length. The function of this appliance is to render the diverging rays, shown by the dotted lines, nearly parallel, in order that more light may reach  $R$  and be thrown back again. But the principle may be conceived without respect to the telescope, all the rays being ignored except the central one, which passes over the course we have described.

Conceiving the apparatus arranged in such a way that the observer sees the light reflected from the distant mirror  $R$ , a fine toothed wheel  $WX$  is placed immediately in front of the glass  $M$ , with its plane perpendicular to the course of the ray, in such a way that the ray goes out and returns through an opening between two adjacent teeth. This wheel is represented in section by  $WX$  in fig. 1, and a part of its circumference, with the teeth as viewed by the observer, is shown in fig. 2. We conceive that the latter sees the luminous point between two of the teeth at  $K$ . Now, conceive that the wheel is set in revolution. The ray is then interrupted as every tooth passes, so that what is sent out is a succession of flashes. Conceive that the speed of the mirror is such that while the flash is going to the distant mirror and returning again, each tooth of the wheel takes the place of an opening between the teeth. Then each flash sent out will, on its return, be intercepted by the adjacent tooth, and will therefore become invisible. If the speed be now doubled, so that the teeth pass at intervals equal to the time required for the light to go and come, each flash sent through an opening will return through the adjacent opening, and will therefore be seen with full brightness. If the speed be continuously increased the result will be successive disappearances and reappearances of the light, according as a tooth is or is not interposed when the ray reaches the apparatus on its return. The computation of the time of passage and return is then very simple. The speed of the wheel being known, the number of teeth passing in one second can be computed. The order of the disappearance, or the number of teeth which have passed while the light is going and coming, being also determined in each case, the interval of time is computed by a simple formula.



FIG. 2.

The most elaborate determination yet made by Fizeau's method was that of Cornu. The station of observation was at the Paris Observatory. The distant reflector, a telescope with a reflector at its focus, was at Monthléry, distant 22,910 metres from the toothed wheel. Of the wheels most used one had 150 teeth, and was 35 millimetres in diameter; the other had 200 teeth, with a diameter of 45 mm. The highest speed attained was about 900 revolutions per second. At this speed, 135,000 (or 180,000) teeth would pass per second, and about 20 (or 28) would pass while the light was going and coming.

But the actual speed attained was generally less than this. The definitive result derived by Cornu from the entire series of experiments was 300,400 kilometres per second. Further details of this work need not be set forth because the method is in several ways deficient in precision. The eclipses and subsequent reappearances of the light taking place gradually, it is impossible to fix with entire precision upon the moment of complete eclipse. The speed of the wheel is continually varying, and it is impossible to determine with precision what it was at the instant of an eclipse.

The defect would be lessened were the speed of the toothed wheel placed under control of the observer who, by action in one direction or the other, could continually check or accelerate it, so as to keep the return point of light at the required phase of brightness. If the phase of complete extinction is chosen for this purpose a definite result cannot be reached; but by choosing the moment when the light is of a certain definite brightness, before or after an eclipse, the observer will know at each instant whether the speed should be accelerated or retarded, and can act accordingly. The nearly constant speed through as long a period as is deemed necessary would then be found by dividing the entire number of revolutions of the wheel by the time through which the light was kept constant. But even with these improvements, which were not actually tried by Cornu, the estimate of the brightness on which the whole result depends would necessarily be uncertain. The outcome is that, although Cornu's discussion of his experiments is a model in the care taken to determine so far as practicable every source of error, his definitive result is shown by other determinations to have been too great by about  $\frac{1}{1000}$  part of its whole amount.

An important improvement on the Fizeau method was made in 1880 by James Young and George Forbes at Glasgow. This consisted in using two distant reflectors which were placed nearly in the same straight line, and at unequal distances. The ratio of the distances was nearly 12 : 13. The phase observed was not that of complete extinction of either light, but that when the two lights appeared equal in intensity. But it does not appear that the very necessary device of placing the speed of the toothed wheel under control of the observer was adopted. The accordance between the different measures was far from satisfactory, and it will suffice to mention the result which was

$$\text{Velocity in vacuo} = 301,382 \text{ km. per second.}$$

These experimenters also found a difference of 2% between the speed of red and blue light, a result which can only be attributed to some unexplained source of error.

The Foucault system is much more precise, because it rests upon the measurement of an angle, which can be made with great precision.

