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THE ENCYCLOPÆDIA BRITANNICA

A DICTIONARY OF ARTS, SCIENCES, LITERATURE AND GENERAL INFORMATION

ELEVENTH EDITION

VOLUME X SLICE V

Fleury, Claude to Foraker

Articles in This Slice

FLEURY, CLAUDE (1640-1723), French ecclesiastical historian, was born at Paris on the 6th of December 1640. Destined for the bar, he was educated at the aristocratic college of Clermont (now that of Louis-le-Grand). In 1658 he was nominated an advocate to the parlement of Paris, and for nine years followed the legal profession. But he had long been of a religious disposition, and in 1667 turned from law to theology. He had been some time in orders when Louis XIV., in 1672, selected him as tutor of the princes of Conti, with such success that the king next entrusted to him the education of the count of Vermandois, one of his natural sons, on whose death in 1683 Fleury received for his services the Cistercian abbey of Loc-Dieu, in the diocese of Rhodez. In 1689 he was appointed sub-preceptor of the dukes of Burgundy, of Anjou, and of Berry, and thus became intimately associated with Fénelon, their chief tutor. In 1696 he was elected to fill the place of La Bruyère in the French Academy; and on the completion of the education of the young princes the king bestowed upon him the rich priory of Argenteuil, in the diocese of Paris (1706). On assuming this benefice he resigned, with rare disinterestedness, that of the abbey of Loc-Dieu. About this time he began his great work, the first of the kind in France, and one for which he had been collecting materials for thirty years—the *Histoire ecclésiastique*. Fleury's evident intention was to write a history of the church for all classes of society; but at the time in which his great work appeared it 501 was less religion than theology that absorbed the attention of the clergy and the educated public; and his work accordingly appealed to the student rather than to the popular reader, dwelling as it does very particularly on questions of doctrine, of discipline, of supremacy, and of rivalry between the priesthood and the imperial power. Nevertheless it had a great success. The first edition, printed at Paris in 20 volumes 4to, 1691, was followed by many others, among which may be mentioned that of Brussels, in 32 vols. 8vo, 1692, and that of Nismes, in 25 vols. 8vo, 1778 to 1780. The work of Fleury only comes down to the year 1414. It was continued by J. Claude Fabre and Goujet down to 1595, in 16 vols. 4to. In consulting the work of Fleury and its supplement, the general table of contents, published by Rondel, Paris, 1758, 1 vol. 4to, will be found very useful. Translations have been made of the entire work into Latin, German and Italian. The Latin translation, published at Augsburg, 1758-1759, 85 vols. 8vo, carries the work down to 1684. Fleury, who had been appointed confessor to the young king Louis XV. in 1716, because, as the duke of Orleans said, he was neither Jansenist nor Molinist, nor Ultramontanist, but Catholic, died on the 14th of July 1723. His great learning was equalled by the modest simplicity of his life and the uprightness of his conduct.

Fleury left many works besides his *Histoire ecclésiastique*. The following deserve special mention:—*Histoire du droit françois* (1674, 12mo); *Mœurs des Israélites* (1681, 12mo); *Mœurs des Chrétiens* (1682, 12mo); *Traité du choix et de la méthode des études* (1686, 2 vols. 12mo); *Les Devoirs des maîtres et des domestiques* (1688, 12mo). A number of the smaller works were published in one volume at Paris in 1807. The Roman Congregation of the Index condemned his *Catéchisme historique* (1679) and the *Institution du droit ecclésiastique* (1687).

See C. Ernst Simonetti, *Der Character eines Geschichtsschreibers in dem Leben und aus den Schriften des Abts C. Fleury* (Göttingen, 1746, 4to); C.F.P. Jaeger, *Notice sur C. Fleury, considéré comme historien de l'église* (Strassburg, 1847, 8vo); Reichlin-Meldegg, *Geschichte des Christentums, i.*

FLIEDNER, THEODOR (1800-1864), German Protestant divine, was born on the 21st of January 1800 at Epstein (near Wiesbaden), the small village in which his father was pastor. He studied theology at the universities of Giessen and Göttingen, and at the theological seminary of Herborn, and at the age of twenty he passed his final examination. After a year spent in teaching and preaching, in 1821 he accepted a call from the Protestant church at Kaiserswerth, a little town on the Rhine, a few miles below Düsseldorf. To help his people and to provide an endowment for his church, he undertook journeys in 1822 through part of Germany, and then in 1823 to Holland and England. He met with considerable success, and had opportunities of observing what was being done towards prison reform; in England he made the acquaintance of the philanthropist Elizabeth Fry. The German prisons were then in a very bad state. The prisoners were huddled together in dirty rooms, badly fed, and left in complete idleness. No one dreamed of instructing them, or of collecting statistics to form the basis of useful legislation on the subject. Fliedner, at first singly, undertook the work. He applied for permission to be imprisoned for some time, in order that he might look at prison life from the inside. This petition was refused, but he was allowed to hold fortnightly services in the Düsseldorf prison, and to visit the inmates individually. Those interested in the subject banded themselves together, and on the 18th of June 1826 the first Prison Society of Germany (*Rheinisch-Westfälischer Gefängnisverein*) was founded. In 1833 Fliedner opened in his own parsonage garden at Kaiserswerth a refuge for discharged female convicts. His circle of practical philanthropy rapidly increased. The state of the sick poor had for some time excited his interest, and it seemed to him that hospitals might be best served by an organized body of specially trained women. Accordingly in 1836 he began the first deaconess house, and the hospital at Kaiserswerth. By their ordination vows the deaconesses devoted themselves to the care of the poor, the sick and the young; but their engagements were not final—they might leave their work and return to ordinary life if they chose. In addition to these institutions Fliedner founded in 1835 an infant school, then a normal school for infant school mistresses (1836), an orphanage for orphan girls of the middle class (1842), and an asylum for female lunatics (1847). Moreover, he assisted at the foundation and in the management of similar institutions, not only in Germany, but in various parts of Europe.

In 1849 he resigned his pastoral charge, and from 1849 to 1851 he travelled over a large part of Europe, America and the East—the object of his journeys being to found "mother houses," which were to be not merely training schools for deaconesses, but also centres whence other training establishments might arise. He established a deaconess house in Jerusalem, and after his return assisted by counsel and money in the erection of establishments at Constantinople, Smyrna, Alexandria and Bucharest. Among his later efforts may be mentioned the Christian house of refuge for female servants in Berlin (connected with which other institutions soon arose) and the "house of evening rest" for retired deaconesses at Kaiserswerth. In 1855 Fliedner received the degree of doctor in theology from the university of Bonn, in recognition rather of his practical activity than of his theological attainments. He died on the 4th of October 1864, leaving behind him over 100 stations attended by 430 deaconesses; and these by 1876 had increased to 150 with an attendance of 600.

Fliedner's son Fritz Fliedner (1845-1901), after studying in Halle and Tübingen, became in 1870 chaplain to the embassy in Madrid. He followed in his father's footsteps by founding several philanthropic institutions in Spain. He was also the author of a number of books, amongst which was an autobiography, *Aus meinem Leben. Erinnerungen und Erfahrungen* (1901). 502

Theodor Fliedner's writings are almost entirely of a practical character. He edited a periodical, *Der Armen und Kranken Freund,* which contained information regarding the various institutions, and also the yearly almanac of the Kaiserswerth institution. Besides purely educational and devotional works, he wrote *Buch der Märtyrer* (1852); *Kurze Geschichte der Entstehung der ersten evang. Liebesanstalten zu Kaiserswerth* (1856); *Nachricht über das Diakonissen-Werk in der Christ. Kirche* (5th ed., 1867); *Die evangel. Märtyrer Ungarns und Siebenbürgens; and Beschreibung der Reise nach Jerusalem und Constantinopel*. All were published at Kaiserswerth. There is a translation of the German life by C. Winkworth (London, 1867). See also G. Fliedner, *Theodor Fliedner, kurzer Abriss seines Lebens und Wirkens* (3rd ed., 1892). See also on Fliedner and his work *Kaiserswerth Deaconesses* (London, 1857); Dean John S. Howson's *Deaconesses* (London, 1862); *The Service of the Poor*, by E.C. Stephen (London, 1871); W.F. Stevenson's *Praying and Working* (London, 1865).

FLIGHT and **FLYING.** Of the many scientific problems of modern times, there are few possessing a wider or more enduring interest than that of aerial navigation (see also Aeronautics). To fly has always been an object of ambition with man; nor will this occasion surprise when we remember the marvellous freedom enjoyed by volant as compared with non-volant animals. The subject of aviation is admittedly one of extreme difficulty. To tread upon the air (and this is what is really meant) is, at first sight, in the highest degree utopian; and yet there are thousands of living creatures which actually accomplish this feat. These creatures, however varied in form and structure, all fly according to one and the same principle; and this is a significant fact, as it tends to show that the air must be attacked in a particular way to ensure flight. It behoves us then at the outset to scrutinize very carefully the general configuration of flying animals, and in particular the size, shape and movements of their flying organs.

Flying animals differ entirely from sailing ships and from balloons, with which they are not unfrequently though erroneously compared; and a flying machine constructed upon proper principles can have nothing in common with either of those creations. The ship floats upon water and the balloon upon air; but the ship differs from the balloon, and the ship and the balloon differ from the flying creature and flying machine. The water and air, moreover, have characteristics of their own. The analogies which connect the water with the air, the ship with the balloon, and the ship and the balloon with the flying creature and flying machine are false analogies. A sailing ship is supported by the water and requires merely to be propelled; a flying creature and a flying machine constructed on the living type require to be both supported and propelled. This arises from the fact that water is much denser than air, and because water supports on its surface substances which fall through air. While water and air are both fluid media, they are to be distinguished from each other in the following particulars. Water is comparatively very heavy, inelastic and incompressible; air, on the other hand, is comparatively very light, elastic and compressible. If water be struck with violence, the recoil obtained is great when compared with the recoil obtained from air similarly treated. In water we get a maximum recoil with a minimum of displacement; in air, on the contrary, we obtain a minimum recoil with a maximum of displacement. Water and air when unconfined yield readily to pressure. They thus form *movable fulcra* to bodies acting upon them. In order to meet these peculiarities the travelling organs of aquatic and flying animals (whether they be feet, fins, flippers or wings) are made not of rigid but of elastic materials. The travelling organs, moreover, increase in size in proportion to the tenuity of the fluid to be acted upon. The difference in size of the travelling organs of animals becomes very marked when the land animals are contrasted with the aquatic, and the aquatic with the aerial, as in figs. 1, 2 and 3.

The peculiarities of water and air as supporting media are well illustrated by a reference to swimming, diving and flying birds. A bird when swimming extends its feet simultaneously or alternately in a backward direction, and so obtains a forward recoil. The water supports the bird, and the feet simply propel. In this case the bird is lighter than the water, and the long axis of the body is horizontal (*a* of fig. 4). When the bird dives, or flies under water, the long axis of the body is inclined obliquely downwards and forwards, and the bird forces itself into and beneath the water by the action of its feet, or wings, or both. In diving or sub-aquatic flight the feet strike upwards and backwards, the wings downwards and *backwards* (*b* of fig. 4). In aerial flying everything is reversed. The long axis of the bird is inclined obliquely upwards and forwards, and the wings strike, not downwards and backwards, but downwards and *forwards* (*c* of fig. 4). These changes in the direction of the long axis of the bird in swimming, diving and flying, and in the direction of the stroke of the wings in sub-aquatic and aerial flight, are due to the fact that the bird is heavier than the air and lighter than the water.

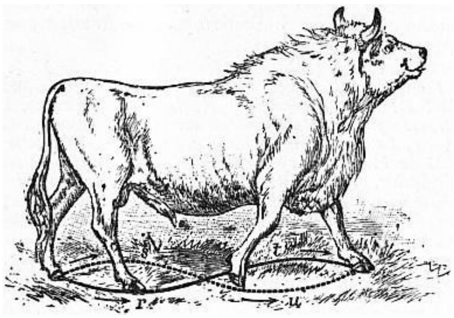


Fig. 1.—Chillingham Bull (*Bos Scoticus*). Small travelling extremities adapted for land. *r, s, t, u*, figure-of-8 described by the feet in walking.

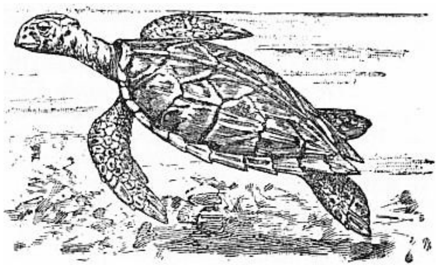


Fig. 2.—The Turtle (*Chelonia imbricata*). Enlarged travelling extremities (flippers) adapted for water.

Fig. 3.—The Bat (*Phyllocina gracilis*). Greatly expanded travelling extremities adapted for air.

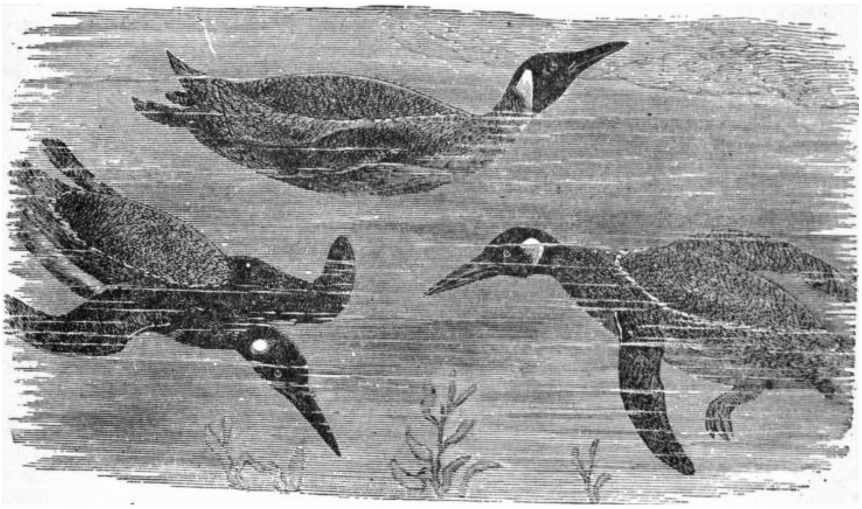


Fig. 4.—The King Penguin in the positions assumed by a bird in (*a*) swimming, (*b*) diving, and (*c*) flying.

The physical properties of water and air explain in a great measure how the sailing ship differs from the balloon, and how the latter differs from the flying creature and flying machine constructed on the natural type. The sailing ship is, as it were, immersed in two oceans, viz. an ocean of water and an ocean of air—the former being greatly heavier and denser than the latter. The ocean of water buoys or floats the ship, and the ocean of air, or part of it in motion, swells the sails which propel the ship. The moving air, which strikes the sails directly, strikes the hull of the vessel indirectly and forces it through the water, which, as explained, is a comparatively dense fluid. When the ship is in motion it can be steered either 503
by the sails alone, or by the rudder alone, or by both combined. A balloon differs from a sailing ship in being immersed in only one ocean, viz. the ocean of air. It resembles the ship in floating upon the air, as the ship floats upon the water; in other words, the balloon is lighter than the air, as the ship is lighter than the water. But here all analogy ceases. The ship, in virtue of its being immersed in two fluids having different densities, can be steered and made to tack about in a horizontal plane in any given direction. This in the case of the balloon, immersed in one fluid, is impossible. The balloon in a calm can only rise and fall in a vertical line. Its horizontal movements, which ought to be the more important, are accidental movements due to air currents, and cannot be controlled; the balloon, in short, cannot be guided. One might as well attempt to steer a boat carried along by currents of water in the absence of oars, sails and wind, as to steer a balloon carried along by currents of air. The balloon has no hold upon the air, and this consequently cannot be employed as a *fulcrum* for regulating its course. The balloon, because of its vast size and from its being lighter than the air, is completely at the mercy of the wind. It forms an integral part, so to speak, of the wind for the time being, and the direction of the wind in every instance determines the horizontal motion of the balloon. The force required to propel a balloon against even a moderate breeze would result in its destruction. The balloon cannot be transferred with any degree of certainty from one point of the earth's surface to another, and hence the chief danger in its employment. It may, quite as likely as not, carry its occupants out to sea. The balloon is a mere lifting machine and is in no sense to be regarded as a flying machine. It resembles the flying creature only in this, that it is immersed in the ocean of air in which it sustains itself. The mode of suspension is wholly different. The balloon floats because it is lighter than the air; the flying creature floats because it extracts from the air, by the vigorous downward action of its wings, a certain amount of upward recoil. The balloon is passive; the flying creature is active. The balloon is controlled by the wind; the flying creature controls the wind. The balloon in the absence of wind can only rise and fall in a vertical line; the flying creature can fly in a horizontal plane in any given direction. The balloon is inefficient because of its levity; the flying creature is efficient because of its weight.

Weight, however paradoxical it may appear, is necessary to flight. Everything which flies is vastly heavier than the air. The inertia of the mass of the flying creature enables it to control and direct its movements in the air. Many are of opinion that flight is a mere matter of levity and power. This is quite a mistake. No machine, however light and powerful, will ever fly whose travelling surfaces are not properly fashioned and properly applied to the air.

It was supposed at one time that the air sacs of birds contributed in some mysterious way to flight, but this is now known to be erroneous. The bats and some of the best-flying birds have no air sacs. Similar remarks are to be made of the heated air imprisoned within the bones of certain birds.[1] Feathers even are not necessary to flight. Insects and bats have no feathers, and yet fly well. The only facts in natural history which appear even indirectly to countenance the flotation theory are the presence of a swimming bladder in some fishes, and the existence of membranous expansions or pseudo-wings in certain animals, such as the flying fish, flying dragon and flying squirrel. As, however, the animals referred to do not actually fly, but merely dart into the air and there sustain themselves for brief intervals, they afford no real support to the theory. The so-called floating animals are depicted at figs. 5, 6 and 7.

Fig. 5.—The Red-throated Dragon (*Draco haematopogon*).

Fig. 6.—The Flying Colugo (*Galeopithecus volans*); also called flying lemur and flying squirrel.

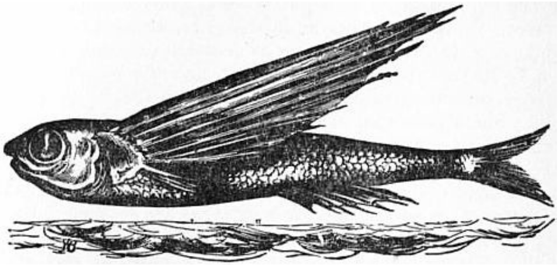


Fig. 7.—The Flying Fish (*Exocoetus exiliens*).

It has been asserted, and with some degree of plausibility, that a fish lighter than the water might swim, and that a bird lighter than the air might fly: it ought, however, to be borne in mind that, in point of fact, a fish lighter than the water could not hold its own if the water were in the least perturbed, and that a bird lighter than the air would be swept into space by even a moderate breeze without hope of return. Weight and power are always associated in living animals, and 504
the fact that living animals are made heavier than the medium they are to navigate may be regarded as a conclusive argument in favour of weight being necessary alike to the swimming of the fish and the flying of the bird. It may be stated once for all that flying creatures are for the most part as heavy, bulk for bulk, as other animals, and that flight in every instance is the product, not of superior levity, but of *weight* and *power* directed upon properly constructed flying organs.

This fact is important as bearing on the construction of flying machines. It shows that a flying machine need not necessarily be a light, airy structure exposing an immoderate amount of surface. On the contrary, it favours the belief that it should be a compact and moderately heavy and powerful structure, which trusts for elevation and propulsion entirely to its flying appliances—whether actively moving wings, or screws, or aeroplanes wedged forward by screws. It should attack and subdue the air, and never give the air an opportunity of attacking or subduing it. It should smite the air intelligently and as a master, and its vigorous well-directed thrusts should in every instance elicit an upward and forward recoil. The flying machine must be *multum in parvo*. It must launch itself in the ocean of air, and must extract from that air, by means of its travelling surfaces—however fashioned and however applied—the recoil or resistance necessary to elevate and carry it forward. Extensive inert surfaces indeed are contra-indicated in a flying machine, as they approximate it to the balloon, which, as has been shown, cannot maintain its position in the air if there are air currents. A flying machine which could not face air currents would necessarily be a failure. To obviate this difficulty we are forced to fall back upon *weight*, or rather the structures and appliances which weight represents. These appliances as indicated should not be unnecessarily expanded, but when expanded they should, wherever practicable, be converted into actively moving flying surfaces, in preference to fixed or inert dead surfaces.

The question of surface is a very important one in aviation: it naturally resolves itself into one of active and passive surface. As there are active and passive surfaces in the flying animal, so there are, or should be, active and passive surfaces in the flying machine. Art should follow nature in this matter. The active surfaces in flying creatures are always greatly in excess of the passive ones, from the fact that the former virtually increase in proportion to the spaces through which they are made to travel. Nature not only distinguishes between active and passive surfaces in flying animals, but she strikes a just balance between them, and utilizes both. She regulates the surfaces to the strength and weight of the flying creature and the air currents to which the surfaces are to be exposed and upon which they are to operate. In her calculations she never forgets that her flying subjects are to control and not to be controlled by the air. As a rule she reduces the passive surfaces of the body to a minimum; she likewise reduces as far as possible the actively moving or flying surfaces. While, however, diminishing the surfaces of the flying animal as a whole, she increases as occasion demands the active or wing surfaces by wing movements, and the passive or dead surfaces by the forward motion of the body in progressive flight. She knows that if the wings are driven with sufficient rapidity they practically convert the spaces through which they move into solid bases of support; she also knows that the body in rapid flight derives support from all the air over which it passes. The manner in which the wing surfaces are increased by the wing movements will be readily understood from the accompanying illustrations of the blow-fly with its wings at rest and in motion (figs. 8 and 9). In fig. 8 the surfaces exposed by the body of the insect and the wings are, as compared with those of fig. 9, trifling. The wing would have much less purchase on fig. 8 than on fig. 9, provided the surfaces exposed by the latter were passive or dead surfaces. But they are not dead surfaces: they represent the spaces occupied by the rapidly vibrating wings, which are actively moving flying organs. As, moreover, the wings travel at a much higher speed than any wind that blows, they are superior to and control the wind; they enable the insect to dart through the wind in whatever direction it pleases.

The reader has only to imagine figs. 8 and 9 cut out in paper to realize that extensive, inert, horizontal aeroplanes[2] in a flying machine would be a mistake. It is found to be so practically, as will be shown by and by. Fig. 9 so cut out would be heavier than fig. 8, and if both were exposed to a current of air, fig. 9 would be more blown about than fig. 8.

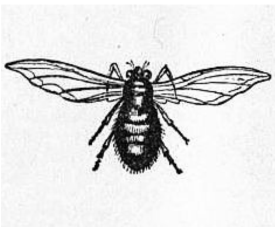


Fig. 8.—Blow-fly (*Musca vomitoria*) with its wings at rest.

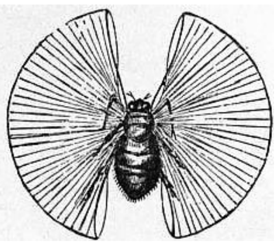


Fig. 9.—Blow-fly with its wings in motion as in flight.

It is true that in beetles and certain other insects there are the elytra or wing cases—thin, light, horny structures inclined slightly upwards—which in the act of flight are spread out and act as sustainers or gliders. The elytra, however, are comparatively long narrow structures which occupy a position in front of the wings, of which they may be regarded as forming the anterior parts. The elytra are to the delicate wings of some insects what the thick anterior margins are to stronger wings. The elytra, moreover, are not wholly passive structures. They can be moved, and the angles made by their under surfaces with the horizon adjusted. Finally, they are not essential to flight, as flight in the great majority of instances is performed without them. The elytra serve as protectors to the wings when the wings are folded upon the back of the insect, and as they are extended on either side of the body more or less horizontally when the insect is flying they contribute to flight indirectly, in virtue of their being carried forward by the body in motion.

Natural Flight.—The manner in which the wings of the insect traverse the air, so as practically to increase the basis of support, raises the whole subject of natural flight. It is necessary, therefore, at this stage to direct the attention of the

reader somewhat fully to the subject of flight, as witnessed in the insect, bird and bat, a knowledge of natural flight preceding, and being in some sense indispensable to, a knowledge of artificial flight. The bodies of flying creatures are, as a rule, very strong, comparatively light and of an elongated form,—the bodies of birds being specially adapted for cleaving the air. Flying creatures, however, are less remarkable for their strength, shape and comparative levity than for the size and extraordinarily rapid and complicated movements of their wings. Prof. J. Bell Pettigrew first satisfactorily analysed those movements, and reproduced them by the aid of artificial wings. This physiologist in 1867[3] showed that all natural wings, whether of the insect, bird or bat, are screws structurally, and that they act as screws when they are made to vibrate, from the fact that they twist in opposite directions during the down and up strokes. He also explained that all wings act upon a common principle, and that they present oblique, kite-like surfaces to the air, through which they pass much in the same way that an oar passes through water in sculling. He further pointed out that the wings of flying creatures (contrary to received opinions, and as has been already indicated) strike downwards and *forwards* during the down strokes, and upwards and *forwards* during the up strokes. Lastly he demonstrated that the wings of flying creatures, when the bodies of said creatures are fixed, describe *figure-of-8 tracks* in space—the figure-of-8 tracks, when 505
the bodies are released and advancing as in rapid flight, being opened out and converted into *waved tracks*.

It may be well to explain here that a claim has been set up by his admirers for the celebrated artist, architect and engineer, Leonardo da Vinci, to be regarded as the discoverer of the principles and practice of flight (see Theodore Andrea Cook, *Spirals in Nature and Art*, 1903). The claim is, however, unwarranted; Leonardo's chief work on flight, bearing the title *Codice sul Volo degli Uccelli e Varie Altre Materie*, written in 1505, consists of a short manuscript of twenty-seven small quarto pages, with simple sketch illustrations interspersed in the text. In addition he makes occasional references to flight in his other manuscripts, which are also illustrated. In none of Leonardo's manuscripts, however, and in none of his figures, is the slightest hint given of his having any knowledge of the spiral movements made by the wing in flight or of the spiral structure of the wing itself. It is claimed that Leonardo knew the direction of the stroke of the wing, as revealed by recent researches and proved by modern instantaneous photography. As a matter of fact, Leonardo gives a wholly inaccurate account of the direction of the stroke of the wing. He states that the wing during the down stroke strikes downwards and *backwards*, whereas in reality it strikes downwards and *forwards*. In speaking of artificial flight Leonardo says: "The wings have to row downwards and *backwards* to support the machine on high, so that it moves forward." In speaking of natural flight he remarks: "If in its descent the bird rows *backwards* with its wings the bird will move rapidly; this happens because the wings strike the air which successively runs behind the bird to fill the void whence it comes." There is nothing in Leonardo's writings to show that he knew either the anatomy or physiology of the wing in the modern sense.