The vital appliance is a rapidly revolving mirror. Let AB (fig. 3) be a section of this mirror, which we shall first suppose at rest. A ray of light LM emanating from a source at L, is reflected in the direction

**Foucault.**

perpendicularly reflected back upon its original course. This mirror R should be slightly concave, with the centre of curvature near M, so that the ray shall always be reflected back to M on whatever point of R it may fall. Conceiving the revolving mirror M as at rest, the return ray will after three reflections, at M, R and M again, be returned along its original course to the point L from which it emanated. An important point is that the return ray will always follow the fixed line ML no matter what the position of the movable mirror M, provided there is a distant reflector to send the ray back. Now, suppose that, while the ray is going and coming, the mirror M, being set in revolution, has turned from the position in which the ray was reflected to that shown by the dotted line. If  $\alpha$  be the angle through which the surface has turned, the course of the return ray, after reflection, will then deviate from ML by the angle  $2\alpha$ , and so be thrown to a point E, such that the angle LME =  $2\alpha$ . If the mirror is in rapid rotation the ray reflected from it will strike the distant mirror as a series of flashes, each formed by the light reflected when the mirror was in the position AB. If the speed of rotation is uniform, the reflected rays from the successive flashes while the mirror is in the dotted position will thus all follow the same direction ME after their second reflection from the mirror. If the motion is sufficiently rapid an eye observing the reflected ray will see the flashes as an invariable point of light so long as the speed of revolution remains constant. The time required for the light to go and come is then equal to that required by the mirror to turn through half the angle LME, which is therefore to be measured. In practice it is necessary on this system, as well as on that of Fizeau, to condense the light by means of a lens, Q, so placed that L and R shall be at conjugate foci. The position of the lens may be either between the luminous point L and the mirror M, or between M and R, the latter being the only one shown in the figure. This position has the advantage that more light can be concentrated, but it has the disadvantage that, with a given magnifying power, the effect of atmospheric undulation, when the concave reflector is situated at a great distance, is increased in the ratio of the focal length of the lens to the distance LM from the light to the mirror. To state the fact in another form, the amplitude of the disturbances produced by the air in linear measure are proportional to the focal distance of the lens, while the magnification required increases in the inverse ratio of the distance LM. Another difficulty associated with the Foucault system in the form in which its originator used it is that if the axis of the mirror is at right angles to the course of the ray, the light from the source L will be flashed directly into the eye of the observer, on every passage of the revolving mirror through the position in which its normal bisects the two courses of the ray. This may be avoided by inclining the axis of the mirror.

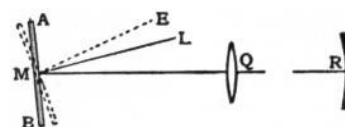


FIG. 3.

In Foucault's determination the measures were not made upon a luminous point, but upon a reticule, the image of which could not be seen unless the reflector was quite near the revolving mirror. Indeed the whole apparatus was contained in his laboratory. The effective distance was increased by using several reflectors; but the entire course of the ray measured only 20 metres. The result reached by Foucault for the velocity of light was 298,000 kilometres per second.

The first marked advance on Foucault's determination was made by Albert A. Michelson, then a young officer on duty at the U.S. Naval Academy, Annapolis. The improvement consisted in using the image of a slit through which the rays of the sun passed after reflection from a heliostat. In this way it was found possible to see the image of the slit reflected from the distant mirror when the latter was nearly 600 metres from the station of observation. The essentials of the arrangement are those we have used in fig. 3, L being the slit. It will be seen that the revolving mirror is here interposed between the lens and its focus. It was driven by an air turbine, the blast of which was under the control of the observer, so that it could be kept at any required speed. The speed was determined by the vibrations of two tuning forks. One of these was an electric fork, making about 120 vibrations per second, with which the mirror was kept in unison

**Michelson.**

by a system of rays reflected from it and the fork. The speed of this fork was determined by comparison with a freely vibrating fork from time to time. The speed of the revolving mirror was generally about 275 turns per second, and the deflection of the image of the slit about 112.5 mm. The mean result of nearly 100 fairly accordant determinations was:—

Velocity of light in air	299,828 km. per sec.
Reduction to a vacuum	+82
Velocity of light in a vacuum	299,910 ± 50

While this work was in progress Simon Newcomb obtained the official support necessary to make a determination on a yet larger scale. The most important modifications made in the Foucault-**Newcomb**. Michelson system were the following:—

1. Placing the reflector at the much greater distance of several kilometres.
2. In order that the disturbances of the return image due to the passage of the ray through more than 7 km. of air might be reduced to a minimum, an ordinary telescope of the "broken back" form was used to send the ray to the revolving mirror.
3. The speed of the mirror was, as in Michelson's experiments, completely under control of the observer, so that by drawing one or the other of two cords held in the hand the return image could be kept in any required position. In making each measure the receiving telescope hereafter described was placed in a fixed position and during the "run" the image was kept as nearly as practicable upon a vertical thread passing through its focus. A "run" generally lasted about two minutes, during which time the mirror commonly made between 25,000 and 30,000 revolutions. The speed per second was found by dividing the entire number of revolutions by the number of seconds in the "run." The extreme deviations between the times of transmission of the light, as derived from any two runs, never approached to the thousandth part of its entire amount. The average deviation from the mean was indeed less than  $\frac{1}{5000}$  part of the whole.

To avoid the injurious effect of the directly reflected flash, as well as to render unnecessary a comparison between the directions of the outgoing and the return ray, a second telescope, turning horizontally on an axis coincident with that of the revolving mirror, was used to receive the return ray after reflection. This required the use of an elongated mirror of which the upper half of the surface reflected the outgoing ray, and the lower other half received and reflected the ray on its return. On this system it was not necessary to incline the mirror in order to avoid the direct reflection of the return ray. The greatest advantage of this system was that the revolving mirror could be turned in either direction without break of continuity, so that the angular measures were made between the directions of the return ray after reflection when the mirror moved in opposite directions. In this way the speed of the mirror was as good as doubled, and the possible constant errors inherent in the reference to a fixed direction for the sending telescope were eliminated. The essentials of the apparatus are shown in fig. 4. The revolving mirror was a rectangular prism M of steel, 3 in. high and 1½ in. on a side in cross section, which was driven by a blast of air acting on two fan-wheels, not shown in the fig., one at the top, the other at the bottom of the mirror. NPO is the object-end of the fixed sending telescope the rays passing through it being reflected to the mirror by a prism P. The receiving telescope ABO is straight, and has its objective under O. It was attached to a frame which could turn around the same axis as the mirror. The angle through which it moved was measured by a divided arc immediately below its eye-piece, which is not shown in the figure. The position AB is that for receiving the ray during a rotation of the mirror in the anti-clockwise direction; the position A'B' that for a clockwise rotation.

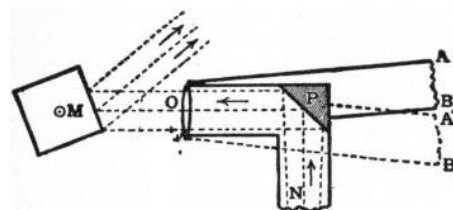


FIG. 4.

In these measures the observing station was at Fort Myer, on a hill above the west bank of the Potomac river. The distant reflector was first placed in the grounds of the Naval Observatory, at a distance of 2551 metres. But the definitive measures were made with the reflector at the base of the Washington monument, 3721 metres distant. The revolving mirror was of nickel-plated steel, polished on all four vertical sides. Thus four reflections of the ray were received during each turn of the mirror, which would be coincident were the form of the mirror invariable. During the preliminary series of measures it was found that two images of the return ray were sometimes formed, which would result in two different conclusions as to the velocity of light, according as one or the other was observed. The only explanation of this defect which presented itself was a torsional vibration of the revolving mirror, coinciding in period with that of revolution, but it was first thought that the effect was only occasional.

In the summer of 1881 the distant reflector was removed from the Observatory to the Monument station. Six measures made in August and September showed a systematic deviation of +67 km. per second from the result of the Observatory series. This difference led to measures for eliminating the defect from which it was supposed to arise. The pivots of the mirror were reground, and a change made in the arrangement, which would permit of the effect of the vibration being determined and eliminated. This consisted in making the relative position of the sending and receiving telescopes interchangeable. In this way, if the measured deflection was too great in one position of the telescopes, it would be too small by an equal amount in the reverse position. As a matter of fact, when the definitive measures were made, it was found that with the improved pivots the mean result was the same in the two positions. But the new result differed systematically from both the former ones. Thirteen measures were made from the Monument in the summer of 1882, the results of which will first be stated in the form of the time required by the ray to go and come. Expressed in millionths of a second this was:—

Least result of the 13 measures	24.819
Greatest result	24.831
Double distance between mirrors	7.44242 km.