Pettigrew's discovery of the figure-of-8 and waved movements made by the wing in stationary and progressive flight was confirmed some two years after it was made by Prof. E.J. Marey of Paris[4] by the aid of the "sphygmograph."[5] The movements in question are now regarded as fundamental, from the fact that they are alike essential to natural and artificial flight.

The following is Pettigrew's description of wings and wing movements published in 1867:—

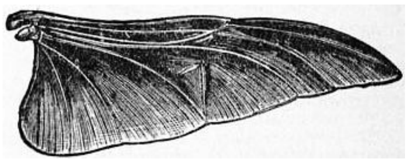


Fig. 10.—Right Wing of the Beetle (*Goliathus micans*) when at rest; seen from above.

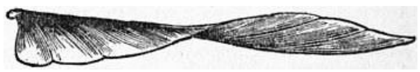


Fig. 11.—Right Wing of the Beetle (*Goliathus micans*) when in motion; seen from behind. This figure shows how the wing twists and untwists when in action, and how it forms a true screw.

"The wings of insects and birds are, as a rule, more or less triangular in shape, the base of the triangle being directed towards the body, its sides anteriorly and posteriorly. They are also conical on section from within outwards and from before backwards, this shape converting the pinions into delicately graduated instruments balanced with the utmost nicety to satisfy the requirements of the muscular system on the one hand and the resistance and resiliency of the air on the other. While all wings are graduated as explained, innumerable varieties occur as to their general contour, some being falcated or scythe-like, others oblong, others rounded or circular, some lanceolate and some linear. The wings of insects may consist either of one or two pairs—the anterior or upper pair, when two are present, being in some instances greatly modified and presenting a corneous condition. They are then known as elytra, from the Gr. ἔλυτρον, a sheath. Both pairs are composed of a duplicature of the integument, or investing membrane, and are strengthened in various directions by a system of hollow, horny tubes, known to entomologists as the neurae or nervures. These nervures taper towards the extremity of the wing, and are strongest towards its root and anterior margin, where they supply the place of the arm in birds and bats. The neurae are arranged at the axis of the wing after the manner of a fan or spiral stair—the anterior one occupying a higher position than that farther back, and so of the others. As this arrangement extends also to the margins, *the wings are more or less twisted upon themselves* and present a certain degree of convexity on their superior or upper surface, and a corresponding concavity on their inferior or under surface,—their free edges supplying those fine curves which act with such efficacy upon the air in obtaining the maximum of resistance and the minimum of displacement. As illustrative examples of the form of wings alluded to, those of the beetle, bee and fly may be cited—the pinions in those insects acting as *helices*, or *twisted levers*, and elevating weights much greater than the area of the wings would seem to warrant" (figs. 10 and 11).... "To confer on the wings the multiplicity of movements which they require, they are supplied with double hinge or compound joints, which enable them to move not only in an upward, downward, forward and backward direction, but also at various intermediate degrees of obliquity. An insect with wings thus hinged may, as far as steadiness of body is concerned, be not inaptly compared to a compass set upon gimbals, where the universality of motion in one direction ensures comparative fixedness in another."... "All wings obtain their leverage by presenting oblique surfaces to the air, the degree of obliquity gradually increasing in a direction from behind, forwards and downwards, during extension when the sudden or effective stroke is being given, and gradually decreasing in an opposite direction during flexion, or when the wing is being more slowly recovered preparatory to making a second stroke. The effective stroke in insects, and this holds true also of birds, is therefore delivered *downwards and forwards*, and not, as the majority of writers believe, vertically, or even slightly backwards.... The wing in the insect is more flattened than in the bird; and advantage is taken on some occasions of this circumstance, particularly in heavy-bodied, small-winged, quick-flying insects, *to reverse the pinion more or less completely during the down and up strokes*."... "This is effected in the following manner. The posterior margin of the wing is made to rotate, during the down stroke, in a direction from above downwards and from behind forwards—the anterior margin travelling in an opposite direction and reciprocating. The wing may thus be said to attack the air by a *screwing movement* from above. During the up or return stroke, on the other hand, the posterior margin rotates in a direction from below upwards and from before backwards, so that by a similar but *reverse screwing motion* the pinion attacks the air from beneath."... "*A figure-of-8*, compressed laterally and placed obliquely with its long axis running from left to right of the spectator, represents the movements in question. *The down and up strokes*, as will be seen from this account, *cross each other*, the wing smiting the air during its descent from above, as in the bird and bat, and during its ascent from below as in the flying fish and boy's kite" (fig. 12).

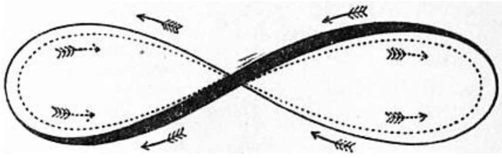


FIG. 12 shows the figure-of-8 made by the margins of the wing in extension (continuous line), and flexion (dotted line). As the tip of the wing is mid-way between its margins, a line between the continuous and dotted lines gives the figure-of-8 made by the tip. The arrows indicate the reversal of the planes of the wing, and show how the down and up strokes *cross each other*.

... "The figure-of-8 action of the wing explains how an insect or bird may fix itself in the air, the backward and forward reciprocating action of the pinion affording support, but no propulsion. In these instances the backward and forward strokes are made to counterbalance each other. Although the figure-of-8 represents with considerable fidelity the twisting of the wing upon its axis during extension and flexion, when the insect is playing its wings before an object, or still better when it is artificially fixed, it is otherwise when the down stroke is added and the insect is fairly on the wing and progressing rapidly. In this case the wing, in virtue of its being carried forward by the body in motion, describes an undulating or spiral course, as shown in fig. 13."

... "The down and up strokes are compound movements—the termination of the down stroke embracing the beginning of the up stroke, and the termination of the up stroke including the beginning of the down stroke. This is necessary in order that the down and up strokes may glide into each other in such a manner as to prevent jerking and unnecessary retardation."[6]...

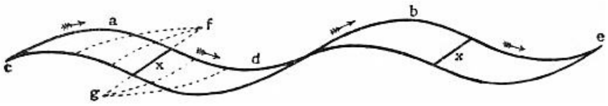


FIG. 13.—Wave track made by the wing in progressive flight. *a, b*, Crests of the wave; *c, d, e*, up strokes; *x, x*, down strokes; *f*, point corresponding to the anterior margin of the wing, and forming a centre for the downward rotation of the wing (*a, g*); *g*, point corresponding to the posterior margin of the wing, and forming a centre for the upward rotation of the wing (*d, f*).

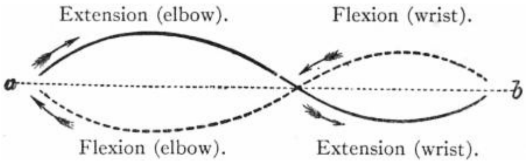


FIG. 14.—*a, b*, line along which the wing travels during extension and flexion. The arrows indicate the direction in which the wing is spread out in extension and closed or folded in flexion.

"The wing of the bird, like that of the insect, is concavo-convex, and *more or less twisted upon itself* when extended, so that the anterior or thick margin of the pinion presents a different degree of curvature to that of the posterior or thin margin. This twisting is in a great measure owing to the manner in which the bones of the wing are twisted upon themselves, and the spiral nature of their articular surfaces—the long axes of the joints always intersecting each other at right angles, and the bones of the elbow and wrist making a quarter of a turn or so during extension and the same amount during flexion. As a result of this disposition of the articular surfaces, the wing may be shot out or extended, and retracted or flexed in nearly the same plane, the bones composing the wing rotating on their axes during either movement (fig. 14). The secondary action, or the revolving of the component bones on their own axes, is of the greatest importance in the movements of the wing, as it communicates to the hand and forearm, and consequently to the primary and secondary feathers which they bear, the precise angles necessary for flight. It in fact ensures that the wing, and the curtain or fringe of the wing which the primary and secondary feathers form, shall be screwed into and down upon the wind in extension, and unscrewed or withdrawn from the wind during flexion. The wing of the bird may therefore be compared to a huge gimlet or auger, the axis of the gimlet representing the bones of the wing, the flanges or spiral thread of the gimlet the primary and secondary feathers" (figs. 15 and 16).... "From this description it will be evident that by the mere rotation of the bones of the forearm and hand the maximum and minimum of resistance is secured much in the same way that this object is attained by the alternate dipping and feathering of an oar."... "The wing, both when at rest and when in motion, may not inaptly be compared to the blade of an ordinary screw propeller as employed in navigation. Thus the general outline of the wing corresponds closely with the outline of the propeller (figs. 11, 16 and 18), and the track described by the wing in space *is twisted upon itself* propeller fashion[7] (figs. 12, 20, 21, 22, 23). The great velocity with which the wing is driven converts the impression or blur made by it into what is equivalent to a solid for the time being, in the same way that the spokes of a wheel in violent motion, as is well understood, more or less completely occupy the space contained within the rim or circumference of the wheel" (figs. 9, 20 and 21).

FIG. 15.—Right Wing of the Red-legged Partridge (*Perdix rubra*). Dorsal aspect as seen from above.

FIG. 16.—Right Wing of the Red-legged Partridge (*Perdix rubra*). Dorsal and ventral aspects as seen from behind; showing auger-like conformation of wing. Compare with figs. 11 and 18.

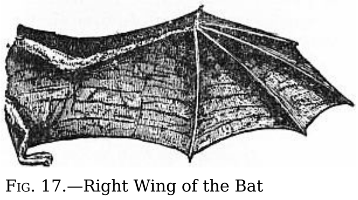


FIG. 17.—Right Wing of the Bat (*Phyllocina gracilis*). Dorsal aspect as seen from above.

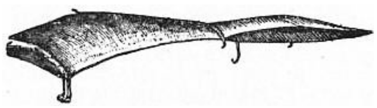


FIG. 18.—Right Wing of the Bat (*Phyllocina gracilis*). Dorsal and ventral aspects, as seen from behind. These show the screw-like configuration of the wing, and also how the wing twists and untwists during its action.

... "The wing of the bat bears a considerable resemblance to that of the insect, inasmuch as it consists of a delicate, semi-transparent, continuous membrane, supported in divers directions, particularly towards its anterior margin, by a system of osseous stays or stretchers which confer upon it the degree of rigidity requisite for flight. It is, as a rule, deeply concave on its under or ventral surface, and in this respect resembles the wing of the heavy-bodied birds. The movement of the bat's wing in extension is a *spiral* one, the spiral running alternately from below upwards and forwards and from above downwards and backwards. The action of the wing of the bat, and the movements of its component bones, are essentially the same as in the bird" (figs. 17

and 18).

... “The wing strikes the air precisely as a boy’s kite would if it were jerked by its string, the only difference being that the kite is *pulled forwards* upon the wind by the string and the hand, whereas in the insect, bird and bat the wing is *pushed forwards* on the wind by the weight of the body and the power residing in the pinion itself” (fig. 19).[8]

Fig. 19.—The Cape Barn-owl (*Strix capensis*), showing the kite-like surfaces presented by the ventral aspect of the wings and body in flight.

The figure-of-8 and kite-like action of the wing referred to lead us to explain how it happens that the wing, which in many instances is a comparatively small and delicate organ, can yet attack the air with such vigour as to extract from it the recoil necessary to elevate and propel the flying creature. The accompanying figures from one of Pettigrew’s later memoirs[9] will serve to explain the *rationale* (figs. 20, 21, 22 and 23).

As will be seen from these figures, the wing during its vibration sweeps through a comparatively very large space. This space, as already explained, is practically a solid basis of support for the wing and for the flying animal. The wing attacks the air in such a manner as virtually to have no slip—this for two reasons. The wing reverses instantly and acts as a kite during nearly the entire down and up strokes. The angles, moreover, made by the wing with the horizon during the down and up strokes are at no two intervals the same, but (and this is a remarkable circumstance) they are always adapted to 507
the speed at which the wing is travelling for the time being. The increase and decrease in the angles made by the wing as it hastens to and fro are due partly to the resistance offered by the air, and partly to the mechanism and mode of application of the wing to the air. The wing, during its vibrations, rotates upon two separate centres, the tip rotating round the root of the wing as an axis (short axis of wing), the posterior margin rotating around the anterior margin (long axis of wing). The wing is really eccentric in its nature, a remark which applies also to the rowing feathers of the bird’s wing. The compound rotation goes on throughout the entire down and up strokes, and is intimately associated with the power which the wing enjoys of alternately seizing and evading the air.

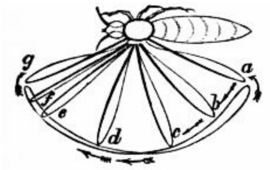


Fig. 20.

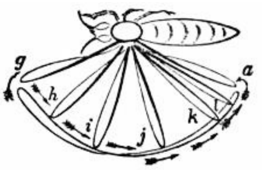


Fig. 21.

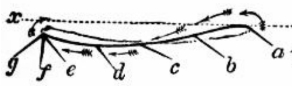


Fig. 22.

Fig. 23.

Figs. 20, 21, 22 and 23 show the area mapped out by the left wing of the Wasp when the insect is fixed and the wing made to vibrate. These figures illustrate the various angles made by the wing with the horizon as it hastens to and fro, and show how the wing reverses and reciprocates, and how it twists upon itself in opposite directions, and describes a figure-of-8 track in space. Figs. 20 and 22 represent the forward or down stroke (*a b c d e f g*), figs. 21 and 23 the backward or up stroke (*g h i j k l a*). The terms forward and back strokes are here employed with reference to the head of the insect, *x, x*′, line to represent the horizon. If fig. 22, representing the down or forward stroke, be placed upon fig. 23, representing the up or backward stroke, it will be seen that *the wing crosses its own track* more or less completely at every stage of the down and up strokes.

The compound rotation of the wing is greatly facilitated by the wing being elastic and flexible. It is this which causes the wing to twist and untwist diagonally on its long axis when it is made to vibrate. The twisting referred to is partly a vital and partly a mechanical act;—that is, it is occasioned in part by the action of the muscles and in part by the greater resistance experienced from the air by the tip and posterior margin of the wing as compared with the root and anterior margin,—the resistance experienced by the tip and posterior margin causing them to reverse always subsequently to the root and anterior margin, which has the effect of throwing the anterior and posterior margins of the wing into figure-of-8 curves, as shown at figs. 9, 11, 12, 16, 18, 20, 21, 22 and 23.

The compound rotation of the wing, as seen in the bird, is represented in fig. 24.

Not the least curious feature of the wing movements is the remarkable power which the wing possesses of making and utilizing its own currents. Thus, when the wing descends it draws after it a strong current, which, being met by the wing during its ascent, greatly increases the efficacy of the up stroke. Similarly and conversely, when the wing ascends, it creates an upward current, which, being met by the wing when it descends, powerfully contributes to the efficiency of the down stroke. This statement can be readily verified by experiment both with natural and artificial wings. Neither the up nor the down strokes are complete in themselves.

The wing to act efficiently must be driven at a certain speed, and in such a manner that the down and up strokes shall glide into each other. It is only in this way that the air can be made to pulsate, and that the rhythm of the wing and the air waves can be made to correspond. The air must be seized and let go in a certain order and at a certain speed to extract a maximum recoil. The rapidity of the wing movements is regulated by the size of the wing, small wings being driven at a very much higher speed than larger ones. The different parts of the wing, moreover, travel at different degrees of velocity—the tip and posterior margin of the wing always rushing through a much greater space, in a given time, than the root and anterior margin.

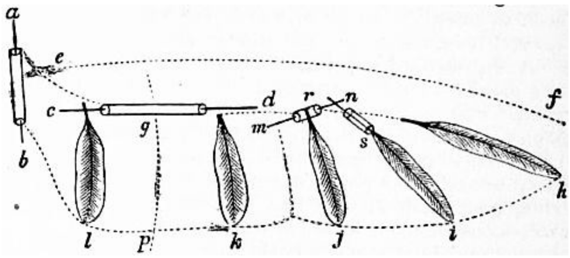


FIG. 24.—Wing of the Bird with its root (*a, b*) cranked forwards.

a, b, Short axis of the wing (axis for tip of wing, *h*).
c, d, Long axis (axis for posterior margin of wing, *h, i, j, k, l*).
m, n, Short axis of rowing feathers of wing.
r, s, Long axis of rowing feathers of wing. The rotation of the rowing feathers on their long axis (they are eccentrics) enables them to open or separate during the up, and close or come together during the down strokes.
e f, g p, concave shape presented by the under surface of the wing.

The rapidity of travel of the insect wing is in some cases enormous. The wasp, for instance, is said to ply its wings at the rate of 110, and the common house-fly at the rate of 330 beats per second. Quick as are the vibrations of natural wings, the speed of certain parts of the wing is amazingly increased. Wings as a rule are long and narrow. As a consequence, a comparatively slow and very limited movement at the root confers great range and immense speed at the tip, the speed of each portion of the wing increasing as the root of the wing is receded from. This is explained on a principle well understood in mechanics, viz. that when a wing or rod hinged at one end is made to move in a circle, the tip or free end of the wing or rod describes a much wider circle in a given time than a portion of the wing or rod nearer the hinge (fig. 25).

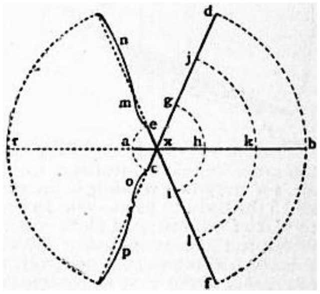


FIG. 25 shows how different portions of the wing travel at different degrees of speed. In this figure the rod *a, b,* hinged at *x,* represents the wing. When the wing is made to vibrate, its several portions travel through the spaces *d b f, j k l, g h i,* and *e a c* in exactly the same interval of time. The part of the wing marked b, which corresponds with the tip, consequently travels very much more rapidly than the part marked *a*, which corresponds with the root. *m n, o p,* curves made by the wing at the end of the up and down strokes; *r*, position of the wing at the middle of the stroke.

One naturally inquires why the high speed of wings, and why the progressive increase of speed at their tips and posterior margins? The answer is not far to seek. If the wings were not driven at a high speed, and if they were not eccentrics made to revolve upon two separate axes, they would of necessity be large cumbrous structures; but large heavy wings would be difficult to work, and what is worse, they would (if too large), instead of controlling the air, be controlled by it, and so cease to be flying organs.

There is, however, another reason why wings should be made to vibrate at high speeds. The air, as explained, is a very light, thin, elastic medium, which yields on the slightest pressure, and unless the wings attacked it with great violence the necessary recoil or resistance could not be obtained. The atmosphere, because of its great tenuity, mobility and comparative imponderability, presents little resistance to bodies passing through it at low velocities. If, however, the speed be greatly accelerated, the action of even an 508
ordinary cane is sufficient to elicit a recoil. This comes of the action and reaction of matter, the resistance experienced varying according to the density of the atmosphere and the shape, extent and velocity of the body acting upon it. While, therefore, scarcely any impediment is offered to the progress of an animal in motion in the air, it is often exceedingly difficult to compress the air with sufficient rapidity and energy to convert it into a suitable fulcrum for securing the necessary support and forward impetus. This arises from the fact that bodies moving in air experience a *minimum of resistance* and occasion a *maximum of displacement*. Another and very obvious difficulty is traceable to the great disparity in the weight of air as compared with any known solid, and the consequent want of buoying or sustaining power which that disparity involves. If we compare air with water we find it is nearly 1000 times lighter. To meet these peculiarities the insect, bird and bat are furnished with extensive flying surfaces in the shape of wings, which they apply with singular velocity and power to the air, as levers of the third order. In this form of lever the power is applied between the fulcrum and the weight to be raised. The power is represented by the wing, the fulcrum by the air, and the weight by the body of the flying animal. Although the third order of lever is particularly inefficient when the fulcrum is rigid and immobile, it possesses singular advantages when these conditions are reversed, that is, when the fulcrum, as happens with the air, is *elastic* and *yielding*. In this instance a very slight movement at the root of the pinion, or that end of the lever directed towards the body, is followed by an immense sweep of the extremity of the wing, where its elevating and propelling power is greatest—this arrangement ensuring that the large quantity of air necessary for support and propulsion shall be compressed under the most favourable conditions.

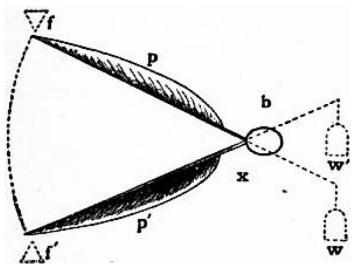


FIG. 26.—In this figure *f, f′* represent the movable fulcra furnished by the air, *p p′* the power residing in the wing, and b the body to be moved. In order to make the problem of flight more intelligible, the lever formed by the wing is prolonged beyond the body (*b*), and to the root of the wing so extended the weight (*w, w′*) is attached; x represents the universal joint by which the wing is attached to the body. When the wing ascends as shown at *p*, the air (fulcrum *f*) resists its upward passage, and forces the body (*b*) or its representative (*w*) slightly downwards. When the wing descends as shown at *p′*, the air (fulcrum *f′*) resists its downward passage, and forces the body (*b*) or its representative (*w′*) slightly upwards. From this it follows that when the wing rises the body falls, and vice versa—the wing describing the arc of a large circle (*f f′*), the body (*b*), or the weights (*w, w′*) representing it, describing the arc of a small circle.

In this process the weight of the body performs an important part, by acting upon the inclined planes formed by the wings in the plane of progression. The power and the weight may thus be said to reciprocate, the two sitting as it were side by side and blending their peculiar influences to produce a common result, as indicated at fig. 26.

When the wings descend they elevate the body, the wings being active and the body passive; when the body descends it contributes to the elevation of the wings,[10] the body being active and the wings more or less passive. It is in this way that weight forms a factor in flight, the wings and the weight of the body reciprocating and mutually assisting and relieving each other. This is an argument for employing four wings in artificial flight,—the wings being so arranged that the two which are up shall always by their fall mechanically elevate the two which are down. Such an arrangement is calculated greatly to conserve the driving power, and as a consequence, to reduce the weight.

That the weight of the body plays an important part in the production of flight may be proved by a very simple experiment. If two quill feathers are fixed in an ordinary cork, and so arranged that they expand and arch above it (fig. 27), it is found that if the apparatus be dropped from a vertical height of 3 yds. it does not fall vertically downwards, but downwards and *forwards* in a curve, the forward travel amounting in some instances to a yard and a half. Here the cork, in falling, acts upon the feathers (which are to all intents and purposes wings), and these in turn act upon the air, in such a manner as to produce a horizontal transference.

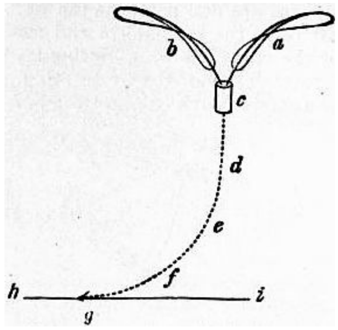


Fig. 27.—*a, b*, quill feathers; *c*, cork; *d, e, f, g*, downward and *forward* curved trajectory made by the feathers and cork before reaching the ground (*h, i*).

In order to utilize the air as a means of transit, the body in motion, whether it moves in virtue of the life it possesses, or because of a force super-added, must be heavier than air. It must tread with its wings and rise upon the air as a swimmer upon the water, or as a kite upon the wind. This is necessary for the simple reason that the body must be active, the air passive. The flying body must act against gravitation, and elevate and carry itself forward at the expense of the air and of the force which resides in it, whatever that may be. If it were otherwise—if it were rescued from the law of gravitation on the one hand, and bereft of independent movement on the other, it would float about uncontrolled and uncontrollable like an ordinary balloon.

In flight one of two things is necessary. Either the wings must attack the air with great violence, or the air in rapid motion must attack the wings: either suffices. If a bird attempts to fly in a calm, the wings must be made to smite the air after the manner of a boy's kite with great vigour and at a high speed. In this case the wings fly the bird. If, however, the bird is fairly launched in space and a stiff breeze is blowing, all that is required in many instances is to extend the wings at a slight upward angle to the horizon so that the under parts of the wings present kite-like surfaces. In these circumstances the rapidly moving air flies the bird. The flight of the albatross supplies the necessary illustration. If by any chance this magnificent bird alights upon the sea he must flap and beat the water and air with his wings with tremendous energy until he gets fairly launched. This done he extends his enormous pinions[11] and sails majestically along, seldom deigning to flap his wings, the breeze doing the work for him. A familiar illustration of the same principle may be witnessed any day when children are engaged in the pastime of kite-flying. If two boys attempt to fly a kite in a calm, the one must hold up the kite and let go when the other runs. In this case the under surface of the kite is made to strike the still air. If, however, a stiff autumn breeze be blowing, it suffices if the boy who formerly ran when the kite was let go stands still. In this case the air in rapid motion strikes the under surface of the kite and forces it up. The string and the hand are to the kite what the weight of the flying creature is to the inclined planes formed by its wings.

The area of the insect, bird and bat, when the wings are fully expanded, is greater than that of any other class of animal, their weight being proportionally less. As already stated, however, it ought never to be forgotten that even the lightest insect, bird or bat is vastly heavier than the air, and that no fixed relation exists between the weight of body and expanse of wing in any of the orders. We have thus light-bodied and large-winged insects and birds, as the butterfly and 509
heron; and others with heavy bodies and small wings, as the beetle and partridge. Similar remarks are to be made of bats. Those apparent inconsistencies in the dimensions of the body and wings are readily explained by the greater muscular development of the heavy-bodied, small-winged insects, birds and bats, and the increased power and rapidity with which the wings in them are made to oscillate. This is of the utmost importance in the science of aviation, as showing that flight may be attained by a heavy powerful animal with comparatively small wings, as well as by a lighter one with greatly enlarged wings. While, therefore, there is apparently no correspondence between the area of the wing and the animal to be raised, there is, except in the case of sailing insects, birds and bats, an unvarying relation as to the weight and number of oscillations; so that the problem of flight would seem to resolve itself into one of weight, power, velocity and small surfaces, *versus* buoyancy, debility, diminished speed and extensive surfaces—weight in either case being a *sine qua non*.

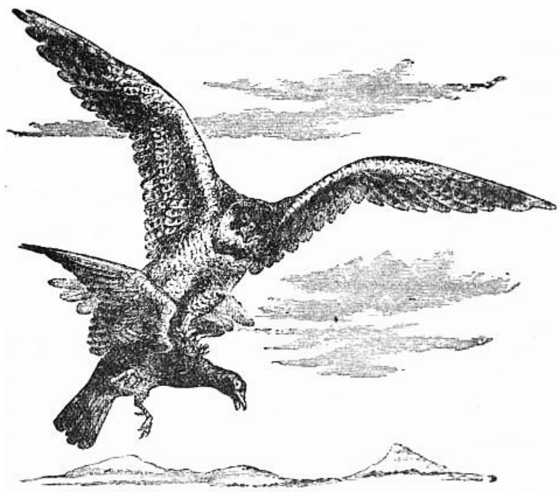


Fig. 28.—Hawk and Pigeon.

That no fixed relation exists between the area of the wings and the size and weight of the body to be elevated is evident on comparing the dimensions of the wings and bodies of the several orders of insects, bats and birds. If such comparison be made, it will be found that the pinions in some instances diminish while the bodies increase, and the converse. No practical good can therefore accrue to aviation from elaborate measurements of the wings and body of any flying thing; neither can any rule be laid down as to the extent of surface required for sustaining a given weight in the air. The statements here advanced are borne out by the fact that the wings of insects, bats and birds may be materially reduced without impairing their powers of flight. In such cases the speed with which the wings are driven is increased in the direct ratio of the mutilation. The inference to be deduced from the foregoing is plainly this, that even in large-bodied, small-winged insects and birds the wing-surface is greatly in excess, the surplus wing area supplying that degree of elevating and sustaining power which is necessary to prevent undue exertion on the part of the volant animal. In this we have a partial explanation of the buoyancy of insects, and the great lifting power possessed by birds and bats,—the bats carrying their young without inconvenience, the birds elevating surprising quantities of fish, game, carrion, &c. (fig. 28).

While as explained, no definite relation exists between the weight of a flying animal and the size of its flying surfaces, there being, as stated, heavy-bodied and small-winged insects, birds and bats, and the converse, and while, as has been shown, flight is possible within a wide range, the wings being, as a rule, in excess of what are required for the purposes of flight,—still it appears from the researches of L. de Lucy that there is a general law, to the effect that the larger the volant animal, the smaller, by comparison, are its flying surfaces. The existence of such a law is very encouraging so far as artificial flight is concerned, for it shows that the flying surfaces of a large, heavy, powerful flying machine will be comparatively small, and consequently comparatively compact and strong. This is a point of very considerable importance, as the object desiderated in a flying machine is elevating capacity.

De Lucy tabulated his results as under:—

Insects				Birds.			
Names.	Flying Surface referred to the Kilogramme = 2 ℔ 8 oz. 3 dwt. 2 gr. avoird. = 2 ℔ 3 oz. 4.428 dr. troy.			Names.	Flying Surface referred to the Kilogramme.		
	sq. yds.	ft.	in.		sq. yds.	ft.	in.
Gnat	11	8	92	Swallow	1	1	104½
Dragon-fly (small)	7	2	56	Sparrow	0	5	142½
Coccinella (Lady-bird)	5	13	87	Turtle-dove	0	4	100½
Dragon-fly (common)	5	2	89	Pigeon	0	2	113
Tipula, or Daddy-long-legs	3	5	11	Stork	0	2	20
Bee	1	2	74½	Vulture	0	1	116
Meat-fly	1	3	54½	Crane of Australia	0	0	130
Drone (blue)	1	2	20				
Cockchafer	1	2	50				
Lucanus cervus Stag-beetle (female)	1	1	39½				
Lucanus cervus Stag-beetle (male)	0	8	33				
Rhinoceros-beetle	0	6	122½				

"It is easy, by the aid of this table, to follow the order, always decreasing, of the surfaces, in proportion as the winged animal increases in size and weight. Thus, in comparing the insects with one another, we find that the gnat, which weighs 460 times less than the stag-beetle, has 14 times more of surface. The lady-bird weighs 150 times less than the stag-beetle, and possesses 5 times more of surface, &c. It is the same with the birds. The sparrow weighs about 10 times less than the pigeon, and has twice as much surface. The pigeon weighs about 8 times less than the stork, and has twice as much surface. The sparrow weighs 339 times less than the Australian crane, and possesses 7 times more surface, &c. If now we compare the insects and the birds, the gradation will become even much more striking. The gnat, for example, weighs 97,000 times less than the pigeon, and has 40 times more surface; it weighs three millions of times less than the crane of Australia, and possesses 140 times more of surface than this latter, the weight of which is about 9 kilogrammes 500 grammes (25 ℔ 5 oz. 9 dwt. troy, 20 ℔ 15 oz. 2¼ dr. avoirdupois).

"The Australian crane, the heaviest bird weighed, is that which has the smallest amount of surface, for, referred to the kilogramme, it does not give us a surface of more than 899 square centimetres (139 sq. in.), that is to say, about an eleventh part of a square metre. But every one knows that these grallatorial animals are excellent birds of flight. Of all travelling birds they undertake the longest and most remote journeys. They are, in addition, the eagle excepted, the birds which elevate themselves the highest, and the flight of which is the longest maintained."[12]

The way in which the natural wing rises and falls on the air, and reciprocates with the body of the flying creature, has a very obvious bearing upon artificial flight. In natural flight the body of the flying creature falls slightly forward in a curve when the wing ascends, and is slightly elevated in a curve when the wing descends. The wing and body are consequently 510
always playing at cross purposes, the wing rising when the body is falling and vice versa. The alternate rise and fall of the body and wing of the bird are well seen when contemplating the flight of the gull from the stern of a steamboat, as the bird is following in the wake of the vessel. The complementary movements referred to are indicated at fig. 29, where the continuous waved line represents the trajectory made by the wing, and the dotted waved line that made by the body. As will be seen from this figure, *the wing advances both when it rises and when it falls*. It is a peculiarity of natural wings, and of artificial wings constructed on the principle of living wings, that when forcibly elevated or depressed, even in a strictly vertical direction, they inevitably dart forward. If, for instance, the wing is suddenly depressed in a vertical direction, as at *a b* of fig. 29, it at once darts downwards and forwards in a double curve (see continuous line of figure) to *c*, thus converting the vertical down stroke into a *down, oblique, forward stroke*. If, again, the wing be suddenly elevated in a strictly vertical direction, as at *c d*, the wing as certainly darts upwards and forwards in a double curve to *e*, thus converting the vertical up strokes into an *upward, oblique, forward stroke*. The same thing happens when the wing is depressed from *e* to *f* and elevated from *g* to *h*, the wing describing a *waved track* as at *e g, g i*.

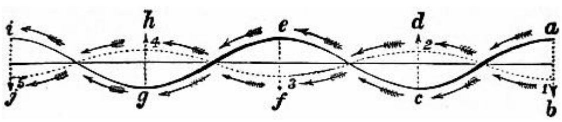


Fig. 29 shows how in progressive flight the wing and the body describe *waved tracks*,—the crests of the waves made by the wing (*a, c, e, g, i*) being placed opposite the crests of the waves made by the body (1, 2, 3, 4, 5).

There are good reasons why the wings should always be in advance of the body. A bird when flying is a body in motion; but a body in motion tends to fall not vertically downwards, but *downwards and forwards*. The wings consequently must be made to strike *forwards* and kept in advance of the body of the bird if they are to prevent the bird from falling *downwards and forwards*. If the wings were to strike backwards in aerial flight, the bird would turn a forward somersault.

That the wings invariably strike forwards during the down and up strokes in aerial flight is proved alike by observation and experiment. If any one watches a bird rising from the ground or the water, he cannot fail to perceive that the head and body are slightly tilted upwards, and that the wings are made to descend with great vigour in a downward and *forward* direction. The dead natural wing and a properly constructed artificial wing act in precisely the same way. If the wing of a gannet, just shot, be removed and made to flap in what the operator believes to be a strictly vertical downward direction, the tip of the wing, in spite of him, will dart forwards between 2 and 3 ft.—the amount of forward movement being regulated by the rapidity of the down stroke. This is a very striking experiment. The same thing happens with a properly constructed artificial wing. The down stroke with the artificial as with the natural wing is invariably converted into an oblique, downward and forward stroke. No one ever saw a bird in the air flapping its wings towards its tail. The old idea was that the wings during the down stroke *pushed* the body of the bird in an upward and forward direction; in reality the wings do not push but *pull*, and in order to pull they must always be in advance of the body to be flown. If the wings did not themselves fly *forward*, they could not possibly cause the body of the bird to fly forward. It is the wings which cause the bird to fly.

It only remains to be stated that the wing acts as a true kite, during both the down and the up strokes, its under concave or biting surface, in virtue of the forward travel communicated to it by the body of the flying creature, being closely applied to the air, during both its ascent and its descent. This explains how the wing furnishes a persistent buoyancy alike when it rises and when it falls (fig. 30).

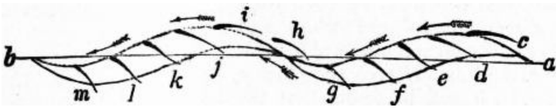


Fig. 30 shows the kite-like action of the wing during the down and up strokes, how the angles made by the wing with the horizon (*a, b*) vary at every stage of these strokes, and how the wing evades the superimposed air during the up stroke, and seizes the nether air during the down stroke. In this figure the spaces between the double dotted lines (*c g, i b*) represent the down strokes, the single dotted line (*h, i*) representing the up stroke. The kite-like surfaces and angles made by the wing with the horizon (*a, b*) during the down strokes are indicated at *c d e f g, j k l m*,—those made during the up strokes being indicated at *g h i*. As the down and up strokes run into each other, and the convex surface of the wing is always directed upwards and the concave surface downwards, it follows that the upper surface of the wing evades in a great measure the upper air, while the under surface seizes the nether air. It is easy to understand from this figure how the wing always flying forwards furnishes a persistent buoyancy.

The natural kite formed by the wing differs from the artificial kite only in this, that the former is capable of being moved in all its parts, and is more or less flexible and elastic, whereas the latter is comparatively rigid. The flexibility and elasticity of the kite formed by the natural wing are rendered necessary by the fact that the wing, as already stated, is practically hinged at its root and along its anterior margin, an arrangement which necessitates its several parts travelling at different degrees of speed, in proportion as they are removed from the axes of rotation. Thus the tip travels at a higher speed than the root, and the posterior margin than the anterior margin. This begets a *twisting diagonal movement* of the wing on its long axis, which, but for the elasticity referred to, would break the wing into fragments. The elasticity contributes also to the continuous play of the wing, and ensures that no two parts of it shall reverse at exactly the same instant. If the wing was inelastic, every part of it would reverse at precisely the same moment, and its vibration would be characterized by pauses or dead points at the end of the down and up strokes which would be fatal to it as a flying organ. The elastic properties of the wing are absolutely essential, when the mechanism and movements of the pinion are taken into account. A rigid wing can never be an effective flying instrument.

The kite-like surfaces referred to in natural flight are those upon which the constructors of flying machines very properly ground their hopes of ultimate success. These surfaces may be conferred on artificial wings, aeroplanes, aerial screws or similar structures; and these structures, if we may judge from what we find in nature, *should be of moderate size and elastic*. The power of the flying organs will be increased if they are driven at a comparatively high speed, and particularly if they are made to reverse and reciprocate, as in this case they will practically create the currents upon which they are destined to rise and advance. The angles made by the kite-like surfaces with the horizon should vary according to circumstances. They should be small when the speed is high, and vice versa. This, as stated, is true of natural wings. It should also be true of artificial wings and their analogues.

Artificial Flight.—We are now in a position to enter upon a consideration of artificial wings and wing movements, and of artificial flight and flying machines.

We begin with artificial wings. The first properly authenticated account of an artificial wing was given by G.A. Borelli in 1670. This author, distinguished alike as a physiologist, mathematician and mechanician, describes and figures a bird with artificial wings, each of which consists of *a rigid rod in front and flexible feathers behind*. The wings are represented as striking *vertically downwards*, as the annexed duplicate of Borelli's figure shows (fig. 31).

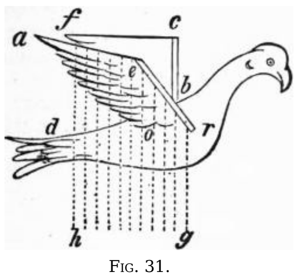


Fig. 31.

Borelli's bird with artificial wings.

r e, Anterior margin of the right wing, consisting of a rigid rod.
o a, Posterior margin of the right wing, consisting of flexible feathers.
b c, Anterior; and
f, Posterior margins of the left wing same as the right.
d, Tail of the bird.
r g, d h, Vertical direction of the down stroke of the wing.

Borelli was of opinion that flight resulted from the application of an inclined plane, which beats the air, and which has a wedge action. He, in fact, endeavours to prove that a bird wedges itself forward upon the air by the perpendicular vibration of its wings, the wings during their action forming a wedge, the base of which (*c b e*) is directed towards the head of the bird, the apex (*a f*) being directed towards the tail (*d*). In the 196th proposition of his work (*De motu animalium*, Leiden, 1685) he states that— 511

> "If the expanded wings of a bird suspended in the air shall strike the undisturbed air beneath it with a motion *perpendicular to the horizon*, the bird will fly with *a transverse motion* in a plane parallel with the horizon." "If," he adds, "the wings of the bird be expanded, and the under surfaces of the wings be struck by the air *ascending perpendicularly to the horizon* with such a force as shall prevent the bird gliding downwards (*i.e.* with a tendency to glide downwards) from falling, it will be urged in a horizontal direction."
>
> The same argument is restated in different words as under:—"If the air under the wings be struck by the flexible portions of the wings (*flabella*, literally fly flaps or small fans) with a motion perpendicular to the horizon, the sails (*vela*) and flexible portions of the wings (*flabella*) will yield in an upward direction and form a wedge, the point of which is directed towards the tail. Whether, therefore, the air strikes the wings from below, or the wings strike the air from above, the result is the same,—the posterior or flexible margins of the wings *yield in an upward direction*, and in so doing urge the bird in a *horizontal direction*."

There are three points in Borelli's argument to which it is necessary to draw attention: (1) the direction of the down stroke: it is stated to be *vertically downwards*; (2) the construction of the anterior margin of the wing: it is stated to consist of *a rigid rod*; (3) the function delegated to the posterior margin of the wing: it is said *to yield in an upward direction* during the down stroke.

With regard to the first point. It is incorrect to say the wing strikes vertically downwards, for, as already explained, the body of a flying bird is a body in motion; but as a body in motion tends to fall downwards and forwards, the wing must strike downwards and forwards in order effectually to prevent its fall. Moreover, in point of fact, all natural wings, and all artificial wings constructed on the natural type, invariably strike downwards and forwards.

With regard to the second point, viz. the supposed rigidity of the anterior margin of the wing, it is only necessary to examine the anterior margins of natural wings to be convinced that they are in every case flexible and elastic. Similar remarks apply to properly constructed artificial wings. If the anterior margins of natural and artificial wings were rigid, it would be impossible to make them vibrate smoothly and continuously. This is a matter of experiment. If a rigid rod, or a wing with a rigid anterior margin, be made to vibrate, the vibration is characterized by an unequal jerky motion, at the end of the down and up strokes, which contrasts strangely with the smooth, steady fanning movement peculiar to natural wings.

As to the third point, viz. the upward bending of the posterior margin of the wing during the down stroke, it is necessary to remark that the statement is true if it means a slight upward bending, but that it is untrue if it means an extensive upward bending.

Borelli does not state the amount of upward bending, but one of his followers, E.J. Marey, maintains that during the down stroke the wing yields until its under surface makes a backward angle with the horizon of 45°. Marey further states that during the up stroke the wing yields to a corresponding extent in an opposite direction—the posterior margin of the wing, according to him, passing through an angle of 90°, plus or minus according to circumstances, every time the wing rises and falls.

That the posterior margin of the wing yields to a slight extent during both the down and up strokes will readily be admitted, alike because of the very delicate and highly elastic properties of the posterior margins of the wing, and because of the comparatively great force employed in its propulsion; but that it does not yield to the extent stated by Marey is a matter of absolute certainty. This admits of direct proof. If any one watches the horizontal or upward flight of a large bird he will observe that the posterior or flexible margin of the wing never rises during the down stroke to a perceptible extent, so that the under surface of the wing, as a whole, never looks backwards. On the contrary, he will perceive that the under surface of the wing (during the down stroke) invariably looks forwards and forms a true kite with the horizon, the angles made by the kite varying at every part of the down stroke, as shown more particularly at *c d e f g, i j k l m* of fig. 30.

The authors who have adopted Borelli's plan of artificial wing, and who have endorsed his mechanical views of the wing's action most fully, are J. Chabrier, H.E.G. Strauss-Dürckheim and Marey. Borelli's artificial wing, it will be remembered, consists of a rigid rod in front and a flexible sail behind. It is also made to strike vertically downwards. According to Chabrier, the wing has only one period of activity. He believes that if the wing be suddenly lowered by the depressor muscles, it is elevated solely by the reaction of the air. There is one unanswerable objection to this theory: the birds and bats, and some if not all the insects, have distinct elevator muscles, and can elevate their wings at pleasure when not flying and when, consequently, the reaction of the air is not elicited. Strauss-Dürckheim agrees with Borelli both as to the natural and the artificial wing. He is of opinion that the insect abstracts from the air by means of the inclined plane a component force (composant) which it employs to support and direct itself. In his theology of nature he describes a schematic wing as consisting of a rigid ribbing in front, and a flexible sail behind. A membrane so constructed will, according to him, be fit for flight. It will suffice if such a sail elevates and lowers itself successively. It will of its own accord dispose itself as an inclined plane, and receiving obliquely the reaction of the air, it transfers into tractile force a part of the vertical impulsion it has received. These two parts of the wing, moreover, are equally indispensable to each other.

Marey repeats Borelli and Dürckheim with very trifling modifications, so late as 1869. He describes two artificial wings, the one composed of a rigid rod and sail—the rod representing the stiff anterior margin of the wing; the sail, which is made of paper bordered with cardboard, the flexible posterior margin. The other wing consists of a rigid nervure in front and behind of thin parchment which supports fine rods of steel. He states that if the wing only elevates and depresses itself, "the resistance of the air is sufficient to produce all the other movements. In effect (according to Marey) the wing of an insect has not the power of equal resistance in every part. On the anterior margin the extended nervures make it rigid, while behind it is fine and flexible. During the vigorous depression of the wing, the nervure has the power of remaining rigid, whereas the flexible portion, being pushed in an upward direction on account of the resistance it experiences from the air, assumes an oblique position which causes the upper surface of the wing to look forwards." The reverse of this, in Marey's opinion, takes place during the elevation of the wing—the resistance of the air from above causing the upper surface of the wing to look backwards.... "At first," he says, "the plane of the wing is parallel with the body of the animal. It lowers itself—the front part of the wing strongly resists, the sail which follows it being flexible yields. Carried by the ribbing (the anterior margin of the wing) which lowers itself, the sail or posterior margin of the wing being raised meanwhile by the air, which sets it straight again, the sail will take an intermediate position and incline itself about 45° plus or minus according to circumstances.... The wing continues its movements of depression inclined to the horizon; but the impulse of the air, which continues its effect, and naturally acts upon the surface which it strikes, has the power of 512
resolving itself into two forces, a vertical and a horizontal force; the first suffices to raise the animal, the second to move it along."[13] Marey, it will be observed, reproduces Borelli's artificial wing, and even his text, at a distance of nearly two centuries.

The artificial wing recommended by Pettigrew is a more exact imitation of nature than either of the foregoing. It is of a more or less triangular form, thick at the root and anterior margin, and thin at the tip and posterior margin. No part of it is rigid. It is, on the contrary, highly elastic and flexible throughout. It is furnished with springs at its root to contribute to its continued play, and is applied to the air by a direct piston action in such a way that it descends in a downward and forward direction during the down stroke, and ascends in an upward and forward direction during the up stroke. It elevates and propels both when it rises and falls. It, moreover, twists and untwists during its action and describes figure-of-8 and waved tracks in space, precisely as the natural wing does. The twisting is most marked at the tip and posterior margin, particularly that half of the posterior margin next the tip. The wing when in action may be divided into two portions by a line running diagonally between the tip of the wing anteriorly and the root of the wing posteriorly. The tip and posterior parts of the wing are more active than the root and anterior parts, from the fact that the tip and posterior parts (the wing is an eccentric) always travel through greater spaces, in a given time, than the root and anterior parts.

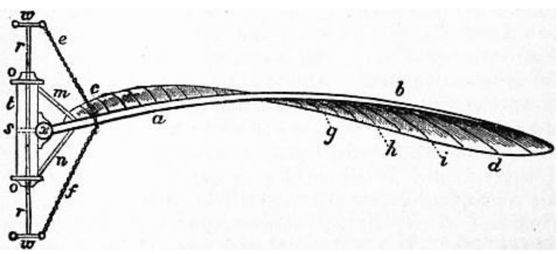


FIG. 32.—Elastic Spiral Wing, which twists and untwists during its action, to form *a mobile helix or screw*. This wing is made to vibrate by a direct piston action, and by a slight adjustment can be propelled vertically, horizontally or at any degree of obliquity.

a b, Anterior margin of wing, to which the neurae or ribs are affixed.
c d, Posterior margin of wing crossing anterior one.
x, Ball-and-socket joint at root of wing, the wing being attached to the side of the cylinder by the socket.
t, Cylinder.
r r, Piston, with cross heads (*w, w*) and piston head (*s*).
o o, Stuffing boxes.
e, f, Driving chains.
m, Superior elastic band, which assists in elevating the wing.
n, Inferior elastic band, which antagonizes m. The alternate stretching of the superior and inferior elastic bands contributes to the continuous play of the wing, by preventing dead points at the end of the down and up strokes. The wing is free to move in a vertical and horizontal direction and at any degree of obliquity.

The wing is so constructed that the posterior margin yields freely in a downward direction during the up stroke, while it yields comparatively little in an upward direction during the down stroke; and this is a distinguishing feature, as the wing is thus made to fold and elude the air more or less completely during the up stroke, whereas it is made to expand and seize the air with avidity during the down stroke. The oblique line referred to as running diagonally across the wing virtually divides the wing into an active and a passive part, the former elevating and propelling, the latter sustaining.

It is not possible to determine with exactitude the precise function discharged by each part of the wing, but experiment tends to show that the tip of the wing elevates, the posterior margin propels, and the root sustains.

The wing—and this is important—is driven by a direct piston action with an irregular hammer-like movement, the pinion having communicated to it a smart click at the beginning of every down stroke—the up stroke being more uniform. The following is the arrangement (fig. 32). If the artificial wing here represented (fig. 32) be compared with the natural wing as depicted at fig. 33, it will be seen that there is nothing in the one which is not virtually reproduced in the other. In addition to the foregoing, Pettigrew recommended a double elastic wing to be applied to the air like a steam-hammer, by being fixed to the head of the piston. This wing, like the single wing described, twists and untwists as it rises and falls, and possesses all the characteristics of the natural wing (fig. 34).

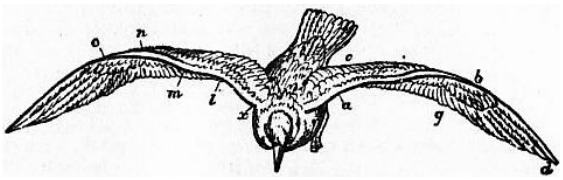


FIG. 33 shows the Spiral Elastic Wings of the Gull. Each wing forms a mobile helix or screw.

a b, Anterior margin of left wing.
c d, Posterior margin of ditto.
d g, Primary or rowing feathers of left wing.
g a, Secondary feathers ditto.
x, Root of right wing with ball-and-socket joint.
l, Elbow joint.
m, Wrist joint,
n,o, Hand and finger joints.

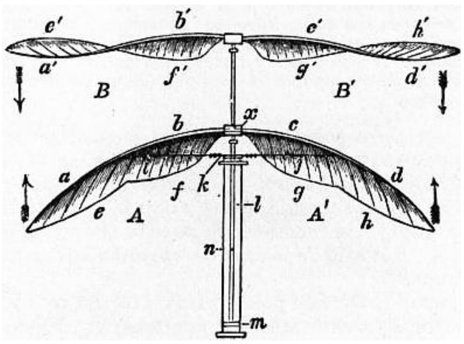


FIG. 34.—Double Elastic Wing driven by direct piston action. During the up stroke of the piston the wing is very decidedly convex on its upper surface (*a b c d*, A A′); its under surface (*e f g h*, A A′) being deeply concave and inclined obliquely upwards and forwards. It thus evades, to a considerable extent, the air during the up stroke. During the down stroke of the piston the wing is flattened out in every direction, and its extremities twisted in such a manner as to form two screws, as seen at *a′ b′ c′ d′, e′ f′ g′ h′*, B, B′. The active area of the wing is by this arrangement considerably diminished during the up stroke, and considerably augmented during the down stroke; the wing seizing the air with greater avidity during the down than during the up stroke. *i, j, k*, elastic band to regulate the expansion of the wing; *l*, piston; *m*, piston head; *n*, cylinder.

He also recommends an elastic aerial screw consisting of two blades, which taper and become thinner towards the tips and posterior margins. When the screw is made to rotate, the blades, because of their elasticity, assume a great variety of angles, the angles being least where the speed of the blades is greatest and vice versa. The pitch of the blades is thus regulated by the speed attained (fig. 35).

The peculiarity of Pettigrew’s wings and screws consists in their elasticity, their twisting action, and their great comparative length and narrowness. They offer little resistance to the air when they are at rest, and when in motion the speed with which they are driven is such as to ensure that the comparatively large spaces through which they travel shall practically be converted into solid bases of support.

After Pettigrew enunciated his views (1867) as to the screw configuration and elastic properties of natural wings, and more especially after his introduction of spiral, elastic artificial wings, and elastic screws, a great revolution took place in the construction of flying models. Elastic aeroplanes were advocated by D.S. Brown,[14] elastic aerial screws by J. Armour,[15] and elastic aeroplanes, wings and screws by Alphonse Pénaud.[16]

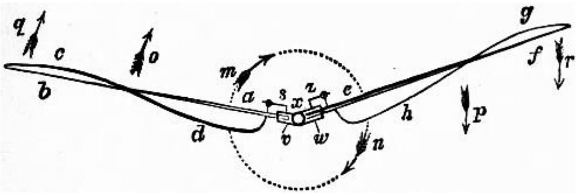


Fig. 35.—Elastic Aerial Screw with twisted blades resembling wings (*a b c d, e f g h*).

x, End of driving shaft.
v,w, Sockets in which the roots of the blades of the screw rotate, the degree of rotation being limited by steel springs (*z, s*).
a b, e f, tapering elastic rods forming anterior or thick margins of blades of screw.
d c, h g, Posterior or thin elastic margins of blades of screw. The arrows *m, n, o, p, q, r* indicate the direction of travel.