Applying a correction of +12 km. for a slight convexity in the face of the revolving mirror, this gives as the mean result for the speed of light in air, 299,778 km. per second. The mean results for the three series were:—

Observatory, 1880-1881	V in air = 299,627
Monument, 1881	V in air = 299,694
Monument, 1882	V in air = 299,778

The last result being the only one from which the effect of distortion was completely eliminated, has been adopted as definitive. For reduction to a vacuum it requires a correction of +82 km. Thus the final result was concluded to be

$$\text{Velocity of light in vacuo} = 299,860 \text{ km. per second.}$$

This result being less by 50 km. than that of Michelson, the latter made another determination with improved apparatus and arrangements at the Case School of Applied Science in Cleveland. The result was

$$\text{Velocity in vacuo} = 299,853 \text{ km. per second.}$$

So far as could be determined from the discordance of the separate measures, the mean error of Newcomb's result would be less than  $\pm 10$  km. But making allowance for the various sources of systematic error the actual probable error was estimated at  $\pm 30$  km.

It seems remarkable that since these determinations were made, a period during which great improvements have become possible in every part of the apparatus, no complete redetermination of this fundamental physical constant has been carried out.

The experimental measures thus far cited have been primarily those of the velocity of light in air, the reduction to a vacuum being derived from theory alone. The fundamental constant at the basis of the whole theory is the speed of light in a vacuum, such as the celestial spaces. The question of the relation between the velocity in vacuo, and in a transparent medium of any sort, belongs to the domain of physical optics. Referring to the preceding section for the principles at play we shall in the present part of the article confine ourselves to the experimental results. With the theory of the effect of a transparent medium is associated that of the possible differences in the speed of light of different colours.

The question whether the speed of light in vacuo varies with its wave-length seems to be settled with entire certainty by observations of variable stars. These are situated at different distances, some being so far that light must be several centuries in reaching us from them. Were there any difference in the speed of light of various colours it would be shown by a change in the colour of the star as its light waxed and waned. The light of greatest speed preceding that of lesser speed would, when emanated during the rising phase, impress its own colour on that which it overtook. The slower light would predominate during the falling phase. If there were a difference of 10 minutes in the time at which light from the two ends of the visible spectrum arrived, it would be shown by this test. As not the slightest effect of the kind has ever been seen, it seems certain that the difference, if any, cannot approximate to  $\frac{1}{1,000,000}$  part of the entire speed. The case is different when light passes through a refracting medium. It is a theoretical result of the undulatory theory of light that its velocity in such a medium is inversely proportional to the refractive index of the medium. This being different for different colours, we must expect a corresponding difference in the velocity.

Foucault and Michelson have tested these results of the undulatory theory by comparing the time required for a ray of light to pass through a tube filled with a refracting medium, and through air. Foucault thus found, in a general way, that there actually was a retardation; but his observations took account only of the mean retardation of light of all the wave-lengths, which he found to correspond with the undulatory theory. Michelson went further by determining the retardation of light of various wave-lengths in carbon bisulphide. He made two series of experiments, one with light near the brightest part of the spectrum; the other with red and blue light. Putting  $V$  for the speed in a vacuum and  $V_1$  for that in the medium, his result was

Yellow light	$V : V_1 = 1.758$
Refractive index for yellow	1.64
Difference from theory	+0.12

The estimated uncertainty was only 0.02, or  $\frac{1}{50}$  of the difference between observation and theory.

The comparison of red and blue light was made differentially. The colours selected were of wave-length about 0.62 for red and 0.49 for blue. Putting  $V_r$  and  $V_b$  for the speeds of red and blue light respectively in bisulphide of carbon, the mean result compares with theory as follows:—

Observed value of the ratio $V_r, V_b$	1.0245
Theoretical value (Verdet)	1.025

This agreement may be regarded as perfect. It shows that the divergence of the speed of yellow light in the medium from theory, as found above, holds through the entire spectrum.