Pénaud’s experiments are alike interesting and instructive. He constructed models to fly by three different methods:—(*a*) by means of screws acting vertically upwards; (*b*) by aeroplanes propelled horizontally by screws; and (*c*) by wings which flapped in an upward and downward direction. An account of his helicoptère or screw model appeared in the *Aeronaut* for January 1872, but before giving a description of it, it may be well to state very briefly what is known regarding the history of the screw as applied to the air.

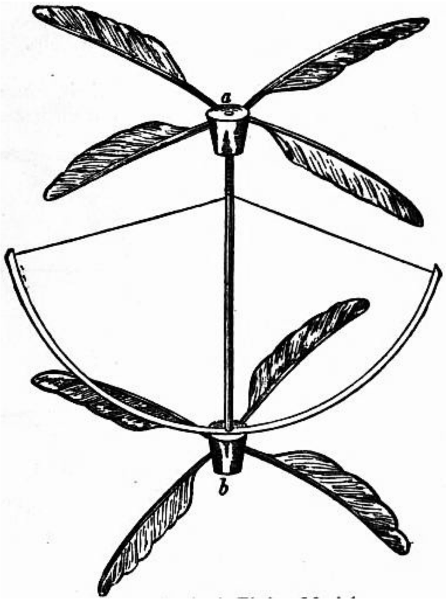


Fig. 36.—Cayley’s Flying Model.

The first suggestion on this subject was given by A.J.P. Paucton in 1768. This author, in his treatise on the *Théorie de la vis d’Archimède*, describes a machine provided with two screws which he calls a “ptérophores.” In 1796 Sir George Cayley gave a practical illustration of the efficacy of the screw as applied to the air by constructing a small machine, consisting of two screws made of quill feathers, a representation of which we annex (fig. 36). Sir George writes as under:—

> “As it may be an amusement to some of your readers to see a machine rise in the air by mechanical means, I will conclude my present communication by describing an instrument of this kind, which any one can construct at the expense of ten minutes’ labour.
>
> “*a* and *b*, fig. 36, are two corks, into each of which are inserted four wing feathers from any bird, so as to be slightly inclined like the sails of a windmill, but in opposite directions in each set. A round shaft is fixed in the cork *a*, which ends in a sharp point. At the upper part of the cork *b* is fixed a whalebone bow, having a small pivot hole in its centre to receive the point of the shaft. The bow is then to be strung equally on each side to the upper portion of the shaft, and the little machine is completed. Wind up the string by turning the flyers different ways, so that the spring of the bow may unwind them with their anterior edges ascending; then place the cork with the bow attached to it upon a table, and with a finger on the upper cork press strong enough to prevent the string from unwinding, and, taking it away suddenly, the instrument will rise to the ceiling.”

Cayley’s screws were peculiar, inasmuch as they were superimposed and rotated in opposite directions. He estimated that if the area of the screws was increased to 200 sq. ft., and moved by a man, they would elevate him. His interesting experiment is described at length, and the apparatus figured in *Nicolson’s Journal*, 1809, p. 172.

Other experimenters, such as J. Degen in 1816 and Ottoris Sarti in 1823, followed Cayley at moderate intervals, constructing flying models on the vertical screw principle. In 1842 W.H. Phillips succeeded, it is stated, in elevating a steam model by the aid of revolving fans, which according to his account flew across two fields after having attained a great altitude; and in 1859 H. Bright took out a patent for a machine to be sustained by vertical screws. In 1863 the subject of aviation by vertical screws received a fresh impulse from the experiments of Gustave de Ponton d’Amécourt, G. de la Landelle, and A. Nadar, who exhibited models driven by clock-work springs, which ascended with graduated weights a distance of from 10 to 12 ft. These models were so fragile that they usually broke in coming in contact with the ground in their descent. Their flight, moreover, was unsatisfactory, from the fact that it only lasted a few seconds.

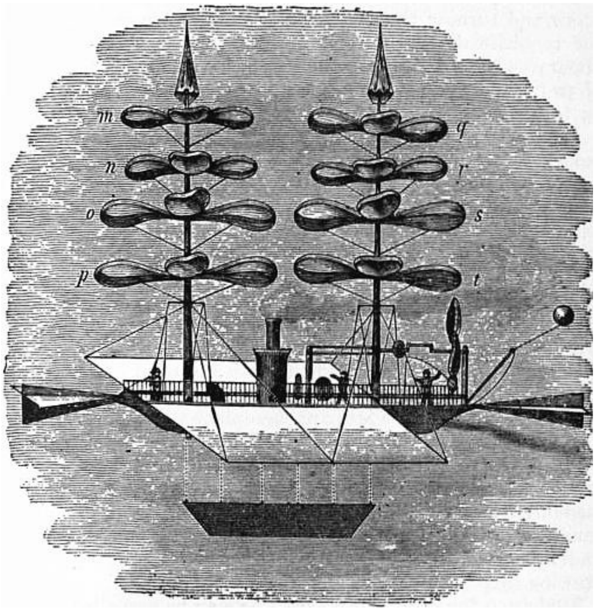


FIG. 37.—De la Landelle's Flying-machine. *m, n, o, p*; *q, r, s, t*, Screws arranged on vertical axes to act vertically upwards. The vertical axes are surmounted by two parachutes, and the body of the machine is furnished with an engine, propeller, rudders and an extensive aeroplane.

Stimulated by the success of his spring models, Ponton d'Amécourt had a small steam model constructed. This model, which was shown at the exhibition of the Aeronautical Society of Great Britain at the Crystal Palace in 1868, consisted of two superposed screws propelled by an engine, the steam for which was generated (for lightness) in an aluminium boiler. This steam model proved a failure, inasmuch as it only lifted a third of its own weight. Fig. 37 embodies de la Landelle's ideas.

All the models referred to (Cayley's excepted[17]) were provided with rigid screws. In 1872 Pénaud discarded the rigid 514
screws in favour of elastic ones, as Pettigrew had done some years before.

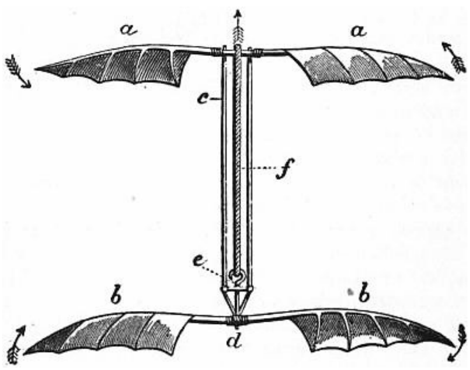


FIG. 38.—Hélicoptère or Screw-Model, by Pénaud.

Pénaud also substituted india-rubber under torsion for the whalebone and clock springs of the smaller models, and the steam of the larger ones. His hélicoptère or screw-model is remarkable for its lightness, simplicity and power. The accompanying sketch will serve to illustrate its construction (fig. 38). It consists of two superposed elastic screws (*a a, b b*), the upper of which (*a a*) is fixed in a vertical frame (*c*), which is pivoted in the central part (*d*) of the under screw. From the centre of the under screw an axle provided with a hook (*e*), which performs the part of a crank, projects in an upward direction. Between the hook or crank (*e*) and the centre of the upper screw (*a a*), the india-rubber in a state of torsion (*f*) extends. By fixing the lower screw and turning the upper one a sufficient number of times the requisite degree of torsion and power is obtained. The apparatus when liberated flies into the air sometimes to a height of 50 ft., and gyrates in large circles for a period varying from 15 to 30 seconds.

Pénaud next directed his attention to the construction of a model, to be propelled by a screw and sustained by an elastic aeroplane extending horizontally. Sir George Cayley proposed such a machine in 1810, and W.S. Henson constructed and patented a similar machine in 1842. Several inventors succeeded in making models fly by the aid of aeroplanes and screws, as, *e.g.* J. Stringfellow in 1847,[18] and F. du Temple in 1857. These models flew in a haphazard sort of a way, it being found exceedingly difficult to confer on them the necessary degree of stability fore and aft and laterally. Pénaud succeeded in overcoming the difficulty in question by the invention of what he designated an automatic rudder. This consisted of a small elastic aeroplane placed aft or behind the principal aeroplane which is also elastic. The two elastic aeroplanes extended horizontally and made a slight upward angle with the horizon, the angle made by the smaller aeroplane (the rudder) being slightly in excess of that made by the larger. The motive power was india-rubber in the condition of torsion; the propeller, a screw. The reader will understand the arrangement by a reference to the accompanying drawing (fig. 39).

Models on the aeroplane screw type may be propelled by two screws, one fore and one aft, rotating in opposite directions; and in the event of only one screw being employed it may be placed in front of or behind the aeroplane.

When such a model is wound up and let go it descends about 2 ft., after which, having acquired initial velocity, it rises and flies in a forward direction at a height of from 8 to 10 ft. from the ground for a distance of from 120 to 130 ft. It flies this distance in from 10 to 11 seconds, its mean speed being something like 12 ft. per second. From experiments made with this model, Pénaud calculates that one horse-power would elevate and support 85 ℔

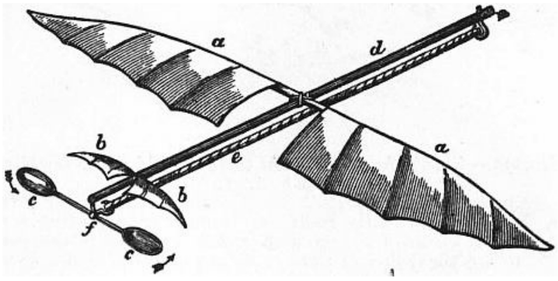


Fig. 39.—Aeroplane Model with Automatic Rudder.

a a, Elastic aeroplane.
b b, Automatic rudder.
c c, Aerial screw centred at *f*.
d, Frame supporting aeroplane, rudder and screw.
e, India-rubber, in a state of torsion, attached to hook or crank at *f*. By holding the aeroplane (*a a*) and turning the screw (*c c*) the necessary power is obtained by torsion. (Pénaud.)

D.S. Brown also wrote (1874) in support of elastic aero-biplanes. His experiments proved that two elastic aeroplanes united by a central shaft or shafts, and separated by a wide interval, always produce increased stability. The production of flight by the vertical flapping of wings is in some respects the most difficult, but this also has been attempted and achieved. Pénaud and A.H. de Villeneuve each constructed winged models. Marey was not so fortunate. He endeavoured to construct an artificial insect on the plan advocated by Borelli, Strauss-Dürckheim and Chabrier, but signally failed, his insect never having been able to lift more than a third of its own weight.

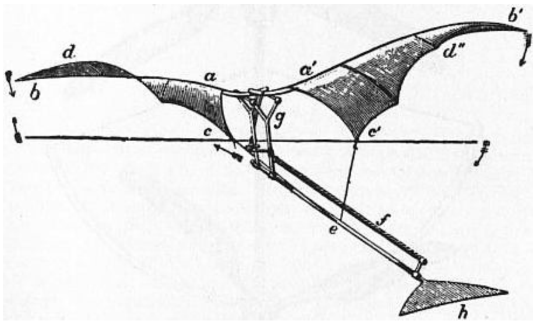


Fig. 40.—Pénaud’s Artificial Flying Bird.

a b c d, a′ b′ c′ d′, Elastic wings, which twist and untwist when made to vibrate.
a b, a′ b′, Anterior margins of wings.
c d, c′ d′, Posterior margins of wings.
c, c′, Inner portions of wings attached to central shaft of model by elastic bands at e.
f, India-rubber in a state of torsion, which provides the motive power, by causing the crank situated between the vertical wing supports (*g*) to rotate; as the crank revolves the wings are made to vibrate by means of two rods which extend between the crank and the roots of the wings.
h, Tail of artificial bird.

De Villeneuve and Pénaud constructed their winged models on different types, the former selecting the bat, the latter the bird. De Villeneuve made the wings of his artificial bat conical in shape and comparatively rigid. He controlled the movements of the wings, and made them strike downwards and forwards in imitation of natural wings. His model possessed great power of rising. It elevated itself from the ground with ease, and flew in a horizontal direction for a distance of 24 ft., and at a velocity of 20 m. an hour. Pénaud’s model differed from de Villeneuve’s in being provided with elastic wings, the posterior margins of which in addition to being elastic were free to move round the anterior margins as round axes (see fig. 24). India-rubber springs were made to extend between the inner posterior parts of the wings and the frame, corresponding to the backbone of the bird.

A vertical movement having been communicated by means of india-rubber in a state of torsion to the roots of the wings, the wings themselves, in virtue of their elasticity, and because of the resistance experienced from the air, twisted and untwisted and formed reciprocating screws, precisely analogous to those originally described and figured by Pettigrew in 1867. Pénaud’s arrangement is shown in fig. 40.

If the left wing of Pénaud’s model (*a b, c d* of fig. 40) be compared with the wing of the bat (fig. 18), or with Pettigrew’s artificial wing (fig. 32), the identity of principle and application is at once apparent.

In Pénaud’s artificial bird the equilibrium is secured by the addition of a tail. The model cannot raise itself from the ground, but on being liberated from the hand it descends 2 ft. or so, when, having acquired initial velocity, it flies horizontally for a distance of 50 or more feet, and rises as it flies from 7 to 9 ft. The following are the measurements of the model in question:—length of wing from tip to tip, 32 in.; weight of wing, tail, frame, india-rubber, &c., 73 grammes (about 2½ ounces).

(J. B. P.)

Flying Machines.—Henson’s flying machine, designed in 1843, was the earliest attempt at aviation on a great scale. Henson was one of the first to combine aerial screws with extensive supporting structures occupying a nearly horizontal position. The accompanying illustration explains the combination (fig. 41).

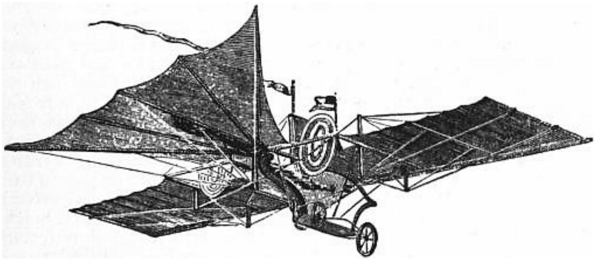


Fig. 41.—Henson’s Aerostat.

> “The chief feature of the invention was the very great expanse of its sustaining planes, which were larger in proportion to the weight it had to carry than those of many birds. The machine advanced with its front edge a little raised, the effect of which was to present its under surface to the air over which it passed, the resistance of which, acting upon it like a strong wind on the sails of a windmill, prevented the descent of the machine and its burden. The sustaining of the whole, therefore, depended upon the speed at which it travelled through the air, and the angle at which its under surface impinged on the air in its front.... The machine, fully prepared for flight, was started from the top of an inclined plane, in descending which it attained a velocity necessary to sustain it in its further progress. That velocity would be gradually destroyed by the resistance of the air to the forward flight; it was, therefore, the office of the steam-engine and the vanes it actuated simply to repair the loss of velocity; it was made, therefore, only of the power and weight necessary for that small effect.” The editor of Newton’s *Journal of Arts and Sciences* speaks of it thus:—“The apparatus consists of a car containing the goods, passengers, engines, fuel, &c., to which a rectangular frame, made of wood or bamboo cane, and covered with canvas or oiled silk, is attached. This frame extends on either side of the car in a similar manner to the outstretched wings of a bird; but with this difference, that the frame is immovable. Behind the wings are two vertical fan wheels, furnished with oblique vanes, which are intended to propel the apparatus through the air. The rainbow-like circular wheels are the propellers, answering to the wheels of a steamboat, and acting upon the air after the manner of a windmill. These wheels receive motions from bands and pulleys from a steam or other engine contained in the car. To an axis at the stern of the car a triangular frame is attached, resembling the tail of a bird, which is also covered with canvas or oiled silk. This may be expanded or contracted at pleasure, and is moved up and down for the purpose of causing the machine to ascend or descend. Beneath the tail is a rudder for directing the course of the machine to the right or to the left; and to facilitate the steering a sail is stretched between two masts which rise from the car. The amount of canvas or oiled silk necessary for buoying up the machine is stated to be equal to one square foot for each half pound of weight.”

F.H. Wenham, thinking to improve upon Henson, invented in 1866 what he designated his aeroplanes.[19] These were thin, light, long, narrow structures, arranged above each other in tiers like so many shelves. They were tied together at a slight upward angle, and combined strength and lightness. The idea was to obtain great sustaining area in comparatively small space with comparative ease of control. It was hoped that when the aeroplanes were wedged forward in the air by vertical screws, or by the body to be flown, each aeroplane would rest or float upon a stratum of undisturbed air, and that practically the aeroplanes would give the same support as if spread out horizontally. The accompanying figures illustrate Wenham’s views (figs. 42 and 43).

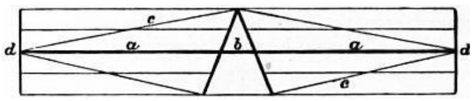


Fig. 42.—Wenham’s system of Aeroplanes designed to carry a man.

- *a, a,* Thin planks, tapering at each end, and attached to a triangle.
- *b,* Similar plank for supporting the aeronaut.
- *c, c,* Thin bands of iron with truss planks a, a, and
- *d, d,* Vertical rods. Between these are stretched five bands of holland 15 in. broad and 16 ft. long, the total length of the web being 80 ft. This apparatus when caught by a gust of wind, actually lifted the aeronaut.

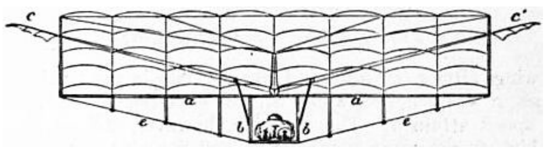


Fig. 43.—A similar system, planned by Wenham.

- *a, a,* Main spar 16 ft. long;
- *b, b,* Panels, with base board for aeronaut attached to main spar.
- *e, e,* Thin tie-band of steel with struts starting from main spar. This forms a strong light framework for the aeroplanes, consisting of six webs of thin holland 15 in. broad. The aeroplanes are kept in parallel plane by vertical divisions of holland 2 ft. wide.
- *c, c′,* Wing propellers driven by the feet.

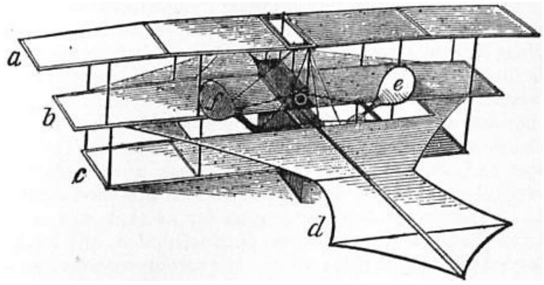


Fig. 44.—Stringfellow’s Flying Machine.

Stringfellow, who was originally associated with Henson, and built a successful flying model in 1847, made a second model in 1868, in which Wenham’s aeroplanes were combined with aerial screws. This model was on view at the exhibition of the Aeronautical Society of Great Britain, held at the Crystal Palace, London, in 1868. It was remarkably compact, elegant and light, and obtained the £100 prize of the exhibition for its engine, which was the lightest and most powerful so far constructed. The illustration below (fig. 44), drawn from a photograph, gives a very good idea of the arrangement—*a*, *b*, *c* representing the superimposed aeroplanes, *d* the tail, *e*, *f* the screw propellers. The superimposed aeroplanes (*a*, *b*, *c*) in this machine contained a sustaining area of 28 sq. ft., in addition to the tail (*d*). Its engine represented a third of a horse power, and the weight of the whole (engine, boiler, water, fuel, superimposed aeroplanes and propellers) was under 12 ℔ Its sustaining area, if that of the tail (*d*) be included, was something like 36 sq. ft., *i.e.* 3 516
sq. ft. for every pound. The model was forced by its propellers along a wire at a great speed, but so far as an observer could determine, failed to lift itself, notwithstanding its extreme lightness and the comparatively very great power employed. Stringfellow, however, stated that it occasionally left the wire and was sustained by its aeroplanes alone.

The aerial steamer of Thomas Moy (fig. 45), designed in 1874, consisted of a light, powerful, skeleton frame resting on three wheels; a very effective light engine constructed on a new principle, which dispensed with the old-fashioned, cumbrous boiler; two long, narrow, horizontal aeroplanes; and two comparatively very large aerial screws. The idea was to get up the initial velocity by a preliminary run on the ground. This accomplished it was hoped that the weight of the machine would gradually be thrown upon the aeroplanes in the same way that the weight of certain birds—the eagle, *e.g.* —is thrown upon the wings after a few hops and leaps. Once in the air the aeroplanes, it was believed, would become effective in proportion to the speed attained. The machine, however, did not realize the high expectations formed of it, and like all its predecessors it was doomed to failure.

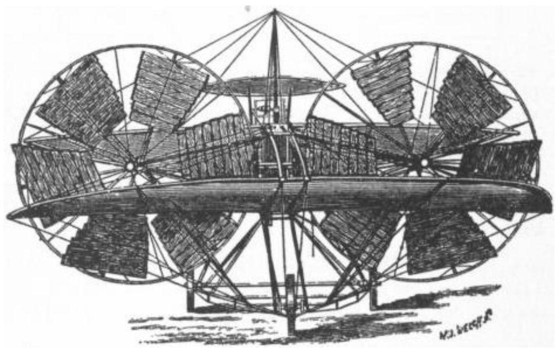


Fig. 45.—Moy’s Aerial Steamer.

Two of the most famous of the next attempts to solve the problem of artificial flight, by means of aeroplanes, were those of Prof. S.P. Langley and Sir Hiram S. Maxim, who began their aerial experiments about the same time (1889-1890). By 1893-1894 both had embodied their views in models and large flying machines.

Langley, who occupied the position of secretary to the Smithsonian Institution, Washington, U.S.A., made many small flying models and one large one. These he designated “aerodromes.” They were all constructed on a common principle, and were provided with extensive flying surfaces in the shape of rigid aeroplanes inclined at an upward angle to the horizon, and more or less fixed on the plan advocated by Henson. The cardinal idea was to force the aeroplanes (slightly elevated at their anterior margins) forwards, kite-fashion, by means of powerful vertical screw propellers driven at high speed—the greater the horizontal speed provided by the propellers, the greater, by implication, the lifting capacity of the aerodrome. The bodies, frames and aeroplanes of the aerodromes were strengthened by vertical and other supports, to which were attached aluminium wires to ensure absolute rigidity so far as that was possible. Langley aimed at great lightness of construction, and in this he succeeded to a remarkable extent. His aeroplanes were variously shaped, and were, as a rule, concavo-convex, the convex surface being directed upwards. He employed a competent staff of highly trained mechanics at the Smithsonian Institution, and great secrecy was observed as to his operations. He flew his smallest models in the great lecture room of the National Museum, and his larger ones on the Potomac river about 40 m. below Washington.

While Langley conducted his preliminary experiments in 1889, he did not construct and test his steam-driven flying models until 1893. These were made largely of steel and aluminium, and one of them in 1896 made the longest flight then recorded for a flying machine, namely, fully half a mile on the Potomac river. The largest aerodrome, intended to carry passengers and to be available for war purposes, was built to the order and at the expense of the American government, which granted a sum of fifty thousand dollars for its construction.

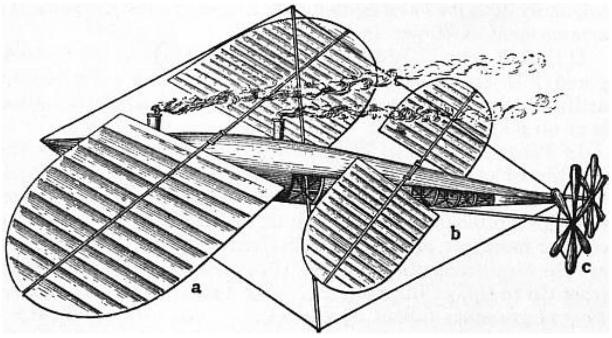


Fig. 46.—Langley’s Flying Machine. *a*, Large aeroplane; *b*, Small aeroplane; *c*, Propelling screws.

Langley’s machine shown in fig. 46 was a working model, not intended to carry passengers. In configuration the body-portion closely resembled a mackerel. The backbone was a light but very rigid tube of aluminium steel, 15 ft. in length, and a little more than 2 in. in diameter. The engines were located in the portion of the framework corresponding to the head of the fish; they weighed 60 oz. and developed one horse-power. There were four boilers made of thin hammered copper and weighing a little more than 7 ℔ each; these occupied the middle portion of the fish. The fuel used was refined gasoline, and the extreme end of the tail of the fish was utilized for a storage tank with a capacity of one quart. There were twin screw propellers, which could be adjusted to different angles in practice, to provide for steering, and made 1700 revolutions a minute. The wings, or aeroplanes, four in number, consisted of light frames of tubular aluminium steel covered with china silk. The pair in front were 42 in. wide and 40 ft. from tip to tip. They could be adjusted at different angles. The machine required to be dropped from a height, or a preliminary forward impetus had to be given to it, before it could be started. Fixity of all the parts was secured by a tubular mast extending upwards and downwards through about the middle of the craft, and from its extremities ran stays of aluminium wire to the tips of the aeroplanes and the end of the tubular backbone. By this trussing arrangement the whole structure was rendered exceedingly stiff.

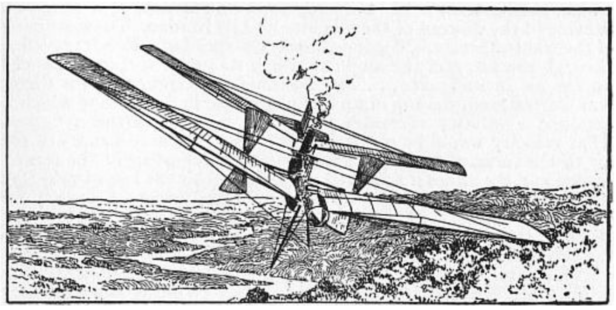


Fig. 47.—Langley’s Aerodrome in flight.