The excess of the retardation above that resulting from theory is probably due to a difference between "wave-speed" and "group-speed" pointed out by Rayleigh. Let fig. 5 represent a short series of progressive undulations of constant period and wave-length. The wave-speed is that required to carry a wave crest A to the position of the crest B in the wave time. But when a flash of light like that measured passes through a refracting medium, the front waves of the flash are continually dying away, as shown at the end of the figure, and the place of each is taken by the wave following. A familiar case of this sort is seen when a stone is thrown into a pond. The front waves die out one at a time, to be followed by others, each of which goes further than its predecessor, while new waves are formed in the rear. Hence the group, as represented in the figure by the larger waves in the middle, moves as a whole more slowly than do the individual waves. When the speed of light is measured the result is not the wave-speed as above defined, but something less, because the result depends on the time of the group passing through the medium. This lower speed is called the group-velocity of light. In a vacuum there is no dying out of the waves, so that the group-speed and the wave-speed are identical. From Michelson's experiments it would follow that the retardation was about  $\frac{1}{4}$  of the whole speed. This would indicate that in carbon bisulphide

each individual light wave forming the front of a moving ray dies out in a space of about 15 wave-lengths.

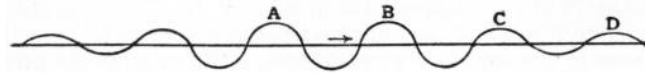


FIG. 5.

AUTHORITIES.—For Foucault's descriptions of his experiments see *Comptes Rendus* (September 22 and November 24, 1862), and *Recueil de Travaux Scientifiques de Léon Foucault* (2 vols., 4to, Paris, 1878). Cornu's determination is found in *Annales de l'Observatoire de Paris, Mémoires*, vol. xiii. The works of Michelson and Newcomb are published *in extenso* in the *Astronomical Papers of the American Ephemeris*, vols. i. and ii.

(S. N.)

- 1 The invention of "aethers" is to be carried back, at least, to the Greek philosophers, and with the growth of knowledge they were empirically postulated to explain many diverse phenomena. Only one "aether" has survived in modern science—that associated with light and electricity, and of which Lord Salisbury, in his presidential address to the British Association in 1894, said, "For more than two generations the main, if not the only, function of the word 'aether' has been to furnish a nominative case to the verb 'to undulate.'" (See [AETHER](#).)
- 2 With the Greeks the word "Optics" or ὀπτικά (from ὀπτομαι, the obsolete present of ὁρῶ, I see) was restricted to questions concerning vision, &c., and the nature of light.
- 3 It seems probable that spectacles were in use towards the end of the 13th century. The Italian dictionary of the *Accademici della Crusca* (1612) mentions a sermon of Jordan de Rivalto, published in 1305, which refers to the invention as "not twenty years since"; and Muschenbroek states that the tomb of Salvinus Armatus, a Florentine nobleman who died in 1317, bears an inscription assigning the invention to him. (See the articles [TELESCOPE](#) and [CAMERA OBSCURA](#) for the history of these instruments.)
- 4 Newton's observation that a second refraction did not change the colours had been anticipated in 1648 by Marci de Kronland (1595-1667), professor of medicine at the university of Prague, in his *Thaumantias*, who studied the spectrum under the name of *Iris trigonia*. There is no evidence that Newton knew of this, although he mentions de Dominic's experiment with the glass globe containing water.
- 5 The geometrical determination of the form of the surface which will reflect, or of the surface dividing two media which will refract, rays from one point to another, is very easily effected by using the "characteristic function" of Hamilton, which for the problems under consideration may be stated in the form that "the optical paths of all rays must be the same." In the case of reflection, if A and B be the diverging and converging points, and P a point on the reflecting surface, then the locus of P is such that  $AP + PB$  is constant. Therefore the surface is an ellipsoid of revolution having A and B as foci. If the rays be parallel, *i.e.* if A be at infinity, the surface is a paraboloid of revolution having B as focus and the axis parallel to the direction of the rays. In refraction if A be in the medium of index  $\mu$ , and B in the medium of index  $\mu'$ , the characteristic function shows that  $\mu AP + \mu' PB$ , where P is a point on the surface, must be constant. Plane sections through A and B of such surfaces were originally investigated by Descartes, and are named Cartesian ovals. If the rays be parallel, *i.e.* A be at infinity, the surface becomes an ellipsoid of revolution having B for one focus,  $\mu'/\mu$  for eccentricity, and the axis parallel to the direction of the rays.
- 6 Young's views of the nature of light, which he formulated as *Propositions* and *Hypotheses*, are given *in extenso* in the article [INTERFERENCE](#). See also his article "Chromatics" in the supplementary volumes to the 3rd edition of the *Encyclopaedia Britannica*.
- 7 A crucial test of the emission and undulatory theories, which was realized by Descartes, Newton, Fermat and others, consisted in determining the velocity of light in two differently refracting media. This experiment was conducted in 1850 by Foucault, who showed that the velocity was less in water than in air, thereby confirming the undulatory and invalidating the emission theory.
- 8 Newton, *Opticks* (London, 1704).
- 9 *Trans. Irish Acad.* 15, p. 69 (1824); 16, part i. "Science," p. 4 (1830), part ii., *ibid.* p. 93 (1830); 17, part i., p. 1 (1832).
- 10 This kind of type will always be used in this article to denote vectors.
- 11 *Phil. Trans.* (1802), part i. p. 12.
- 12 *Œuvres complètes de Fresnel* (Paris, 1866). (The researches were published between 1815 and 1827.)
- 13 *Ann. Phys. Chem.* (1883), 18, p. 663.
- 14 H. A. Lorentz, *Zittingsversl. Akad. v. Wet. Amsterdam*, 4 (1896), p. 176.
- 15 H. A. Lorentz, *Abhandlungen über theoretische Physik*, 1 (1907), p. 415.
- 16 Clerk Maxwell, *A Treatise on Electricity and Magnetism* (Oxford, 1st ed., 1873).
- 17 H. Abraham, *Rapports présentés au congrès de physique de 1900* (Paris), 2, p. 247.
- 18 *Ibid.*, p. 225.
- 19 *Phil. Trans.*, 175 (1884), p. 343.
- 20 *Ann. d. Phys. u. Chem.* 155 (1875), p. 403.
- 21 *Ibid.* 153 (1874), p. 525.
- 22 *Ann. d. Phys.* 11 (1903), p. 873.
- 23 *Phys. Review*, 13 (1901), p. 293.
- 24 Hertz, *Untersuchungen über die Ausbreitung der elektrischen Kraft* (Leipzig, 1892).
- 25 A. Righi, *L'Ottica delle oscillazioni elettriche* (Bologna, 1897); P. Lebedew, *Ann. d. Phys. u. Chem.*, 56 (1895), p. 1.
- 26 "Reflection and Refraction," *Trans. Cambr. Phil. Soc.* 7, p. 1 (1837); "Double Refraction," *ibid.* p. 121 (1839).
- 27 "Double Refraction," *Ann. d. Phys. u. Chem.* 25 (1832), p. 418; "Crystalline Reflection," *Abhandl. Akad. Berlin* (1835), p. 1.
- 28 *Trans. Irish Acad.* 21, "Science," p. 17 (1839).
- 29 *Math. and Phys. Papers* (London, 1890), 3, p. 466.





**LIGHTFOOT, JOHN** (1602-1675), English divine and rabbinical scholar, was the son of Thomas Lightfoot, vicar of Uttoxeter, Staffordshire, and was born at Stoke-upon-Trent on the 29th of March 1602. His education was received at Morton Green near Congleton, Cheshire, and at Christ's College, Cambridge, where he was reckoned the best orator among the undergraduates. After taking his degree he became assistant master at Repton in Derbyshire; after taking orders he was appointed curate of Norton-under-Hales in Shropshire. There he attracted the notice of Sir Rowland Cotton, an amateur Hebraist of some distinction, who made him his domestic chaplain at Bellaport. Shortly after the removal of Sir Rowland to London, Lightfoot, abandoning an intention to go abroad, accepted a charge at Stone in Staffordshire, where he continued for about two years. From Stone he removed to Hornsey, near London, for the sake of reading in the library of Sion College. His first published work, entitled *Erubhin, or Miscellanies, Christian and Judaical, penned for recreation at vacant hours*, and dedicated to Sir R. Cotton, appeared at London in 1629. In September 1630 he was presented by Sir R. Cotton to the rectory of Ashley in Staffordshire, where he remained until June, 1642, when he went to London, probably to superintend the publication of his next work, *A Few and New Observations upon the Book of Genesis: the most of them certain; the rest, probable; all, harmless, strange and rarely heard of before*, which appeared at London in that year. Soon after his arrival in London he became minister of St Bartholomew's church, near the Exchange; and in 1643 he was appointed to preach the sermon before the House of Commons on occasion of the public fast of the 29th of March. It was published under the title of *Elias Redivivus*, the text being Luke i. 17; in it a parallel is drawn between the Baptist's ministry and the work of reformation which in the preacher's judgment was incumbent on the parliament of his own day.