In the larger aerodrome (fig. 47) the aeroplanes were concavo-convex, narrow, greatly elongated and square at their free extremities, the two propellers, which were comparatively very large, being placed amidships, so to speak. At the first trial of this machine, on the 7th of October 1903, just as it left the launching track it was jerked violently down at the front (being caught, as subsequently appeared, by the falling ways), and under the full power of its engine was pulled into the water, carrying with it its engineer. When the aerodrome rose to the surface, it was found that while the front sustaining surfaces had been broken by their impact with the water, yet the rear ones were comparatively uninjured. At the second and last attempt, on the 8th of December 1903, another disaster, again due to the launching ways, occurred as the machine was leaving the track. This time the back part of the machine, in some way still unexplained, was caught by a portion of the launching car, which caused the rear sustaining surface to break, leaving the rear entirely without support 517 and it came down almost vertically into the water. Darkness had come before the engineer, who had been in extreme danger, could aid in the recovery of the aerodrome. The boat and machine had drifted apart, and one of the tugs in its zeal to render assistance had fastened a rope to the frame of the machine in the reverse position from what it should have been attached, and had broken the frame entirely in two. Owing to lack of funds further trials were abandoned (see *Annual Report of the Smithsonian Institution*, 1904, p. 122).

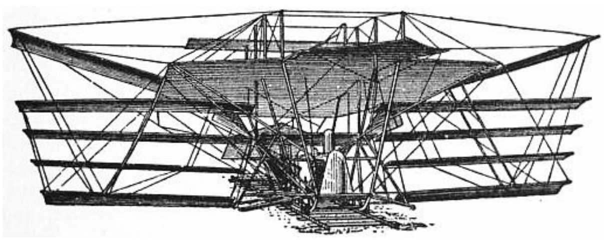


Fig. 48.—Sir H. Maxim’s Flying Machine.

Sir Hiram S. Maxim, like Langley, employed a staff of highly skilled workmen. His machine (fig. 48) consisted of a platform, on which stood a large water-tube boiler, a number of concavo-convex aeroplanes arranged in tiers like shelves, each making a slight upward angle with the horizon, two very large vertical screws placed aft and propelled by steam engines, tanks for the storage of water, naphtha, &c. The boiler was especially noteworthy. The water was contained in about 2000 bent copper tubes, only $3/8$ in. in external diameter, heated by over 7000 gas jets arranged in rows. The fuel was naphtha or gasoline. Steam could be got up in the short space of half a minute. The steam-generating appliances, which weighed only 1000 ℔ in all, were placed in the front of the machine. The motive power was provided by a pair of two-cylinder, compound engines, poised about 8 ft. from the ground, and about 6 ft. apart. Each of them was independently governed, and furnished together 363 horse-power in actual effect, an amount which, considering that their total weight was only 600 ℔, gave the extraordinary efficiency of over 1 horse-power for every 2 ℔ weight. The high and the low pressure cylinders were 5 and 8 in. in diameter respectively, and the stroke was 12 in. When going at full speed these engines conferred 425 revolutions per minute on the two gigantic propellers that drove the machine along. These were in appearance like two-bladed marine propellers except that they were square instead of rounded at the ends, and were broad and thin. They were built from overlapping strips of American pine, planed smooth and covered with glued canvas. They weighed 135 ℔ each, the length of each blade being close upon 9 ft. and the width at the ends 5½ ft. The pitch was 16 ft. They were carefully stayed by steel wires to their shafts, or the first revolution would have snapped them off short. The material of which the framework was built was thin steel tubing, exceedingly light. All the wires and ties were of the best steel, capable of standing a strain of 100 tons to the square inch. The body of the machine was oblong in shape, with the fore-part cut away like a water-chute boat, and a long counter at the stern over which the propellers revolved. It had canvas stretched all over it. High overhead, like a gigantic awning, was the slightly concavo-convex main aeroplane, tilted towards the front at an imperceptible angle, and stretched taut. Its area was 1400 sq. ft., increased by side wings to 2700 sq. ft. There were also side aeroplanes arranged in tiers, and large aeroplanes in front, which were pivoted and served for vertical steering. The machine was strengthened in every direction by vertical and other supports and securely wired together at all points. It was furnished with four strong flanged wheels and ran along a light broad-gauge (9 ft.) railway track, 1800 ft. long, in the hope that when the speed reached a certain point it would leave the rails, but it was prevented from rising more than an inch or so by four arms, or outriggers, furnished with wheels, which projected from its sides and ran under an inverted wooden upper or safety track outside the railway track proper.

At a trial carried out in 1894 at Bexley, Kent, only the main aeroplane, the fore and aft rudders, and the top and bottom side planes were in position. After everything had been got in readiness, careful observers were stationed along the track, and the machine was connected to a dynamometer. The engines were then started and the pump set so as to deliver over 5000 ℔ of water per hour into the boiler. The gas was then carefully turned on until the pressure amounted to 310 ℔ per sq. in., and the dynamometer showed a thrust of more than 2100 ℔ A small safety-valve placed in the steam pipe had been adjusted so as to blow off slightly at 310 ℔ and with a strong blast at 320 ℔ The signal being given to let go, the machine darted forward at a terrific pace, and the safety-valve ceased to blow. More gas was instantly turned on, and before the machine had advanced 300 ft., the steam had mounted to 320 ℔ per sq. in., and the safety-valve was blowing off a steady blast. When the machine had travelled only a few hundred feet, all four of the small outrigger wheels were fully engaged, which showed that the machine was lifting at least 8000 ℔ The speed rapidly increased until when the machine had run about 900 ft. one of the rear axletrees, which were of 2 in. steel tubing, doubled up and set the rear end of the machine completely free. When the machine had travelled about 1000 ft., the left-hand forward wheel became disengaged from the safety track, and shortly after this the right-hand wheel broke the upper track—3 in. by 9 in. Georgia pine—and a plank became entangled in the framework of the machine. Steam had already been shut off, and the machine coming to rest fell directly to the ground, all four of its wheels sinking deeply into the turf without leaving other marks. Before making this run the wheels which were to engage the upper track were painted, and the paint left by them on the upper track indicated the exact point where the machine lifted. The area of the aeroplanes was very nearly 4000 sq. ft. and the total lifting effect was fully 10,000 ℔ The planes therefore lifted 2.5 ℔ per sq. ft., and 5 ℔ for each pound thrust. Nearly half of the power of the engines was lost in the screw slip. This showed that the diameter of the screws was not great enough; it should have been at least 22 ft.

In 1897 M.C. Ader, who had already tested, with indifferent results, two full-sized flying machines, built a third apparatus with funds furnished by the French government. This reproduced the structure of a bird with almost servile imitation, save that traction was obtained by two screw-propellers. The steam engine weighed about 7 ℔ per horse-power, but the equilibrium of the apparatus was defective.

Largely with the view of studying the problem of maintaining equilibrium, several experimenters, including Otto Lilienthal, Percy Pilcher and Octave Chanute, cultivated gliding flight by means of aeroplanes capable of sustaining a man. They depended mainly on the utilization of natural air currents, trusting for stability and balance to movements in their own bodies, or in portions of their machines which they could control. They threw themselves from natural or artificial elevations, or, facing the wind, they ran or were dragged forwards against it until they got under way and the wind caught hold of their aeroplanes. To Lilienthal in Germany belongs the double credit of demonstrating the superiority of arched over flat surfaces, and of reducing gliding flight to regular practice. He made over 2000 glides safely, using gravity as his motive power, with concave, batlike wings, in some cases with superposed surfaces (fig. 49). It was with a machine of the latter type that he was upset by a sudden gust of wind and killed in 1896. Pilcher in England improved somewhat on Lilienthal’s apparatus, but used the same general method of restoring the balance, when endangered, by shifting the weight of the operator’s body. He too made several hundred glides in safety, but finally was thrown over by a gust of wind and killed in 1899. Chanute in America confined his endeavours to the production of automatic stability, and made the surfaces movable instead of the man. He used several different forms of apparatus, including one with five superposed pairs of wings and a tail (fig. 50) and another with two continuous aeroplanes, one above the other (fig. 51). He made over 1000 glides without accident.

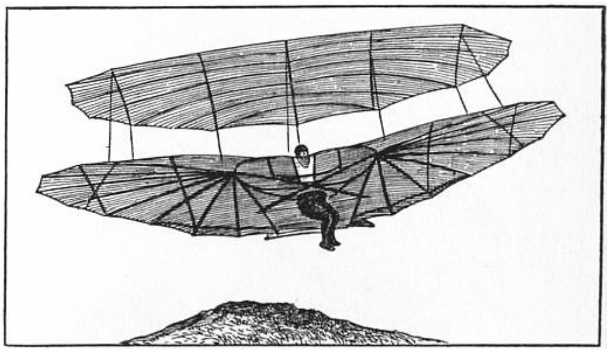


Fig. 49.—Lilienthal’s Gliding Machine.

Similar experiments were meanwhile conducted by Wilbur and Orville Wright of Dayton, Ohio, in whose hands the glider developed into a successful flying machine. These investigators began their work in 1900, and at an early stage introduced two characteristic features—a horizontal rudder in front for steering in the vertical plane, and the flexing or bending of the ends of the main supporting aeroplanes as a means of maintaining the structure in proper balance. Their 518
machines to begin with were merely gliders, the operator lying upon them in a horizontal, position, but in 1903 a petrol motor was added, and a flight lasting 59 seconds was performed. In 1905 they made forty-five flights, in the longest of which they remained in the air for half an hour and covered a distance of 24½ m. The utmost secrecy, however, was maintained concerning their experiments, and in consequence their achievements were regarded at the time with doubt and suspicion, and it was hardly realized that their success would reach the point later achieved.

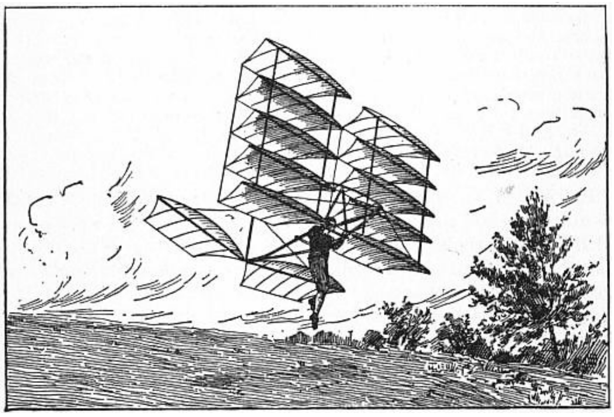


FIG. 50.—Chanute's Multiple Gliding Machine.

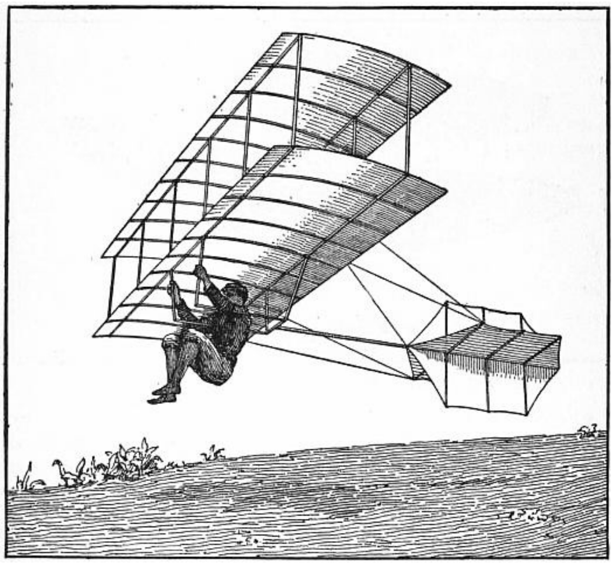


FIG. 51.—Chanute's Biplane Gliding Machine.

Thanks, however, to the efforts of automobile engineers, great improvements were now being effected in the petrol engine, and, although the certainty and trustworthiness of its action still left something to be desired, it provided the designers of flying machines with what they had long been looking for—a motor very powerful in proportion to its weight. Largely in consequence of this progress, and partly no doubt owing to the stimulus given by the activity of builders of dirigible balloons, the construction of motor-driven aeroplanes began to attract a number of workers, especially in France. In 1906 A. Santos Dumont, after a number of successful experiments with dirigible cigar-shaped gas balloons, completed an aeroplane flying machine. It consisted of the following parts:—(*a*) A system of aeroplanes arranged like the capital letter T at a certain upward angle to the horizon and bearing a general resemblance to box kites; (*b*) a pair of very light propellers driven at a high speed; and (*c*) an exceedingly light and powerful petrol engine. The driver occupied a position in the centre of the arrangement, which is shown in fig. 52. The machine was furnished with two wheels and vertical supports which depended from the anterior parts of the aeroplanes and supported it when it touched the ground on either side. With this apparatus he traversed on the 12th of November 1906 a distance of 220 metres in 21 seconds.

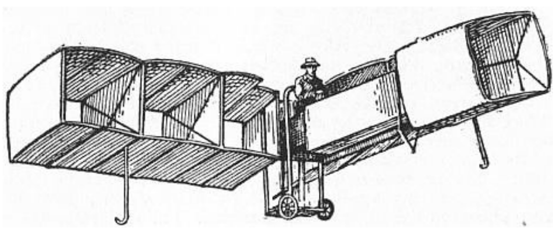


FIG. 52.—Santos Dumont's Flying Machine.

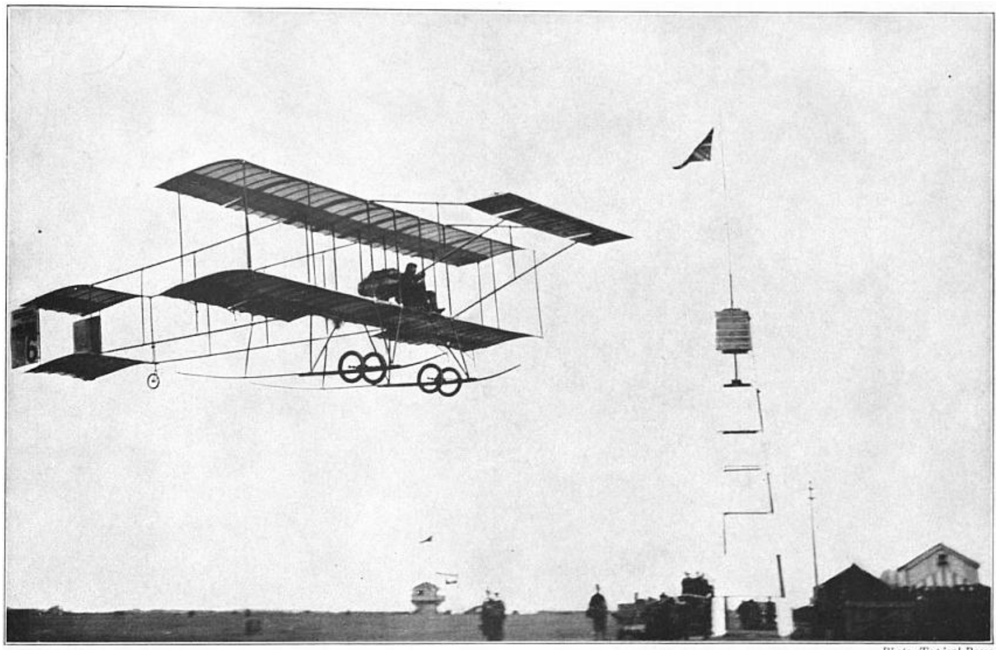
About a year later Henry Farman made several short flights on a machine of the biplane type, consisting of two main supporting surfaces one above the other, with a box-shaped vertical rudder behind and two small balancing aeroplanes in front. The engine was an eight-cylinder Antoinette petrol motor, developing 49 horse-power at 1100 revolutions a minute, and driving directly a single metal screw propeller. On the 27th of October 1906 he flew a distance of nearly half a mile at Issy-les-Molineaux, and on the 13th of January 1908 he made a circular flight of one kilometre, thereby winning the Deutsch-Archdeacon prize of £2000. In March he remained in the air for 3½ minutes, covering a distance of 1¼ m.; but in the following month a rival, Leon Delagrange, using a machine of the same type and constructed by the same makers, Messrs Voisin, surpassed this performance by flying nearly 2½ m. in 6½ minutes. In July Farman remained in the air for over 20 minutes; on the 6th of September Delagrange increased the time to nearly 30 minutes, and on the 29th of the same month Farman again came in front with a flight lasting 42 minutes and extending over nearly 24½ m.

But the best results were obtained by the Wright brothers—Orville Wright in America and Wilbur Wright in France. On the 9th of September 1908 the former, at Fort Myer, Virginia, made three notable flights; in the first he remained in the air 57½ minutes and in the second 1 hour 3 minutes, while in the third he took with him a passenger and covered nearly 4 m. in 6 minutes. Three days later he made a flight of 45 m. in 1 hour 14⅓ minutes, but on the 17th he had an accident, explained as being due to one of his propellers coming into contact with a stay, by which his machine was wrecked, he himself seriously injured, and Lieutenant Selfridge, who was with him, killed. Four days afterwards Wilbur Wright at Le Mans in France beat all previous records with a flight lasting 1 hour 31 minutes 25⅘ seconds, in which he covered about

56 m.; and subsequently, on the 11th of October, he made a flight of 1 hour 9 minutes accompanied by a passenger. On the 31st of December he succeeded in remaining in the air for 2 hours 20 minutes 23 seconds.

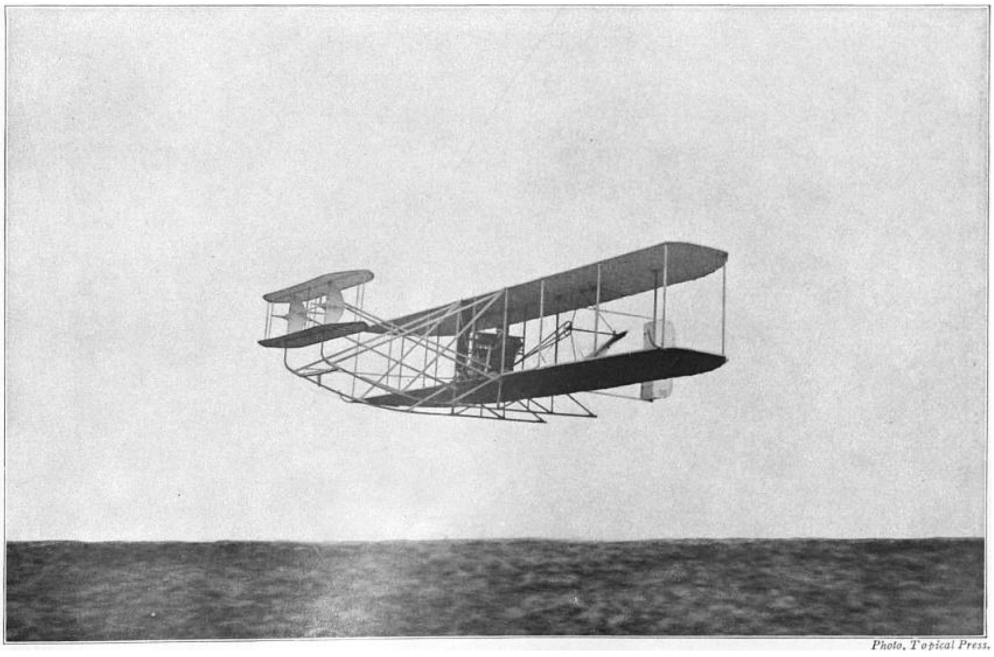
Wilbur Wright’s machine (fig. 53), that used by his brother being essentially the same, consisted of two slightly arched supporting surfaces, each 12½ metres long, arranged parallel one above the other at a distance of 1⅘ metres apart. As they were each about 2 metres wide their total area was about 50 sq. metres. About 3 metres in front of them was arranged a pair of smaller horizontal aeroplanes, shaped like a long narrow ellipse, which formed the rudder that effected changes of elevation, the driver being able by means of a lever to incline them up or down according as he desired to ascend or descend. The rudder for lateral steering was placed about 2½ metres behind the main surfaces and was formed of two vertical pivoted aeroplanes. The lever by which they were turned was connected with the device by which the ends of the main aeroplanes could be flexed simultaneously though in opposite directions; *i.e.* if the ends of the aeroplanes on one side were bent downwards, those on the other were bent upwards. By the aid of this arrangement the natural cant of the machine when making a turn could be checked, if it became excessive. The four-cylinder petrol engine was placed on the lower aeroplane a little to the right of the central line, being counterbalanced by the driver (and passenger if one was carried), who sat a little to the left of the same line. Making about 1200 revolutions a minute, it developed about 24 horse-power, and was connected by chain gearing to two wooden propellers, 2½ metres in diameter and 3½ metres apart, the speed of which was about 450 revolutions a minute. The whole machine, with aeronaut, weighed about 1100 ℔, the weight of the motor being reputed to be 200 ℔ 519

Plate I.



Photo, Topical Press.

Fig. 1.—PAULHAN FLYING ON FARMAN BIPLANE.



Photo, Topical Press.

Fig. 2.—WRIGHT BIPLANE.

Plate II.

Fig. 3.—BLERIOT MONOPLANE.

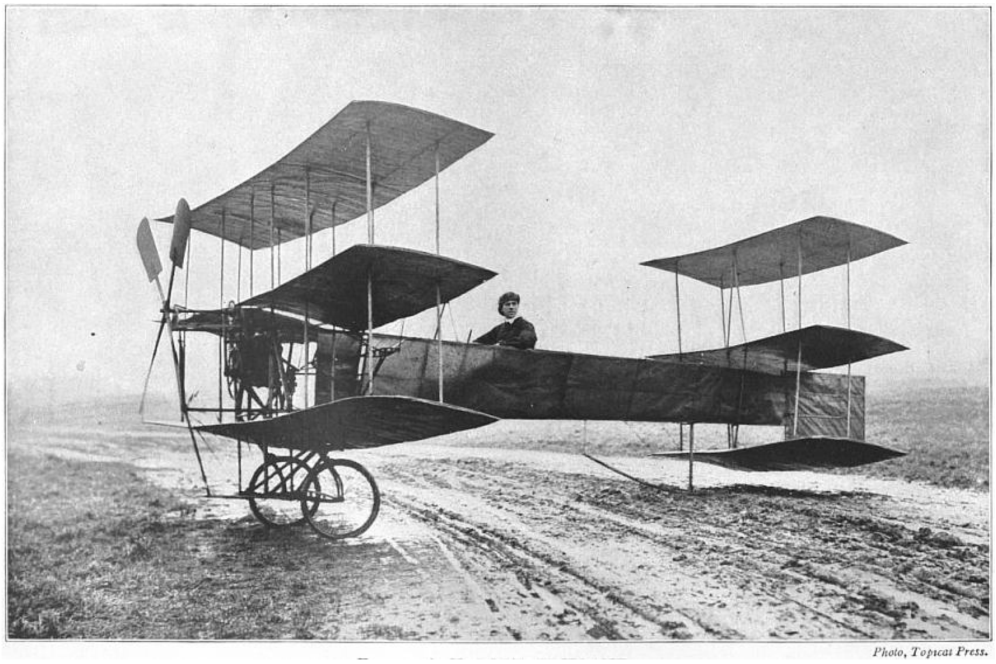


Fig. 4.—A.V. ROE’S TRIPLANE.

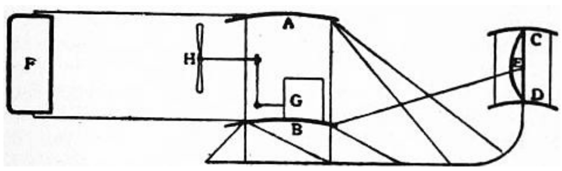


Fig. 53.—Wright Flying Machine; diagrammatic sketch.

A, B, Main supporting surfaces.
C, D, Aeroplanes of horizontal rudder with fixed semilunar fin E.
F, Vertical rudder.
G, Motor.
H, Screws.

A feature of the year 1909 was the success obtained with monoplanes having only a single supporting surface, and it was on a machine of this type that the Frenchman Blériot on July 25th flew across the English Channel from Calais to Dover in 31 minutes. Hubert Latham all but performed the same feat on an Antoinette monoplane. The year saw considerable increases in the periods for which aviators were able to remain in the air, and Roger Sommer’s flight of nearly 2½ hours on August 7th was surpassed by Henry Farman on November 3rd, when he covered a distance estimated at 137¼ m. in 4 hr. 17 min. 53 sec. In both these cases biplanes were employed. Successful aviation meetings were held, among other places, at Reims, Juvisy, Doncaster and Blackpool; and at Blackpool a daring flight was made in a wind of 40 m. an hour by Latham. This aviator also proved the possibility of flying at considerable altitudes by attaining on December 1st a height of over 1500 ft., but this record was far surpassed in the following January by L. Paulhan, who on a biplane rose to a height of 1383 yds. at Los Angeles. In the course of the year three aviators were killed—Lefèvbre and Ferber in September and Fernandez in December; and four men perished in September by the destruction of the French airship “République,” the gas-bag of which was ripped open by a broken propeller. In January 1910 Delagrange was killed by the fracture of one of the wings of a monoplane on which he was flying. On April 27th-28th, 1910, Paulhan successfully flew from London to Manchester, with only one stop, within 24 hours, for the *Daily Mail’s* £10,000 prize.

The progress made by all these experiments at aviation had naturally created widespread interest, both as a matter of sport and also as indicating a new departure in the possibilities of machines of war. And in 1909 the British government appointed a scientific committee, with Lord Rayleigh as chairman, as a consultative body for furthering the development of the science in England.

The table below gives some details, approximately correct, of the principal experiments made with flying machines up to 1908.

Year.	Experimenter.	Tip to Tip.	Surface.	Weight.	Pounds per sq. ft.	Speed per hour.	Maximum Flight.	Motor.	Horse-power.	Pounds sustained per h.p.
		Ft.	Sq. ft.	℔		Mls.	Ft.			
1879	Tatin	6.2	7.5	3.85	0.51	18	100?	Compressed air	0.03	110?
1885 1889	Hargrave (No. 16)	5.5	26.0	5.00	0.19	10	343	”	0.06	79
1893	Phillips	22.0	136.0	402.00	3.00	28	500?	Steam	5.6	72?
1894	Maxim*	50.0	4000.0	8000.00	2.5	36	300?	”	363.00	28
1896	Langley	12.0	70.0	30.00	0.43	24	4,000	”	1.00	30
1897	Tatin and Richet	21.0	86.0	72.00	0.83	40	460	”	1.33	55
1897	Ader*	49.0	270.0	1100.00	4.00	50?	100?	”	40.00	27
1895	Lilienthal*	23.0	151.0	220.00	1.46	23	1,200	Gravity	2.00	110
1896	Pilcher*	23.0	170.0	200.00	1.17	25	900	”	2.00	100
1896	Chanute*	16.0	135.0	178.00	1.31	22	360	”	2.00	89
1906	S. Dumont*	39	560	550	0.98	22.26	2,900	Petrol	50	23
1908	W. Wright*	41	650	1100	1.7	37	295,000	Petrol	24	46

* The apparatus marked thus * carried a man or men.

References.—Some of the books mentioned under Aeronautics contain details of flying machines; see H.W.L. Moedebeck, *A Pocketbook of Aeronautics*, trans. by W. Mansergh Varley (London, 1907); Sir Hiram S. Maxim, *Artificial and Natural Flight* (London, 1908); F.W. Lanchester, *Aerodynamics* and *Aerodonetics* (London, 1907 and 1908); C.C. Turner, *Aerial Navigation of To-day* (London, 1909); also two papers on “Aerial Navigation” read by Colonel G.O. Fullerton before the Royal United Service Institution in 1892 and 1906; papers read by Major B.F.S. Baden-Powell and E.S. Bruce before the Society of Arts, London, in April 1907 and December 1908 respectively; Cantor Lectures by F.W. Lanchester (Society of Arts, 1909); and the *Proceedings* of the Aeronautical Society (founded 1865), &c.

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1 According to Dr Crisp, the swallow, martin, snipe and many birds of passage have no air in their bones.—*Proc. Zool. Soc. Lond.* part xxv., 1857, p. 13.

2 By the term aeroplane is meant a thin, light, expanded structure inclined at a slight upward angle to the horizon intended to float or rest upon the air, and calculated to afford a certain amount of support to any body attached to it.

3 “On the Various Modes of Flight in relation to Aeronautics,” by J. Bell Pettigrew, *Proc. Roy. Inst.*, 1867; “On the Mechanical Appliances by which Flight is attained in the Animal Kingdom,” by the same author, *Trans. Linn. Soc.*, 1867.

4 *Revue des cours scientifiques de la France et de l’Étranger*, 1869.

5 The sphygmograph, as its name indicates, is a recording instrument. It consists of a smoked cylinder revolving by means of clock-work at a known speed, and a style or pen which inscribes its surface by scratching or brushing away the lampblack. The movements to be registered are transferred to the style or pen by one or more levers, and the pen in turn transfers them to the cylinder, where they appear as legible tracings. In registering the movements of the wings the tips and margins of the pinions were, by an ingenious modification, employed as the styles or pens. By this arrangement the different parts of the wings were made actually to record their own movements. As will be seen from this account, the figure-of-8 or wave theory of stationary and progressive flight has been made the subject of a rigorous *experimentum crucis*.

6 This continuity of the down into the up stroke and the converse is greatly facilitated by the elastic ligaments at the root and in the substance of the wing. These assist in elevating, and, when necessary, in flexing and elevating it. They counteract in some measure what may be regarded as the dead weight of the wing, and are especially useful in giving it continuous play.

7 “The importance of the twisted configuration or screw-like form cannot be over-estimated. That this shape is intimately associated with flight is apparent from the fact that the rowing feathers of the wing of the bird are every one of them distinctly spiral in their nature; in fact, one entire rowing feather is equivalent—morphologically and physiologically—to one entire insect wing. In the wing of the martin, where the bones of the pinion are short, and in some respects rudimentary, the primary and secondary feathers are greatly developed, and banked up in such a manner that the wing as a whole presents the same curves as those displayed by the insect’s wing, or by the wing of the eagle, where the bones, muscles and feathers have attained a maximum development. The conformation of the wing is such that it presents a waved appearance in every direction—the waves running longitudinally, transversely and obliquely. The greater portion of the wing may consequently be removed without essentially altering either its form or its functions. This is proved by making sections in various directions, and by finding that in some instances as much as two-thirds of the wing may be lopped off without materially impairing the power of flight.”—*Trans. Roy. Soc. Edin.* vol. xxvi. pp. 325, 326.

8 “On the Various Modes of Flight in relation to Aeronautics,” *Proc. Roy. Inst.*, 1867; “On the Mechanical Appliances by which Flight is attained in the Animal Kingdom,” *Trans. Linn. Soc.*, 1867, 26.

9 “On the Physiology of Wings; being an analysis of the movements by which flight is produced in the Insect, Bat and Bird,” *Trans. Roy. Soc. Edin.* vol. 26.

10 The other forces which assist in elevating the wings are—(*a*) the elevator muscles of the wings, (*b*) the elastic properties of the wings, and (*c*) the reaction of the compressed air on the under surfaces of the wings.

11 The wings of the albatross, when fully extended, measure across the back some 14 ft. They are exceedingly narrow, being sometimes under a foot in width.

12 *On the Flight of Birds, of Bats and of Insects, in reference to the subject of Aerial Locomotion,* by L. de Lucy (Paris).

13 E.J. Marey, *Revue des cours scientifiques de la France et de l’étranger* (1869).

14 “The Aero-bi-plane, or First Steps to Flight,” *Ninth Annual Report of the Aeronautical Society of Great Britain*, 1874.

15 “Resistance to Falling Planes on a Path of Translation,” *Ninth Annual Report of the Aeronautical Society of Great Britain*, 1874.

16 The *Aeronaut* for January 1872 and February 1875.

17 Cayley’s screws, as explained, were made of feathers, and consequently elastic. As, however, no allusion is made in his writings to the superior advantages possessed by elastic over rigid screws, it is to be presumed that feathers were employed simply for convenience and lightness. Pettigrew, there is reason to believe, was the first to advocate the employment of elastic screws for aerial purposes.

18 Stringfellow constructed a second model, which is described and figured further on (fig. 44).

19 “On Aerial Locomotion,” *Aeronautical Society’s Report* for 1867.

FLINCK, GOVERT (1615-1660), Dutch painter, born at Cleves in 1615, was apprenticed by his father to a silk mercer, but having secretly acquired a passion for drawing, was sent to Leuwarden, where he boarded in the house of Lambert Jacobszon, a Mennonite, better known as an itinerant preacher than as a painter. Here Flinck was joined by Jacob Backer, and the companionship of a youth determined like himself to be an artist only confirmed his passion for painting. Amongst the neighbours of Jacobszon at Leuwarden were the sons and relations of Rombert Ulenburg, whose daughter Saske married Rembrandt in 1634. Other members of the same family lived at Amsterdam, cultivating the arts either professionally or as amateurs. The pupils of Lambert probably gained some knowledge of Rembrandt by intercourse with the Ulenburgs. Certainly J. von Sandrart, who visited Holland in 1637, found Flinck acknowledged as one of Rembrandt's best pupils, and living habitually in the house of the dealer Hendrik Ulenburg at Amsterdam. For many years Flinck laboured on the lines of Rembrandt, following that master's style in all the works which he executed between 1636 and 1648; then he fell into peculiar mannerisms by imitating the swelling forms and grand action of Rubens's creations. Finally he sailed with unfortunate complacency into the Dead Sea of official and diplomatic painting. Flinck's relations with Cleves became in time very important. He was introduced to the court of the Great Elector, Frederick William of Brandenburg, who married in 1646 Louisa of Orange. He obtained the patronage of John Maurice of Orange, who was made stadtholder of Cleves in 1649. In 1652 a citizen of Amsterdam, Flinck married in 1656 an heiress, daughter of Ver Hoeven, a director of the Dutch East India Company. He was already well known even then in the patrician circles over which the burgomasters De Graef and the Echevin Six presided; he was on terms of intimacy with the poet Vondel and the treasurer Uitenbogaard. In his house, adorned with antique casts, costumes, and a noble collection of prints, he often 520
received the stadtholder John Maurice, whose portrait is still preserved in the work of the learned Barleius.

The earliest of Flinck's authentic pieces is a likeness of a lady, dated 1636, in the gallery of Brunswick. His first subject picture is the "Blessing of Jacob," in the Amsterdam museum (1638). Both are thoroughly Rembrandtesque in effect as well as in vigour of touch and warmth of flesh tints. The four "civic guards" of 1642, and "the twelve musketeers" with their president in an arm-chair (1648), in the town-hall at Amsterdam, are fine specimens of composed portrait groups. But the best of Flinck's productions in this style is the peace of Münster in the museum of Amsterdam, a canvas with 19 life-size figures full of animation in the faces, "radiant with Rembrandtesque colour," and admirably distributed. Flinck here painted his own likeness to the left in a doorway. The mannered period of Flinck is amply illustrated in the "Marcus Curius eating Turnips before the Samnite Envoys," and "Solomon receiving Wisdom," in the palace on the Dam at Amsterdam. Here it is that Flinck shows most defects, being faulty in arrangement, gaudy in tint, flat and shallow in execution, and partial to whitened flesh that looks as if it had been smeared with violet powder and rouge. The chronology of Flinck's works, so far as they are seen in public galleries, comprises, in addition to the foregoing, the "Grey Beard" of 1639 at Dresden, the "Girl" of 1641 at the Louvre, a portrait group of a male and female (1646) at Rotterdam, a lady (1651) at Berlin. In November 1659 the burgomaster of Amsterdam contracted with Flinck for 12 canvases to represent four heroic figures of David and Samson and Marcus Curius and Horatius Cocles, and scenes from the wars of the Batavians and Romans. Flinck was unable to finish more than the sketches. In the same year he received a flattering acknowledgment from the town council of Cleves on the completion of a picture of Solomon which was a counterpart of the composition at Amsterdam. This and other pictures and portraits, such as the likenesses of Frederick William of Brandenburg and John Maurice of Nassau, and the allegory of "Louisa of Orange attended by Victory and Fame" and other figures at the cradle of the first-born son of the elector, have disappeared. Of several pictures which were painted for the Great Elector, none are preserved except the "Expulsion of Hagar" in the Berlin museum. Flinck died at Amsterdam on the 22nd of February 1660.

FLINDERS, MATTHEW (1774-1814), English navigator, explorer, and man of science, was born at Donington, near Boston, in Lincolnshire, on the 16th of March 1774. Matthew was at first designed to follow his father's profession of surgeon, but his enthusiasm in favour of a life of adventure impelled him to enter the royal navy, which he did on the 23rd of October 1789. After a voyage to the Friendly Islands and West Indies, and after serving in the "Bellerophon" during Lord Howe's "glorious first of June" (1794) off Ushant, Flinders went out in 1795 as midshipman in the "Reliance" to New South Wales. For the next few years he devoted himself to the task of accurately laying down the outline and bearings of the Australian coast, and he did his work so thoroughly that he left comparatively little for his successors to do. With his friend George Bass, the surgeon of the "Reliance," in the year of his arrival he explored George's river; and, after a voyage to Norfolk Island, again in March 1796 the two friends in the same boat, the "Tom Thumb," only 8 ft. long, and with only a boy to help them, explored a stretch of coast to the south of Port Jackson. After a voyage to the Cape of Good Hope, when he was promoted to a lieutenancy, Flinders was engaged during February 1798 in a survey of the Furneaux Islands, lying to the north of Tasmania. His delight was great when, in September of the same year, he was commissioned along with Bass, who had already explored the sea between Tasmania and the south coast to some extent and inferred that it was a strait, to proceed in the sloop "Norfolk" (25 tons) to prove conclusively that Van Diemen's Land was an island by circumnavigating it. In the same sloop, in the summer of next year, Flinders made an exploration to the north of Port Jackson, the object being mainly to survey Glasshouse Bay (Moreton Bay) and Hervey's Bay. Returning to England he was appointed to the command of an expedition for the thorough exploration of the coasts of Terra Australis, as the southern continent was still called, though Flinders is said to have been the first to suggest for it the name Australia. On the 18th of July 1801 the sloop "Investigator" (334 tons), in which the expedition sailed, left Spithead, Flinders being furnished with instructions and with a passport from the French government to all their officials in the Eastern seas. Among the scientific staff was Robert Brown, one of the most eminent English botanists; and among the midshipmen was Flinders's relative, John Franklin, of Arctic fame. Cape Leeuwin, on the south-west coast of Australia, was reached on November 6, and King George's sound on the 9th of December. Flinders sailed round the Great Bight, examining the islands and indentations on the east side, noting the nature of the country, the people, products, &c., and paying special attention to the subject of the variation of the compass. Spenser and St Vincent Gulfs were discovered and explored. On the 8th of April 1802, shortly after leaving Kangaroo Islands, at the mouth of St Vincent Gulf, Flinders fell in with the French exploring ship, "Le Géographe," under Captain Nicolas Baudin, in the bay now known as Encounter Bay. In the narrative of the French expedition published in 1807 (when Flinders was a prisoner in the Mauritius) by M. Peron, the naturalist to the expedition, much of the land west of the point of meeting was claimed as having been discovered by Baudin, and French names were extensively substituted for the English ones given by Flinders. It was only in 1814, when Flinders published his own narrative, that the real state of the case was fully exposed. Flinders continued his examination of the coast along Bass's Strait, carefully surveying Port Phillip. Port Jackson was reached on the 9th of May 1802.

After staying at Port Jackson for about a couple of months, Flinders set out again on the 22nd of July to complete his circumnavigation of Australia. The Great Barrier Reef was examined with the greatest care in several places. The north-east entrance of the Gulf of Carpentaria was reached early in November; and the next three months were spent in an examination of the shores of the gulf, and of the islands that skirt them. An inspection of the “Investigator” showed that she was in so leaky a condition that only with the greatest precaution could the voyage be completed in her. Flinders completed the survey of the Gulf of Carpentaria, and after touching at the island of Timor, the “Investigator” sailed round the west and south of Australia, and Port Jackson was reached on the 9th of June 1803. Much suffering was endured by nearly all the members of the expedition: a considerable proportion of the men succumbed to disease, and their leader was so reduced by scurvy that his health was greatly impaired.

Flinders determined to proceed home in H.M.S. “Porpoise” as a passenger, submit the results of his work to the Admiralty, and obtain, if possible, another vessel to complete his exploration of the Australian coast. The “Porpoise” left Port Jackson on the 10th of August, accompanied by the H.E.I.C.’s ship “Bridgewater” (750 tons) and the “Cato” (450 tons) of London. On the night of the 17th the “Porpoise” and “Cato” suddenly struck on a coral reef and were rapidly reduced to wrecks. The officers and men encamped on a small sandbank near, 3 or 4 ft. above high-water, a considerable quantity of provisions, with many of the papers and charts, having been saved from the wrecks. The reef was in about 22° 11′ S. and 155° E., and about 800 m. from Port Jackson. Flinders returned to Port Jackson in a six-oared cutter in order to obtain a vessel to rescue the party. The reef was again reached on the 8th of October, and all the officers and men having been satisfactorily disposed of, Flinders on the 11th left for Jones Strait in an unsound schooner of 29 tons, the “Cumberland,” with ten companions, and a valuable collection of papers, charts, geological specimens, &c. On the 15th of December he put in at Mauritius, when he discovered that France and England were at war. The passport he possessed from the French government was for the “Investigator”; still, though he was now on board another ship, his mission was 521 essentially the same, and the work he was on was simply a continuation of that commenced in the unfortunate vessel. Nevertheless, on her arrival at Port Louis the “Cumberland” was seized by order of the governor-general de Caen. Flinders’s papers were taken possession of, and he found himself virtually a prisoner. We need not dwell on the sad details of this unjustifiable captivity, which lasted to June 1810. But there can be no doubt that the hardships and inactivity Flinders was compelled to endure for upwards of six years told seriously on his health, and brought his life to a premature end. He reached England in October 1810, after an absence of upwards of nine years. The official red-tapeism of the day barred all promotion to the unfortunate explorer, who set himself to prepare an account of his explorations, though unfortunately an important part of his record had been retained by de Caen. The results of his labours were published in two large quarto volumes, entitled *A Voyage to Terra Australis*, with a folio volume of maps. The very day (July 19, 1814) on which his work was published Flinders died, at the early age of forty. The great work is a model of its kind, containing as it does not only a narrative of his own and of previous voyages, but masterly statements of the scientific results, especially with regard to magnetism, meteorology, hydrography and navigation. Flinders paid great attention to the errors of the compass, especially to those caused by the presence of iron in ships. He is understood to have been the first to discover the source of such errors (which had scarcely been noticed before), and after investigating the laws of the variations, he suggested counter-attractions, an invention for which Professor Barlow got much credit many years afterwards. Numerous experiments on ships’ magnetism were conducted at Portsmouth by Flinders, by order of the admiralty, in 1812. Besides the *Voyage*, Flinders wrote *Observations on the Coast of Van Diemen’s Land*, *Bass’s Strait*, &c., and two papers in the *Phil. Trans.*—one on the “Magnetic Needle” (1805), and the other, “Observations on the Marine Barometer” (1806).

(J. S. K.)

FLINSBERG, a village and watering-place of Germany, in the Prussian province of Silesia, on the Queis, at the foot of the Iserkamm, 1450 ft. above the sea, 5 m. W. of Friedeberg, the terminus station of the railway from Greiffenberg. Pop. (1900) 1957. It contains an Evangelical and a Roman Catholic church, and has some manufactures of wooden wares. Flinsberg is celebrated for its chalybeate waters, specific in cases of feminine disorders, and used both for bathing and drinking. It is also a climatic health resort of some reputation, and the visitors number about 8500 annually.

See Adam, *Bad Flinsberg als klimatischer Kurort* (Görlitz, 1891).

FLINT, AUSTIN (1812-1886), American physician, was born at Petersham, Massachusetts, on the 20th of October 1812, and graduated at the medical department of Harvard University in 1833. From 1847 to 1852 he was professor of the theory and practice of medicine in Buffalo Medical College, of which he was one of the founders, and from 1852 to 1856 he filled the same chair in the university of Louisville. From 1861 to 1886 he was professor of the principles and practice of medicine and clinical medicine in Bellevue Hospital Medical College, New York. He wrote many text-books on medical subjects, among these being *Diseases of the Heart* (1859-1870); *Principles and Practice of Medicine* (1866); *Clinical Medicine* (1879); and *Physical Exploration of the Lungs by means of Auscultation and Percussion* (1882). He died in New York on the 13th of March 1886.

His son, Austin Flint, junr., who was born at Northampton, Massachusetts, on the 28th of March 1836, after studying at Harvard and at the university of Louisville, graduated at the Jefferson Medical College, Philadelphia, in 1857. He then became professor of physiology at the university of Buffalo (1858) and subsequently at other centres, his last connexion being with the Cornell University Medical College (1898-1906). He was better known as a teacher and writer on physiology than as a practitioner, and his *Text-book of Human Physiology* (1876) was for many years a standard book in American medical colleges. He also published an extensive *Physiology of Man* (5 vols., 1866-1874), *Chemical Examination of the Urine in Disease* (1870), *Effects of Severe and Protracted Muscular Exercise* (1871), *Source of Muscular Power* (1878), and *Handbook of Physiology* (1905). In 1896 he became a consulting physician to the New York State Hospital for the Insane.

FLINT, ROBERT (1838-   ), Scottish divine and philosopher, was born near Dumfries and educated at the university of Glasgow. After a few years of pastoral service, first in Aberdeen and then at Kilconquhar, Fife, he was appointed professor of moral philosophy and political economy at St Andrews in 1864. From 1876 to 1903 he was professor of divinity at Edinburgh. He contributed a number of articles to the 9th edition of the *Encyclopaedia Britannica*. His chief works are *Christ’s Kingdom upon Earth* (Sermons, 1865); *Philosophy of History in Europe* (1874; partly rewritten with reference to France and Switzerland, 1894); *Theism* and *Anti-theistic Theories* (2 vols., being the Baird Lectures for 1876-1877; often reprinted); *Socialism* (1894); *Sermons and Addresses* (1899); *Agnosticism* (1903).

FLINT, TIMOTHY (1780-1840), American clergyman and writer, was born in Reading, Massachusetts, on the 11th of July 1780. He graduated at Harvard in 1800, and in 1802 settled as a Congregational minister in Lunenburg, Mass., where he pursued scientific studies with interest; and his labours in his chemical laboratory seemed so strange to the people of that retired region, that some persons supposed and asserted that he was engaged in counterfeiting. This, together with political differences, led to disagreeable complications, which resulted in his resigning his charge (1814) and becoming a missionary (1815) in the valley of the Mississippi. He was also for a short period a teacher and a farmer. His observations on the manners and character of the settlers of the Ohio and Mississippi valleys were recorded in a picturesque work called *Recollections of the Last Ten Years passed in the Valley of the Mississippi* (1826; reprinted in England and translated into French), the first account of the western states which brought to light the real life and character of the people. The success which this work met with, together with the failing health of the writer, led him to relinquish his more active labours for literary pursuits, and, besides editing the *Western Review* in Cincinnati from 1825 to 1828 and *Knickerbocker’s Magazine* (New York) in 1833, he published a number of books, including *Francis Berrian, or the Mexican Patriot* (1826), his best novel; *A Condensed Geography and History of the Western States, or the Mississippi Valley* (2 vols., 1828); *Arthur Clenning* (1828), a novel; and *Indian Wars in the West* (1833). His style is vivid, plain and forcible, and his matter interesting; and his works on the western states are of great value. He died in Salem, Mass., on the 16th of August 1840.

FLINT, a city and the county-seat of Genesee county, Michigan, U.S.A., on Flint river, 68 m. (by rail) N.W. of Detroit. Pop. (1890) 9803; (1900) 13,103, of whom 2165 were foreign-born; (1910, census) 38,550. It is served by the Grand Trunk and the Père Marquette railways, and by an electric line, the Detroit United railway, connecting with Detroit. The city has a fine court-house (1904), a federal building (1908), a city hall (1908) and a public library. The Michigan school for the deaf, established in 1854, and the Oak Grove hospital (private) for the treatment of mental and nervous diseases, are here. Flint has important manufacturing interests, its chief manufactures being automobiles, wagons, carriages—Flint is called “the vehicle city,”—flour, woollen goods, iron goods, cigars, beer, and bricks and tiles; and its grain trade is of considerable importance. In 1904 the total value of the city’s factory product was $6,177,170, an increase of 31.1% over that of 1900. The settlement of the place, then called the Grand Traverse of the Flint, began in 1820, but Flint’s growth was very slow until 1831, when it was platted as a village; it was chartered as a city in 1855.

FLINT, or Flintshire (*sîr Gallestr*), a county of North Wales, the smallest in the country, bounded N. by the Irish Sea and the Dee estuary, N.E. by the Dee, E. by Cheshire, and S.W. by Denbighshire. Area, 257 sq. m. Included in Flint is the detached hundred of Maelor, lying 8 m. S.E. of the main part of the county, and shut in by Cheshire on the N. and N.E., by 522
Shropshire on the S., and by Denbighshire on the W. and N.W. The Clwyd valley is common to Flint and Denbigh. Those of the Alyn and Wepre (from Ewloe Castle to the Dee) are fine. The Dee, entering the county near Overton, divides Maelor from Denbigh on the W., passes Chester and bounds most of the county on the N. The Clwyd enters Flint near Bodfary, and joining the Elwy near Rhuddlan, reaches the Irish Sea near Rhyl. The Alyn enters the county under Moel Fammau, passes Cilcen and Mold (*y Wyddgrug*), runs underground near Hesb-Alyn (Alyn’s drying-up), bends south to Caergwrle, re-enters Denbighshire and joins the Dee. Llyn Helyg (willow-pool), near Whitford, is the chief lake.

Both for their influence upon the physical features and for their economic value the carboniferous rocks of Flintshire are the most important. From Prestatyn on the coast a band of carboniferous limestone passes close by Holywell and through Caerwen; it forms the Halkin Mountain east of Halkin, whence it continues past Mold to beyond the county boundary. The upper portion of this series is cherty in the north—the chert is quarried for use in the potteries of Staffordshire—but traced southward it passes into sandstones and grits; above these beds come the Holywell shales, possibly the equivalent of the Pendleside series of Lancashire and Derbyshire, while upon them lies the Gwespyr sandstone, which has been thought to correspond to the Gannister coal measures of Lancashire, but may be a representative of the Millstone Grit. Farther to the east, the coal measures, with valuable coals, some oil shale, and with fireclays and marls which are used for brick and tile-making, extend from Talacre through Flint, Northop, Hawarden and Broughton to Hope. The carboniferous rocks appear again through the intervention of a fault, in the neighbourhood of St Asaph. Silurian strata, mostly of Wenlock age, lie below the carboniferous limestone on the western border of the county. Triassic red beds of the Bunter fill the Clwyd valley and appear again on the coal measures S.E. of Chester. Lead and zinc ores have been worked in the lower carboniferous rocks in the north of the county, and caves in the same formation, at Caer Gwyn and Ffynnon Beuno, have yielded the remains of Pleistocene mammals along with palaeolithic implements. Much glacial drift obscures the older rocks on the east and north and in the vale of Clwyd. Short stretches of blown sand occur on the coast near Rhyl and Talacre.

The London & North-Western railway follows the coast-line. Other railways which cross the county are the Great Western, and the Wrexham, Mold & Connah’s Quay, acquired by the Great Central company. For pasture the vale of Clwyd is well known. Oats, turnips and swedes are the chief crops. Stock and dairy farming prospers, native cattle being crossed with Herefords and Downs, native sheep with Leicesters and Southdowns, while in the thick mining population a ready market is found for meat, cheese, butter, &c. The population (81,700 in 1901) nearly doubled in the 19th century, and Flintshire to-day is one of the most densely populated counties in North Wales. The area of the ancient county is 164,744 acres, and that of the administrative county 163,025 acres. The collieries begin at Llanasa, run through Whitford, Holywell, Flint, Halkin (Halcyn), Northop, Buckley, Mold and Hawarden (Penarlâg). At Halkin, Mold, Holywell, Prestatyn and Talacre lead is raised, and is sometimes sent to Bagillt, Flint or Chester to be smelted. Zinc, formerly only worked at Dyserth, has increased in output, and copper mines also exist, as at Talargoch, together with smelting works, oil, vitriol, potash and alkali manufactories. Potteries around Buckley send their produce chiefly to Connah’s Quay, whence a railway crosses the Dee to the Birkenhead (Cheshire) district. Iron seams are now thin, but limestone quarries yield building stone, lime for burning and small stone for chemical works. Fisheries are unproductive and textile manufactures small.

The county returns one member to parliament. The parliamentary borough district (returning one member), consists of Caergwrle, Caerwys, Flint, Holywell, Mold, Overton, St Asaph and Rhuddlan. In addition, there is a small part of the Chester parliamentary borough. There is one municipal borough, Flint (pop. 4625). The other urban districts are: Buckley (5780), Connah’s Quay (3369), Holywell (2652), Mold (4263), Prestatyn (1261) and Rhyl (8473). Flint is in the North Wales and Chester circuit, assizes being held at Mold. The Flint borough has a separate commission of the peace, but no separate court of quarter sessions. The ancient county, which is in the dioceses of Chester, Lichfield and St Asaph, contains forty-six entire ecclesiastical parishes and districts, with parts of eleven others.