Lightfoot was also one of the original members of the Westminster Assembly; his "Journal of the Proceedings of the Assembly of Divines from January 1, 1643 to December 31, 1644," now printed in the thirteenth volume of the 8vo edition of his *Works*, is a valuable historical source for the brief period to which it relates. He was assiduous in his attendance, and, though frequently standing almost or quite alone, especially in the Erastian controversy, he exercised a material influence on the result of the discussions of the Assembly. In 1643 Lightfoot published *A Handful of Gleanings out of the Book of Exodus*, and in the same year he was made master of Catharine Hall by the parliamentary visitors of Cambridge, and also, on the recommendation of the Assembly, was promoted to the rectory of Much Munden in Hertfordshire; both appointments he retained until his death. In 1644 was published in London the first instalment of the laborious but never completed work of which the full title runs *The Harmony of the Four Evangelists among themselves, and with the Old Testament, with an explanation of the chiefest difficulties both in Language and Sense: Part I. From the beginning of the Gospels to the Baptism of our Saviour*. The second part *From the Baptism of our Saviour to the first Passover after* followed in 1647, and the third *From the first Passover after our Saviour's Baptism to the second* in 1650. On the 26th of August 1645 he again preached before the House of Commons on the day of their monthly fast. His text was Rev. xx. 1, 2. After controverting the doctrine of the Millenaries, he urged various practical suggestions for the repression with a strong hand of current blasphemies, for a thorough revision of the authorized version of the Scriptures, for the encouragement of a learned ministry, and for a speedy settlement of the church. In the same year appeared *A Commentary upon the Acts of the Apostles, chronical and critical; the Difficulties of the text explained, and the times of the Story cast into annals. From the beginning of the Book to the end of the Twelfth Chapter. With a brief survey of the contemporary Story of the Jews and Romans* (down to the third year of Claudius). In 1647 he published *The Harmony, Chronicle, and Order of the Old Testament*, which was followed in 1655 by *The Harmony, Chronicle, and Order of the New Testament*, inscribed to Cromwell. In 1654 Lightfoot had been chosen vice-chancellor of the university of Cambridge, but continued to reside by preference at Munden, in the rectory of which, as well as in the mastership of Catharine Hall, he was confirmed at the Restoration. The remainder of his life was devoted to helping Brian Walton with the Polyglot Bible (1657) and to his own best-known work, the *Horae Hebraicae et Talmudicae*, in which the volume relating to Matthew appeared in 1658, that relating to Mark in 1663, and those relating to 1 Corinthians, John and Luke, in 1664, 1671 and 1674 respectively. While travelling from Cambridge to Ely (where he had been collated in 1668 by Sir Orlando Bridgman to a prebendal stall), he caught a severe cold, and died at Ely on the 6th of December 1675. The *Horae Hebraicae et Talmudicae impensae in Acta Apostolorum et in Ep. S. Pauli ad Romanos* were published posthumously.

The *Works* of Lightfoot were first edited, in 2 vols. fol., by G. Bright and Strype in 1684; the *Opera Omnia, cura Joh. Texelii*, appeared at Rotterdam in 1686 (2 vols. fol.), and again, edited by J. Leusden, at Franeker in 1699 (3 vols. fol.). A volume of *Remains* was published at London in 1700. The *Hor. Hebr. et Talm.* were also edited in Latin by Carpzov (Leipzig, 1675-1679), and again, in English, by Gandell (Oxford, 1859). The most complete edition is that of the *Whole Works*, in 13 vols. 8vo, edited, with a life, by R. Pitman (London, 1822-1825). It includes, besides the works already noticed, numerous sermons, letters and miscellaneous writings; and also *The Temple, especially as it stood in the Days of our Saviour* (London, 1650).

See D. M. Welton, *John Lightfoot, the Hebraist* (Leipzig, 1878),



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