Among sites of antiquarian or historical interest, besides the fragmentary ruin of Flint Castle, the following may be mentioned:—Caerwys, near Flint, still shows traces of Roman occupation. Bodfary (Bodfari) was traditionally occupied by the Romans. Moel y gaer (bald hill of the fortress), near Northop, is a remarkably perfect old British post. Maes y Garmon (perhaps for *Meusydd Garmon*, as *y*, the article, has no significance before a proper name, and so to be translated, battlefields of Germanus). A mile from Mold is the reputed scene of *une victoire sans larmes, gagnée non par les armes, mais par la foi* (E.H. Vollet). The Britons, says the legend, were threatened by the Picts and Saxons, at whose approach the *Alleluia* of that Easter (A.D. 430) was sung. Panic duly seized the invaders, but the victor, St Germanus, confessor and bishop of Auxerre (A.D. 380-448), had to return to the charge in 446. He has, under the name Garmon, a great titular share in British topography. At Bangor Iscoed, “the great high choir in Maelor,” was the monastery, destroyed with over 2000 monks, by Æthelfred of Northumberland in 607, as (by a curious coincidence) its namesake Bangor in Ireland was sacked by the Danes in the 9th century. Bede says (ii. 2) that Bangor monastery was in seven sections, with three hundred (working) monks. The supposed lines of direction of Watt’s and Offa’s dykes were: Basingwerk, Halkin, Hope, Alyn valley, Oswestry (*Croes Oswallt*, “Oswald’s cross”), for Watt’s, and Prestatyn, Mold, Minera, across the Severn (*Hafren*, or Sabrina) for Offa’s. Owain Gwynedd (Gwynedd or Venedocia, is North Wales) defeated Henry II. at Coed Ewloe (where is a tower) and at Coleshill (*Cynsyllt*). Near Pant Asa (*pant* is a bottom) is the medieval Maen Achwynfan (*achwyn*, to complain, *maen*, stone), and tumuli, menhirs (*meini hirion*) and inscribed stones are frequent throughout the county. There is a 14th-century cross in Newmarket churchyard. Caergwrle Castle seems early Roman, or even British; but most of the castles in the county date from the early Edwards.

See H. Taylor, *Flint* (London, 1883).

FLINT, a municipal borough and the county town of the above; a seaport and contributory parliamentary borough, on the south of the Dee estuary, 192 m. from London by the London & North-Western railway. Pop. (1901) 4265. The seat of great alkali manufactures, it imports chiefly sulphur and other chemicals, exporting coal, soda, potash, copper, &c. The county gaol here, as at Haverfordwest, occupied an angle of the castle, was removed to Mold, and is now Chester Castle (jointly with Cheshire.)

Flint Castle was built on a lonely rock by the riverside by Edward I. Here met Edward II. and Piers Gaveston. Edward III. bestowed its constableship upon the earls of Chester, and here Richard II. surrendered to Bolingbroke. It was twice taken, after siege, by the parliamentarians, and finally dismantled in 1647. There remain a square court (with angle towers), round tower and drawbridge, all three entrusted to a constable, appointed by the crown under the Municipal Corporations Reforms Act. Made a borough by Edward I., Flint was chartered by Edward III., and by Edward the Black Prince, as earl of Chester.

FLINT (a word common in Teutonic and Scandinavian languages, possibly cognate with the Gr. πλίνθος, a tile), in petrology, a dark grey or dark brown crypto-crystalline substance which has an almost vitreous lustre, and when pure appears structureless to the unaided eye. In the mass it is dark and opaque, but thin plates or the edges of splinters are pale yellow and translucent. Its hardness is greater than that of steel, so that a knife blade leaves a grey metallic streak when drawn across its surface. Its specific gravity is 2.6 or only a little less than that of crystalline quartz. It is brittle, and when hammered readily breaks up into a powder of angular grains. The fracture is perfectly conchoidal, so that blows with a hammer detach flakes which have convex, slightly undulating surfaces. At the point of impact a bulb of percussion, which is a somewhat elevated conical mark, is produced. This serves to distinguish flints which have been fashioned by 523
human agencies from those which have been split merely by the action of frost and the weather. The bulb is evidence of a direct blow, probably intentionally made, and is a point of some importance to archaeologists investigating Palaeolithic implements. With skill and experience a mass of flint can be worked to any simple shape by well directed strokes, and further trimming can be effected with pressure by a pointed stone in a direction slightly across the edge of the weapon. The purest flints have the most perfect conchoidal fracture, and prehistoric man is known to have quarried or mined certain bands of flint which were specially suitable for his purposes.

Silica forms nearly the whole substance of flint; calcite and dolomite may occur in it in small amounts, and analysis has also detected minute quantities of volatile ingredients, organic compounds, &c., to which the dark colour is ascribed by some authorities. These are dispelled by heat and the flint becomes white and duller in lustre. Microscopic sections show that flint is very finely crystalline and consists of quartz or chalcedonic silica; colloidal or amorphous silica may also be present but cannot form any considerable part of the rock. Spicules of sponges and fragments of other organisms, such as molluscs, polyzoa, foraminifera and brachiopods, often occur in flint, and may be partly or wholly silicified with retention of their original structure. Nodules of flint when removed from the chalk which encloses them have a white dull rough surface, and exposure to the weather produces much the same appearance on broken flints. At first they acquire a bright and very smooth surface, but this is subsequently replaced by a dull crust, resembling white or yellowish porcelain. It has been suggested that this change is due to the removal of the colloidal silica in solution, leaving behind the fibres and grains of more crystalline structure. This process must be a very slow one as, from its chemical composition, flint is a material of great durability. Its great hardness also enables it to resist attrition. Hence on beaches and in rivers, such as those of the south-east of England, flint pebbles exist in vast numbers. Their surfaces often show minute crescentic or rounded cracks which are the edges of small conchoidal fractures produced by the impact of one pebble on another during storms or floods.

Flint occurs primarily as concretions, veins and tabular masses in the white chalk of such localities as the south of

England (see Chalk). It is generally nodular, and forms rounded or highly irregular masses which may be several feet in diameter. Although the flint nodules often lie in bands which closely follow the bedding, they were not deposited simultaneously with the chalk; very often the flint bands cut across the beds of the limestone and may traverse them at right angles. Evidently the flint has accumulated along fissures, such as bedding planes, joints and other cracks, after the chalk had to some extent consolidated. The silica was derived from the tests of radiolaria and the spicular skeletons of sponges. It has passed into solution, filtered through the porous matrix, and has been again precipitated when the conditions were suitable. Its formation is consequently the result of "concretionary action." Where the flints lie the chalk must have been dissolved away; we have in fact a kind of metasomatic replacement in which a siliceous rock has slowly replaced a calcareous one. The process has been very gradual and the organisms of the original chalk often have their outlines preserved in the flint. Shells may become completely silicified, or may have their cavities occupied by flint with every detail of the interior of the shell preserved in the outer surface of the cast. Objects of this kind are familiar to all collectors of fossils in chalk districts.

Chert is a coarser and less perfectly homogeneous substance of the same nature and composition as flint. It is grey, black or brown, and commonly occurs in limestone (*e.g.* the Carboniferous Limestone) in the same way as flint occurs in chalk. Some cherts contain tests of radiolaria, and correspond fairly closely to the siliceous radiolarian oozes which are gathering at the present day at the bottom of some of the deepest parts of the oceans. Brownish cherts are found in the English Greensand; these often contain remains of sponges.

The principal uses to which flint has been put are the fabrication of weapons in Palaeolithic and Neolithic times. Other materials have been employed where flint was not available, *e.g.* obsidian, chert, chalcedony, agate and quartzite, but to prehistoric man (see Flint Implements below) flint must have been of great value and served many of the uses to which steel is put at the present day. Flint gravels are widely employed for dressing walks and roads, and for rough-cast work in architecture. For road-mending flint, though very hard, is not regarded with favour, as it is brittle and pulverizes readily; binds badly, yielding a surface which breaks up with heavy traffic and in bad weather; and its fine sharp-edged chips do much damage to tires of motors and cycles. Seasoned flints from the land, having been long exposed to the atmosphere, are preferred to flints freshly dug from the chalk pits. Formerly flint and steel were everywhere employed for striking a light; and gun flints were required for fire-arms. A special industry in the shaping of gun flints long existed at Brandon in Suffolk. In 1870 about thirty men were employed. Since then the trade has become almost extinct as gun flints are in demand only in semi-savage countries where modern fire-arms are not obtainable. Powdered flint was formerly used in the manufacture of glass, and is still one of the ingredients of many of the finer varieties of pottery.

(J. S. F.)

FLINT IMPLEMENTS AND WEAPONS. The excavation of these remains of the prehistoric races of the globe in river-drift gravel-beds has marked a revolution in the study of Man's history (see Archaeology). Until almost the middle of the 19th century no suspicion had arisen in the minds of British and European archaeologists that the momentous results of the excavations then proceeding in Egypt and Assyria would be dwarfed by discoveries at home which revolutionized all previous ideas of Man's antiquity. It was in 1841 that Boucher de Perthes observed in some sand containing mammalian remains, at Menchecourt near Abbeville, a flint, roughly worked into a cutting implement. This "find" was rapidly followed by others, and Boucher de Perthes published his first work on the subject, *Antiquités celtiques et antédiluviennes: mémoire sur l'industrie primitive et les arts à leur origin* (1847), in which he proclaimed his discovery of human weapons in beds unmistakably belonging to the age of the Drift. It was not until 1859 that the French archaeologist convinced the scientific world. An English mission then visited his collection and testified to the great importance of his discoveries. The "finds" at Abbeville were followed by others in many places in England, and in fact in every country where siliceous stones which are capable of being flaked and fashioned into implements are to be found. The implements occurred in beds of rivers and lakes, in the tumuli and ancient burial-mounds; on the sites of settlements of prehistoric man in nearly every land, such as the shell-heaps and lake-dwellings; but especially embedded in the high-level gravels of England and France which have been deposited by river-floods and long left high and dry above the present course of the stream. These gravels represent the Drift or Palaeolithic period when man shared Europe with the mammoth and woolly-haired rhinoceros. The worked flints of this age are, however, unevenly distributed; for while the river-gravels of south-eastern England yield them abundantly, none has been found in Scotland or the northern English counties. On the continent the same partial distribution is observable: while they occur plentifully in the north-western area of France, they are not discovered in Sweden, Norway or Denmark. The association of these flints, fashioned for use by chipping only, with the bones of animals either extinct or no longer indigenous, has justified their reference to the earlier period of the Stone Age, generally called Palaeolithic. Those flint implements, which show signs of polishing and in many cases remarkably fine workmanship, and are found in tumuli, peat-bogs and lake-dwellings mixed with the bones of common domestic animals, are assigned to the Neolithic or later Stone Age. The Palaeolithic flints are hammers, flakes, scrapers, implements worked to a cutting edge at one side, implements which resemble rude axes, flat ovoid implements worked to an edge all round, and a great quantity of spear and arrow heads. None of these is ground or polished. The Neolithic flints, on the other hand, exhibit more variety of design, are carefully finished, and the particular use of each weapon can be easily detected. Man has reached the stage of culture when he could socket a stone into a wooden handle, and fix a flaked flint as a handled dagger or knife. The workmanship is superior to that shown in any of the stone utensils made by savage tribes of historic times. The manner of making flint implements appears to have been in all ages much the same. Flint from its mode of fracture is the only kind of stone which can be chipped or flaked into almost any shape, and thus forms the principal material of these earliest weapons. The blows must be carefully aimed or the flakes dislodged will be shattered: a gun-flint maker at Brandon, Suffolk, stated that it took him two years to acquire the art. 524

For accounts of the gun-flint manufacture at Brandon, and detailed descriptions of ancient flint-working, see Sir John Evans, *Ancient Stone Implements* (1897), Lord Avebury's *Prehistoric Times* (1865, 1900); also Thomas Wilson, "Arrow-heads, Spear-heads and Knives of Prehistoric Times," in *Smithsonian Report* for 1897; and W.K. Moorehead, *Prehistoric Implements* (1900).

FLOAT (in O. Eng. *flot* and *flota*, in the verbal form *fléotan*; the Teutonic root is *flut-*, another form of *flu-*, seen in "flow," cf. "fleet"; the root is seen in Gr. πλέειν, to sail, Lat. *pluere*, to rain; the Lat. *fluere* and *fluctus*, wave, is not connected), the action of moving on the surface of water, or through the air. The word is used also of a wave, or the flood of the tide, river, backwater or stream, and of any object floating in water, as a mass of ice or weeds; a movable landing-stage, a flat-bottomed boat, or a raft, or, in fishing, of the cork or quill used to support a baited line or fishing-net. It is also applied to the hollow or inflated organ by means of which certain animals, such as the "Portuguese man-of-war," swim, to a hollow metal ball or piece of whinstone, &c., used to regulate the level of water in a tank or boiler, and to a piece of ivory in the cistern of a barometer. "Float" is also the name of one of the boards of a paddle-wheel or water-wheel. In a theatrical sense, it is used to denote the footlights. The word is also applied to something broad, level and shallow, as a wooden frame attached to a cart or wagon for the purpose of increasing the carrying capacity; and to a special kind of low, broad cart for carrying heavy weights, and to a platform on wheels used for shows in a procession. The term is applied also to various tools, especially to many kinds of trowels used in plastering. It is also used of a dock where vessels may float, as at Bristol, and of the trenches used in "floating" land. In geology and mining, loose rock or ore brought down by water is known as "float," and in tin-mining it is applied to a large trough used for the smelted tin. In weaving the word is used of the passing of weft threads over part of the warp without being woven in with it, also of the threads so passed. In the United States a voter not attached to any particular party and open to bribery is called a "float" or "floater."

FLOCK. 1. (A word found in Old English and Old Norwegian, from which come the Danish and Swedish words, and not in other Teutonic languages), originally a company of people, now mainly, except in figurative usages, of certain animals when gathered together for feeding or moving from place to place. For birds it is chiefly used of geese; and for other animals most generally of sheep and goats. It is from the particular application of the word to sheep that "flock" is used of the Christian Church in its relation to the "Good Shepherd," and also of a congregation of worshippers in its relation to its spiritual head.

2. (Probably from the Lat. *floccus*, but many Teutonic languages have the same word in various forms), a tuft of wool, cotton or similar substance. The name "flock" is given to a material formed of wool or cotton refuse, or of shreds of old woollen or cotton rags, torn by a machine known as a "devil." This material is used for stuffing mattresses or pillows, and also in upholstery. The name is also applied to a special kind of wall-paper, which has an appearance almost like cloth, or, in the more expensive kinds, of velvet. It is made by dusting on a specially prepared adhesive surface finely powdered fibres of cotton or silk. The word "flocculent" is used of many substances which have a fleecy or "flock"-like appearance, such as a precipitate of ferric hydrate.

FLODDEN, or Flodden Field, near the village of Branxton, in Northumberland, England (10 m. N.W. of Wooler), the scene of a famous battle fought on the 9th of September 1513 between the English and the Scots. On the 22nd of August a great Scottish army under King James IV. had crossed the border. For the moment the earl of Surrey (who in King Henry VIII.'s absence was charged with the defence of the realm) had no organized force in the north of England, but James wasted much precious time among the border castles, and when Surrey appeared at Wooler, with an army equal in strength to his own, which was now greatly weakened by privations and desertion, he had not advanced beyond Ford Castle. The English commander promptly sent in a challenge to a pitched battle, which the king, in spite of the advice of his most trusted counsellors, accepted. On the 6th of September, however, he left Ford and took up a strong position facing south, on Flodden Edge. Surrey's reproaches for the alleged breach of faith, and a second challenge to fight on Millfield Plain were this time disregarded. The English commander, thus foiled, executed a daring and skilful march round the enemy's flank, and on the 9th drew up for battle in rear of the hostile army. It is evident that Surrey was confident of victory, for he placed his own army, not less than the enemy, in a position where defeat would involve utter ruin. On his appearance the Scots hastily changed front and took post on Branxton Hill, facing north. The battle began at 4 p.m. Surrey's archers and cannon soon gained the upper hand, and the Scots, unable quietly to endure their losses, rushed to close quarters. Their left wing drove the English back, but Lord Dacre's reserve corps restored the fight on this side. In all other parts of the field, save where James and Surrey were personally opposed, the English gradually gained ground. The king's corps was then attacked by Surrey in front, and by Sir Edward Stanley in flank. As the Scots were forced back, a part of Dacre's force closed upon the other flank, and finally Dacre himself, boldly neglecting an almost intact Scottish division in front of him, charged in upon the rear of King James's corps. Surrounded and attacked on all sides, this, the remnant of the invading army, was doomed. The circle of spearmen around the king grew less and less, and in the end James and a few of his nobles were alone left standing. Soon they too died, fighting to the last man. Among the ten thousand Scottish dead were all the leading men in the kingdom of Scotland, and there was no family of importance that had not lost a member in this great disaster. The "King's Stone," said to mark the spot where James was killed, is at some distance from the actual battlefield. "Sybil's Well," in Scott's *Marmion*, is imaginary.

FLODOARD (894-966), French chronicler, was born at Epernay, and educated at Reims in the cathedral school which had been established by Archbishop Fulcon (822-900). As canon of Reims, and favourite of the archbishops Herivaeus (d. 922) and Seulfus (d. 925), he occupied while still young an important position at the archiepiscopal court, but was twice deprived of his benefices by Heribert, count of Vermandois, on account of his steady opposition to the election of the count's infant son to the archbishopric. Upon the final triumph of Archbishop Artold in 947, Flodoard became for a time his chief adviser, but withdrew to a monastery in 952, and spent the remaining years of his life in literary and devotional work. His history of the cathedral church at Reims (*Historia Remensis Ecclesiae*) is one of the most remarkable productions of the 10th century. Flodoard had been given charge of the episcopal archives, and constructed his history out of the original texts, which he generally reproduces in full; the documents for the period of Hincmar being especially valuable. The *Annales* which Flodoard wrote year by year from 919 to 966 are doubly important, by reason of the author's honesty and the central position of Reims in European affairs in his time. Flodoard's poetical works are of hardly less historical interest. The long poem celebrating the triumph of Christ and His saints was called forth by the favour shown him by Pope Leo VII., during whose pontificate he visited Rome, and he devotes fourteen books to the history of the popes.

Flodoard's works were published in full by J.P. Migne (*Patrologia Latina*, vol. 135); a modern edition of the *Annales* is the one edited by P. Lauer (Paris, 1906). For bibliography see A. Molinier, *Sources de l'histoire de France* (No. 932).

FLOE (of uncertain derivation; cf. Norse *flo*, layer, level plain), a sheet of floating ice detached from the main body of polar ice. It is of less extent than the field of "pack" ice, which is a compacted mass of greater depth drifting frequently under the influence of deep currents, while the floating floe is driven by the wind.

FLOOD, HENRY (1732-1791), Irish statesman, son of Warden Flood, chief justice of the king's bench in Ireland, was born in 1732, and was educated at Trinity College, Dublin, and afterwards at Christ Church, Oxford, where he became proficient in the classics. His father was a man of good birth and fortune, and he himself married a member of the influential Beresford family, who brought him a large fortune. In his early years he was handsome, witty, good-tempered, and a brilliant conversationalist. His judgment was sound, and he had a natural gift of eloquence which had been cultivated and developed by study of classical oratory and the practice of elocution. Flood therefore possessed every personal advantage when, in 1759, he entered the Irish parliament as member for Kilkenny in his twenty-seventh year. There was at that time no party in the Irish House of Commons that could truly be called national, and until a few years before there had been none that deserved even the name of an opposition. The Irish parliament was still constitutionally subordinate to the English privy council; it had practically no powers of independent legislation, and none of controlling the policy of the executive, which was nominated by the ministers in London (see Grattan, Henry). Though the great majority of the people were Roman Catholics, no person of that faith could either enter parliament or exercise the franchise; the penal code, which made it almost impossible for a Roman Catholic to hold property, to follow a learned profession, or even to educate his children, and which in numerous particulars pressed severely on the Roman Catholics and subjected them to degrading conditions, was as yet unrepealed, though in practice largely obsolete; the industry and commerce of Ireland were throttled by restrictions imposed, in accordance with the economic theories of the period, in the interest of the rival trade of Great Britain. Men like Anthony Malone and Hely-Hutchison fully realized the necessity for far-reaching reforms, and it only needed the ability and eloquence of Flood in the Irish House of Commons to raise up an independent party in parliament, and to create in the country a public opinion with definite intelligible aims.

The chief objects for which Flood strove were the shortening of the duration of parliament—which had then no legal limit in Ireland except that of the reigning sovereign's life,—the reduction of the scandalously heavy pension list, the establishment of a national militia, and, above all, the complete legislative independence of the Irish parliament. For some years little was accomplished; but in 1768 the English ministry, which had special reasons at the moment for avoiding unpopularity in Ireland, allowed an octennial bill to pass, which was the first step towards making the Irish House of Commons in some measure representative of public opinion. It had become the practice to allow crown patronage in Ireland to be exercised by the owners of parliamentary boroughs in return for their undertaking to manage the House in the government interest. But during the viceroyalty of Lord Townsend the aristocracy, and more particularly these "undertakers" as they were called, were made to understand that for the future their privileges in this respect would be curtailed. When, therefore, an opportunity was taken by the government in 1768 for reasserting the constitutional subordination of the Irish parliament, these powerful classes were thrown into temporary alliance with Flood. In the following year, in accordance with the established procedure, a money bill was sent over by the privy council in London for acceptance by the Irish House of Commons. Not only was it rejected, but contrary to custom a reason for this course was assigned, namely, that the bill had not originated in the Irish House. In consequence parliament was peremptorily prorogued, and a recess of fourteen months was employed by the government in securing a majority by the most extensive corruption.[1] Nevertheless when parliament met in February 1771 another money bill was thrown out on the motion of Flood; and the next year Lord Townsend, the lord lieutenant whose policy had provoked this conflict, was recalled. The struggle was the occasion of a publication, famous in its day, called *Baratariana*, to which Flood contributed a series of powerful letters after the manner of Junius, one of his collaborators being Henry Grattan.

The success which had thus far attended Flood's efforts had placed him in a position such as no Irish politician had previously attained. He had, as an eminent historian of Ireland observes, "proved himself beyond all comparison the greatest popular orator that his country had yet produced, and also a consummate master of parliamentary tactics. Under parliamentary conditions that were exceedingly unfavourable, and in an atmosphere charged with corruption, venality and subserviency, he had created a party before which ministers had begun to quail, and had inoculated the Protestant constituencies with a genuine spirit of liberty and self-reliance."[2] Lord Harcourt, who succeeded Townsend as viceroy, saw that Flood must be conciliated at any price "rather than risk the opposition of so formidable a leader." Accordingly, in 1775, Flood was offered and accepted a seat in the privy council and the office of vice-treasurer with a salary of £3500 a year. For this step he has been severely criticized. The suggestion that he acted corruptly in the matter is groundless; and although it is true that he lost influence from the moment he became a minister of the crown, Flood may reasonably have held that he had a better prospect of advancing his policy by the leverage of a ministerial position than by means of any opposition party he could hope to muster in an unreformed House of Commons.[3] The result, however, was that the leadership of the national party passed from Flood to Grattan, who entered the Irish parliament in the same session that Flood became a minister.

Flood continued in office for nearly seven years. During this long period he necessarily remained silent on the subject of the independence of the Irish parliament, and had to be content with advocating minor reforms as occasion offered. He was thus instrumental in obtaining bounties on the export of Irish corn to foreign countries and some other trifling commercial concessions. On the other hand he failed to procure the passing of a Habeas Corpus bill and a bill for making the judges irremovable, while his support of Lord North's American policy still more gravely injured his popularity and reputation. But an important event in 1778 led indirectly to his recovering to some extent his former position in the country; this event was the alliance of France with the revolted American colonies. Ireland was thereby placed in peril of a French invasion, while the English government could provide no troops to defend the island. The celebrated volunteer movement was then set on foot to meet the emergency; in a few weeks more than 40,000 men, disciplined and equipped, were under arms, officered by the country gentry, and controlled by the wisdom and patriotism of Lord Charlemont. This volunteer force, in which Flood was a colonel, while vigilant for the defence of the island, soon made itself felt in politics. A Volunteer Convention, formed with all the regular organization of a representative assembly, but wielding the power of an army, began menacingly to demand the removal of the commercial restrictions which were destroying Irish prosperity. Under this pressure the government gave way; the whole colonial trade was in 1779 thrown open to Ireland for the first time, and other concessions were also extorted. Flood, who had taken an active though not a leading part in this movement, now at last resigned his office to rejoin his old party. He found to his chagrin that his former services had been to a great extent forgotten, and that he was eclipsed by Grattan. When in a debate on the constitutional question in

1779 Flood complained of the small consideration shown him in relation to a subject which he had been the first to agitate, he was reminded that by the civil law "if a man should separate from his wife, and abandon her for seven years, another might then take her and give her his protection." But though Flood had lost control of the movement for independence of the Irish parliament, the agitation, backed as it now was by the Volunteer Convention and by increasing signs of popular disaffection, led at last in 1782 to the concession of the demand, together with a number of other important reforms (see GRATTAN, HENRY). 526

No sooner, however, was this great success gained than a question arose—known as the Simple Repeal controversy—as to whether England, in addition to the repeal of the Acts on which the subordination of the Irish parliament had been based, should not be required expressly to renounce for the future all claim to control Irish legislation. The chief historical importance of this dispute is that it led to the memorable rupture of friendship between Flood and Grattan, each of whom assailed the other with unmeasured but magnificently eloquent invective in the House of Commons. Flood's view prevailed—for a Renunciation Act such as he advocated was ungrudgingly passed by the English parliament in 1783—and for a time he regained popularity at the expense of his rival. Flood next (28th of November 1783) introduced a reform bill, after first submitting it to the Volunteer Convention. The bill, which contained no provision for giving the franchise to Roman Catholics—a proposal which Flood always opposed—was rejected, ostensibly on the ground that the attitude of the volunteers threatened the freedom of parliament. The volunteers were perfectly loyal to the crown and the connexion with England. They carried an address to the king, moved by Flood, expressing the hope that their support of parliamentary reform might be imputed to nothing but "a sober and laudable desire to uphold the constitution ... and to perpetuate the cordial union of both kingdoms." The convention then dissolved, though Flood had desired, in opposition to Grattan, to continue it as a means of putting pressure on parliament for the purpose of obtaining reform.

In 1776 Flood had made an attempt to enter the English House of Commons. In 1783 he tried again, this time with success. He purchased a seat for Winchester from the duke of Chandos, and for the next seven years he was a member at the same time of both the English and Irish parliaments. He reintroduced, but without success, his reform bill in the Irish House in 1784; supported the movement for protecting Irish industries; but short-sightedly opposed Pitt's commercial propositions in 1785. He remained a firm opponent of Roman Catholic emancipation, even defending the penal laws on the ground that after the Revolution they "were not laws of persecution but of political necessity"; but after 1786 he does not appear to have attended the parliament in Dublin. In the House at Westminster, where he refused to enrol himself as a member of either political party, he was not successful. His first speech, in opposition to Fox's India Bill on the 3rd of December 1783, disappointed the expectations aroused by his celebrity. His speech in opposition to the commercial treaty with France in 1787 was, however, most able; and in 1790 he introduced a reform bill which Fox declared to be the best scheme of reform that had yet been proposed, and which in Burke's opinion retrieved Flood's reputation. But at the dissolution in the same year he lost his seat in both parliaments, and he then retired to Farmley, his residence in county Kilkenny, where he died on the 2nd of December 1791.

When Peter Burrowes, notwithstanding his close personal friendship with Grattan, declared that Flood was "perhaps the ablest man Ireland ever produced, indisputably the ablest man of his own times," he expressed what was probably the general opinion of Flood's contemporaries. Lord Charlemont, who knew him intimately though not always in agreement with his policy, pronounced him to be "a man of consummate ability." He also declared that avarice made no part of Flood's character. Lord Mountmorres, a critic by no means partial to Flood, described him as a pre-eminently truthful man, and one who detested flattery. Grattan, who even after the famous quarrel never lost his respect for Flood, said of him that he was the best tempered and the most sensible man in the world. In his youth he was genial, frank, sociable and witty; but in later years disappointment made him gloomy and taciturn. As an orator he was less polished, less epigrammatic than Grattan; but a closer reasoner and a greater master of sarcasm and invective. Personal ambition often governed his actions, but his political judgment was usually sound; and it was the opinion of Bentham that Flood would have succeeded in carrying a reform bill which might have preserved Irish parliamentary independence, if he had been supported by Grattan and the rest of his party in keeping alive the Volunteer Convention in 1783. Though he never wavered in loyalty to the British crown and empire, Ireland never produced a more sincere patriot than Henry Flood.

See Warden Flood, *Memoirs of Henry Flood* (London, 1838); Henry Grattan, *Memoirs of the Life and Times of the Right Hon. H. Grattan* (5 vols., London, 1839-1846); Charles Phillips, *Recollections of Curran and some of his Contemporaries* (London, 1822); *The Irish Parliament 1775*, from an official and contemporary manuscript, edited by William Hunt (London, 1907); W.J. O'Neill Daunt, *Ireland and her Agitators*; Lord Mountmorres, *History of the Irish Parliament* (2 vols., London, 1792); W.E.H. Lecky, *History of England in the Eighteenth Century* (8 vols., London, 1878-1890); and *Leaders of Public Opinion in Ireland* (enlarged edition, 2 vols., London, 1903); J.A. Froude, *The English in Ireland*, vols. ii. and iii. (London, 1881); Horace Walpole, *Memoirs of the Reign of George III.* (4 vols., London, 1845, 1894); Sir Jonah Barrington, *Rise and Fall of the Irish Nation* (London, 1833); Francis Plowden, *Historical Review of the State of Ireland* (London, 1803); Alfred Webb, *Compendium of Irish Biography* (Dublin, 1878); F. Hardy, *Memoirs of Lord Charlemont* (London, 1812), especially for the volunteer movement, on which see also *Proceedings of the Volunteer Delegates of Ireland 1784* (Anon. Pamphlet, Brit. Mus.); also *The Charlemont Papers*, and *Irish Parl. Debates*, (vols. i.-iv.).

(R. J. M.)

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1 Walpole's *George III.*, iv. 348.

2 W.E.H. Lecky, *Leaders of Public Opinion in Ireland* (enlarged edition, 2 vols., 1903), i. 48.

3 See Hardy's *Life of Charlemont*, i. 356.

FLOOD (in O. Eng. *flód*, a word common to Teutonic languages, cf. Ger. *Flut*, Dutch *vloed*, from the same root as is seen in "flow," "float"), an overflow of water, an expanse of water submerging land, a deluge, hence "the flood," specifically, the Noachian deluge of Genesis, but also any other catastrophic submersion recorded in the mythology of other nations than the Hebrew (see DELUGE, THE). In the sense of "flowing water," the word is applied to the inflow of the tide, as opposed to "ebb."

FLOOD PLAIN, the term in physical geography for a plain formed of sediment dropped by a river. When the slope down which a river runs has become very slight, it is unable to carry the sediment brought from higher regions nearer its source, and consequently the lower portion of the river valley becomes filled with alluvial deposits; and since in times of flood the rush of water in the high regions tears off and carries down a greater quantity of sediment than usual, the river spreads this also over the lower valley where the plain is flooded, because the rush of water is checked, and the stream in consequence drops its extra load. These flood plains are sometimes of great extent. That of the Mississippi below Ohio has a width of from 20 to 80 m., and its whole extent has been estimated at 50,000 sq. m. Flood plains may be the result of planation, with aggradation, that is, they may be due to a graded river working in meanders from side to side, widening its valley by this process and covering the widened valley with sediment. Or the stream by cutting into another stream (piracy), by cutting through a barrier near its head waters, by entering a region of looser or softer rock, and by glacial drainage, may form a flood plain simply by filling up its valley (alluviation only). Any obstruction across a river's course, such as a band of hard rock, may form a flood plain behind it, and indeed anything which checks a river's course and causes it to drop its load will tend to form a flood plain; but it is most commonly found near the mouth of a large river, such as the Rhine, the Nile, or the Mississippi, where there are occasional floods and the river usually carries a large amount of sediment. "Levees" are formed, inside which the river usually flows, gradually raising its bed above the surrounding plain. Occasional breaches during floods cause the overloaded stream to spread in a great lake over the surrounding country, where the silt covers the ground in consequence. Sections of the Missouri flood plain made by the United States geological survey show a great variety of material of varying coarseness, the stream bed being scoured at one place, and filled at another by currents and floods of varying swiftness, so that sometimes the deposits are of coarse gravel, sometimes of fine sand, or of fine silt, and it is probable that any section of such an alluvial plain would show deposits of a similar character. The flood plain during its formation is marked by meandering, or anastomosing streams, ox-bow lakes and bayous, marshes or stagnant pools, and is occasionally completely covered with water. When the drainage system has ceased to act or is entirely diverted owing to any cause, the flood plain may become a level area of great fertility, similar in appearance to the floor of an old lake. The flood plain differs, however, inasmuch as it is not altogether flat. It has a gentle slope down-stream, and often for a distance from the sides towards the centre. 527

FLOOR (from O. Eng. *flor*, a word common to many Teutonic languages, cf. Dutch *vloer*, and Ger. *Flur*, a field, in the feminine, and a floor, masculine), generally the lower horizontal surface of a room, but specially employed for one covered with boarding or parquetry. The various levels of rooms in a house are designated as "ground-floor," "first-floor," "mezzanine-floor," &c. The principal floor is the storey which contains the chief apartments whether on the ground- or first-floor; in Italy they are always on the latter and known as the "piano nobile." The storey below the ground-floor is called the "basement-floor," even if only a little below the level of the pavement outside; the storey in a roof is known as the "attic-floor." The expressions one pair, two pair, &c., apply to the storeys above the first flight of stairs from the ground (see also Carpentry).

FLOORCLOTH, a rough flannel cloth used for domestic cleaning; also a generic term applied to a variety of materials used in place of carpets for covering floors, and known by such trade names as kamptulicon, oil-cloth, linoleum, corticine, cork-carpet, &c. Kamptulicon (καμπτός, flexible, οὖλος, thick) was patented in 1844 by E. Galloway, but did not attract much attention till about 1862. It was essentially a preparation of india-rubber masticated up with ground cork, and rolled out into sheets between heavy steam-heated rollers, sometimes over a backing of canvas. Owing to its expensiveness, it has given place to cheaper materials serving the same purpose. Oil-cloth is a coarse canvas which has received a number of coats of thick oil paint, each coat being rubbed smooth with pumice stone before the application of the next. Its surface is ornamented with patterns printed in oil colours by means of wooden blocks. Linoleum (*linum*, flax, *oleum*, oil), patented by F. Walton in 1860 and 1863, consists of oxidized linseed oil and ground cork. These ingredients, thoroughly incorporated with the addition of certain gummy and resinous matters, and of pigments such as ochre and oxide of iron as required, are pressed on to a rough canvas backing between steam-heated rollers. Patterns may be printed on its surface with oil paint, or by an improved method may be inlaid with coloured composition so that the colours are continuous through the thickness of the linoleum, instead of being on the surface only, and thus do not disappear with wear. Lincrusta-Walton is a similar material to linoleum, also having oxidized linseed oil as its base, which is stamped out in embossed patterns and used as a covering for walls.

FLOQUET, CHARLES THOMAS (1828-1896), French statesman, was born at St Jean-Pied-de-Port (Basses-Pyrénées) on the 2nd of October 1828. He studied law in Paris, and was called to the bar in 1851. The *coup d'état* of that year aroused the strenuous opposition of Floquet, who had, while yet a student, given proof of his republican sympathies by taking part in the fighting of 1848. He made his name by his brilliant and fearless attacks on the government in a series of political trials, and at the same time contributed to the *Temps* and other influential journals. When the tsar Alexander II. visited the Palais de Justice in 1867, Floquet was said to have confronted him with the cry "Vive la Pologne, monsieur!" He delivered a scathing indictment of the Empire at the trial of Pierre Bonaparte for killing Victor Noir in 1870, and took a part in the revolution of the 4th of September, as well as in the subsequent defence of Paris. In 1871 he was elected to the National Assembly by the department of the Seine. During the Commune he formed the *Ligue d'union républicaine des droits de Paris* to attempt a reconciliation with the government of Versailles. When his efforts failed, he left Paris, and was imprisoned by order of Thiers, but soon released. He became editor of the *République Française*, was chosen president of the municipal council, and in 1876 was elected deputy for the eleventh arrondissement. He took a prominent place among the extreme radicals, and became president of the group of the "Union républicaine." In 1882 he held for a short time the post of prefect of the Seine. In 1885 he succeeded M. Brisson as president of the chamber. This difficult position he filled with such tact and impartiality that he was re-elected the two following years. Having approached the Russian ambassador in such a way as to remove the prejudice existing against him in Russia since the incident of 1867, he rendered himself eligible for office; and on the fall of the Tirard cabinet in 1888 he became president of the council and minister of the interior in a radical ministry, which pledged itself to the revision of the constitution, but was forced to combat the proposals of General Boulanger. Heated debates in the chamber culminated on the 13th of July in a duel between Floquet and Boulanger in which the latter was wounded. In the following February the government fell on the question of revision, and in the new chamber of November Floquet was re-elected to the presidential chair. The Panama scandals, in which he was compelled to admit his implication, dealt a fatal blow to his career: he lost the presidency of the chamber in 1892, and his seat in the house in 1893, but in 1894 was elected to the senate. He died in Paris on the 18th of January 1896.

See *Discours et opinions de M. Charles Floquet*, edited by Albert Faivre (1885).

FLOR, ROGER DI, a military adventurer of the 13th-14th century, was the second son of a falconer in the service of the emperor Frederick II., who fell at Tagliacozzo (1268), and when eight years old was sent to sea in a galley belonging to the Knights Templars. He entered the order and became commander of a galley. At the siege of Acre by the Saracens in 1291 he was accused and denounced to the pope as a thief and an apostate, was degraded from his rank, and fled to Genoa, where he began to play the pirate. The struggle between the kings of Aragon and the French kings of Naples for the possession of Sicily was at this time going on; and Roger entered the service of Frederick, king of Sicily, who gave him the rank of vice-admiral. At the close of the war, in 1302, as Frederick was anxious to free the island from his mercenary troops (called *Almúgavares*), whom he had no longer the means of paying, Roger induced them under his leadership to seek new adventures in the East, in fighting against the Turks, who were ravaging the empire. The emperor Andronicus II. accepted his offer of service; and in September 1303 Roger with his fleet and army arrived at Constantinople. He was adopted into the imperial family, was married to a grand-daughter of the emperor, and was made grand duke and commander-in-chief of the army and the fleet. After some weeks lost in dissipation, intrigues and bloody quarrels, Roger and his men were sent into Asia, and after some successful encounters with the Turks they went into winter quarters at Cyzicus. In May 1304 they again took the field, and rendered the important service of relieving Philadelphia, then invested and reduced to extremities by the Turks. But Roger, bent on advancing his own interests rather than those of the emperor, determined to found in the East a principality for himself. He sent his treasures to Magnesia, but the people slew his Catalans and seized the treasures. He then formed the siege of the town, but his attacks were repulsed, and he was compelled to retire. Being recalled to Europe, he settled his troops in Gallipoli and other towns, and visited Constantinople to demand pay for the *Almúgavares*. Dissatisfied with the small sum granted by the emperor, he plundered the country and carried on intrigues both with and against the emperor, receiving reinforcements all the while from all parts of southern Europe. Roger was now created Caesar, but shortly afterwards the young emperor Michael Palaeologus, not daring to attack the fierce and now augmented bands of adventurers, invited Roger to Adrianople, and there contrived his assassination and the massacre of his Catalan cavalry (April 4, 1306). His death was avenged by his men in a fierce and prolonged war against the Greeks.

See Moncada, *Expedicion de los Catalanes y Aragoneses contre Turcos y Griegos* (Paris, 1840).

528

FLORA, in Roman mythology, goddess of spring-time and flowers, later identified with the Greek Chloris. Her festival at Rome, the Floralia, instituted 238 B.C. by order of the Sibylline books and at first held irregularly, became annual after 173. It lasted six days (April 28-May 3), the first day being the anniversary of the foundation of her temple. It included theatrical performances and animal hunts in the circus, and vegetables were distributed to the people. The proceedings were characterized by excessive merriment and licentiousness. According to the legend, her worship was instituted by Titus Tatius, and her priest, the flamen Floralis, by Numa. In art Flora was represented as a beautiful maiden, bedecked with flowers (Ovid, *Fasti*, v. 183 ff.; Tacitus, *Annals*, ii. 49).

The term “flora” is used in botany collectively for the plant-growth of a district; similarly “fauna” is used collectively for the animals.

FLORE AND BLANCHEFLEUR, a 13th-century romance. This tale, generally supposed to be of oriental origin, relates the passionate devotion of two children, and their success in overcoming all the obstacles put in the way of their love. The romance appears in differing versions in French, English, German, Swedish, Icelandic, Italian, Spanish, Greek and Hungarian. The various forms of the tale receive a detailed notice in E. Hausknecht’s version of the 13th-century Middle English poem of “Floris and Blauncheflur” (*Samml. eng. Denkmäler*, vol. v. Berlin, 1885). Nothing definite can be stated of the origin of the story, but France was in the 12th and 13th centuries the chief market of romance, and the French version of the tale, *Floire et Blanchefleur*, is the most widespread. Floire, the son of a Saracen king of Spain, is brought up in constant companionship with Blanchefleur, the daughter of a Christian slave of noble birth. Floire’s parents, hoping to destroy this attachment, send the boy away at fifteen and sell Blanchefleur to foreign slave-merchants. When Floire returns a few days later he is told that his companion is dead, but when he threatens to kill himself, his parents tell him the truth. He traces her to the tower of the maidens destined for the harem of the emir of Babylon, into which he penetrates concealed in a basket of flowers. The lovers are discovered, but their constancy touches the hearts of their judges. They are married, and Floire returns to his kingdom, when he and all his people adopt Christianity. Of the two 12th-century French poems (ed. Édélestand du Méril, Paris, 1856), the one contains the love story with few additions, the other is a romance of chivalry, containing the usual battles, single combats, &c. Two lyrics based on episodes of the story are printed by Paulin Paris in his *Romancero français* (Paris, 1883). The English poem renders the French version without amplifications, such as are found in other adaptations. Its author has less sentiment than his original, and less taste for detailed description. Among the other forms of the story must be noted the prose romance (*c.* 1340) of Boccaccio, *Il Filocolo*, and the 14th-century *Leggenda della reina Rosana e di Rosana sua figliuola* (pr. Leghorn, 1871). The similarity between the story of Floire and Blanchefleur and *Chante-fable of Aucassin et Nicolete*[1] has been repeatedly pointed out, and they have even been credited with a common source.

See also editions by I. Bekker (Berlin, 1844) and E. Hausknecht (Berlin, 1885); also H. Sundmacher, *Die altfr. und mittelhochdeutsche Bearbeitung der Sage von Flore et Blanscheflur* (Göttingen, 1872); H. Herzog, *Die beiden Sagenkreise von Flore und Blanscheflur* (Vienna, 1884); *Zeitschrift für deut. Altertum* (vol. xxi.) contains a Rhenish version; the Scandinavian *Flores Saga ok Blankiflùr*, ed. E. Kölbing (Halle, 1896); the 13th-century version of Konrad Fleck, *Flore und Blanscheflur*, ed. E. Sommer (Leipzig, 1846); the Swedish by G.E. Klemming (Stockholm, 1844). The English poem was also edited by Hartschorne (*English Metrical Tales*, 1829), by Laing (Abbotsford Club, 1829), and by Lumly (Early Eng. Text Soc., 1866, re-edited G.H. McKnight, 1901). J. Reinhold (*Floire et Blanchefleur*, Paris, 1906) suggests a parallelism with the story of Cupid and Psyche as told by Apuleius; also that the oriental setting does not necessarily imply a connexion with Arab tales, as the circumstances might with small alteration have been taken from the Vulgate version of the book of Esther.

1 Ed. H. Suchier (Paderborn, 1878, 5th ed. 1903); modern French by G. Michaut, with preface by J. Bédier (Tours, 1901); English by Andrew Lang (1887), by F.W. Bourdillon (Oxford, 1896), and by Laurence Housman (1902).

FLORENCE, WILLIAM JERMYN (1831-1891), American actor, of Irish descent, whose real name was Bernard Conlin, was born on the 26th of July 1831 at Albany, N.Y., and first attracted attention as an actor at Brougham's Lyceum in 1851. Two years later he married Mrs Malvina Pray Littell (*d.* 1906), in association with whom, until her retirement in 1889, he won all his successes, notably in Benjamin Woolf's *The Mighty Dollar*, said to have been presented more than 2500 times. In 1856 they had a successful London season, Mrs Florence being one of the first American actresses to appear on the English stage. In 1889 Florence entered into partnership with Joseph Jefferson, playing Sir Lucius O'Trigger to his Bob Acres and Mrs John Drew's Mrs Malaprop on a very successful tour. His last appearance was with Jefferson on the 14th of November 1891, as Ezekiel Homespun in *The Heir-at-law*, and he died on the 18th of November in Philadelphia.

FLORENCE OF WORCESTER (d. 1118), English chronicler, was a monk of Worcester, who died, as we learn from his continuator, on the 7th of July 1118. Beyond this fact nothing is known of his life. He compiled a chronicle called *Chronicon ex chronicis* which begins with the creation and ends in 1117. The basis of his work was a chronicle compiled by Marianus Scotus, an Irish recluse, who lived first at Fulda, afterwards at Mainz. Marianus, who began his work after 1069, carried it up to 1082. Florence supplements Marianus from a lost version of the English Chronicle, and from Asser. He is always worth comparing with the extant English Chronicles; and from 1106 he is an independent annalist, dry but accurate. Either Florence or a later editor of his work made considerable borrowings from the first four books of Eadmer's *Historia novorum*. Florence's work is continued, up to 1141, by a certain John of Worcester, who wrote about 1150. John is valuable for the latter years of Henry I. and the early years of Stephen. He is friendly to Stephen, but not an indiscriminate partisan.

The first edition of these two writers is that of 1592 (by William Howard). The most accessible is that of B. Thorpe (Eng. Hist. Soc., 2 vols., 1848-1849); but Thorpe's text of John's continuation needs revision. Thorpe gives, without explanations, the insertions of an ill-informed Gloucester monk who has obscured the accurate chronology of the original. Thorpe also prints a continuation by John Taxter (died c. 1295), a 13th-century writer and a monk of Bury St Edmunds. Florence and John of Worcester are translated by J. Stevenson in his *Church Historians of England*, vol. ii. pt. i. (London, 1853); T. Forester's translation in Bohn's *Antiquarian Library* (London, 1854) gives the work of Taxter also.

(H. W. C. D.)

FLORENCE, the county-seat of Lauderdale county, Alabama, U.S.A., on the N. bank of the Tennessee river, at the foot of Muscle Shoals Canal, and about 560 ft. above sea-level. Pop. (1880) 1359; (1890) 6012; (1900) 6478 (1952 negroes); (1910) 6689. It is served by the Southern, the Northern Alabama (controlled by the Southern), and the Louisville & Nashville railways, and by electric railway to Sheffield and Tuscumbia, and the Tennessee river is here navigable. Florence is situated in the fertile agricultural lands of the Tennessee river valley on the edge of the coal and iron districts of Alabama, and has various manufactures, including pig-iron, cotton goods, wagons, stoves, fertilizers, staves and mercantile supplies. At Florence are the state Normal College, the Florence University for Women, and the Burrell Normal School (for negroes; founded in 1903 by the American Missionary Association). Florence was founded in 1818, Andrew Jackson, afterwards president of the United States, and ex-president James Madison being among the early property holders. For several years Florence and Nashville, Tennessee, were commercial rivals, being situated respectively at the head of navigation on the Tennessee and Cumberland rivers. The first invasion of Alabama by Federal troops in the Civil War was by a gunboat raid up the Tennessee to Florence on the 8th of February 1862. On the 11th of April 1863 another Federal gunboat raid was attempted, but the vessels were repulsed by a force under Gen. S.A. Wood. On the 26th of May following, Federal troops entered Florence, and destroyed cotton mills and public and private property; but they were driven back by Gen. Philip D. Roddy (1820-1897). On the 11th of December 1863 the town was again raided, but the Federals did not secure permanent possession. Florence was chartered as a city in 1889. 529

FLORENCE (Ital. *Firenze*, Lat. *Florentia*), formerly the capital of Tuscany, now the capital of a province of the kingdom of Italy, and the sixth largest city in the country. It is situated 43° 46′ N., 11° 14′ E., on both banks of the river Arno, which at this point flows through a broad fertile valley enclosed between spurs of the Apennines. The city is 165 ft. above sea-level, and occupies an area of 3 sq. m. (area of the commune, 16½ sq. m.). The geological formation of the soil belongs to the Quaternary and Pliocene period in its upper strata, and to the Eocene and Cretaceous in the lower. *Pietra forte* of the Cretaceous period is quarried north and south of the city, and has been used for centuries as paving stone and for the buildings. *Pietra serena* or *macigno*, a stone of a firm texture also used for building purposes, is quarried at Monte Ceceri below Fiesole. The soil is very fertile; wheat, Indian corn, olives, vines, fruit trees of many kinds cover both the plain and the surrounding hills; the chief non-fruit-bearing trees are the stone pine, the cypress, the ilex and the poplar, while many other varieties are represented. The gardens and fields produce an abundance of flowers, which justify the city's title of *la città dei fiori*.

Climate and Sanitary Conditions.—The climate of Florence is very variable, ranging from severe cold accompanied by high winds from the north in winter to great heat in the summer, while in spring-time sudden and rapid changes of temperature are frequent. At the same time the climate is usually very agreeable from the end of February to the beginning of July, and from the end of September to the middle of November. The average temperature throughout the year is about 57° Fahr.; the maximum heat is about 96.8°, and the minimum 36.5°, sometimes sinking to 21°. The longest day is 15 hours and 33 minutes, the shortest 8 hours and 50 minutes. The average rainfall is about 37½ inches. Epidemic diseases are rare and children's diseases mild; cholera has visited Florence several times, but the city has been free from it for many years. Diphtheria first appeared in 1868 and continued as a severe epidemic until 1872, since when it has only occurred at rare intervals and in isolated cases. Typhoid, pneumonia, tuberculosis, measles and scarlatina, and influenza are the commonest illnesses. The drainage system is still somewhat imperfect, but the water brought from the hills or from the Arno in pipes is fairly good, and the general sanitary conditions are satisfactory.

Churches.

Public Buildings.—Of the very numerous Florentine churches the Duomo (Santa Maria del Fiore) is the largest and most important, founded in 1298 on the plans of Arnolfo di Cambio, completed by Brunelleschi, and consecrated in 1436; the façade, however, was not finished until the 19th century—it was begun in 1875 on the designs of de Fabris and unveiled in 1888. Close by the Duomo is the no less famous Campanile built by Giotto, begun in 1332, and adorned with exquisite bas-reliefs. Opposite is the Baptistery built by Arnolfo di Cambio in the 13th century on the site of an earlier church, and adorned with beautiful bronze doors by Ghiberti in the 15th century. The Badia, Santo Spirito, Santa Maria Novella, are a few among the many famous and beautiful churches of Florence. The existence of these works of art attracts students from all countries, and a German art school subsidized by the imperial government has been instituted.

The streets and piazze of the city are celebrated for their splendid palaces, formerly, and in many cases even to-day the residences of the noble families of Florence. Among others we may mention the Palazzo Vecchio, formerly the seat of the government of the Republic and now the town hall, the Palazzo Riccardi, the residence of the Medici and now the prefecture, the palaces of the Strozzi, Antinori (one of the most perfect specimens of Florentine *quattrocento* architecture), Corsini, Davanzati, Pitti (the royal palace), &c. The palace of the Arte della Lana or gild of wool merchants, tastefully and intelligently restored, is the headquarters of the Dante Society. The centre of Florence, which was becoming a danger from a hygienic point of view, was pulled down in 1880-1890, but, unfortunately, sufficient care was not taken to avoid destroying certain buildings of historic and artistic value which might have been spared without impairing the work of sanitation, while the new structures erected in their place, especially those in the Piazza Vittorio Emanuele, are almost uniformly ugly and quite out of keeping with Florentine architecture. The question aroused many polemics at the time both in Italy and abroad. After the new centre was built, a society called the *Società per la difesa di Firenze antica* was formed by many prominent citizens to safeguard the ancient buildings and prevent them from destruction, and a spirit of intelligent conservatism seems now to prevail in this connexion. The city is growing in all directions, and a number of new quarters have sprung up where the houses are more sanitary than in the older parts, but unfortunately few of them evince much aesthetic feeling. The *viali* or boulevards form pleasant residential streets with gardens, and the system of building separate houses for each family (villini) instead of large blocks of flats is becoming more and more general.

Libraries.

Florence possesses four important libraries besides a number of smaller collections. The *Biblioteca Nazionale*, originally founded by Antonio Magliabecchi in 1747, enjoys the right, shared by the *Vittorio Emanuele* library of Rome, of receiving a copy of every work printed in Italy, since 1870 (since 1848 it had enjoyed a similar privilege with regard to works printed in Tuscany). It contains some 500,000 printed volumes, 700,000 pamphlets, over 9000 prints and drawings (including 284 by Albert Dürer), nearly 20,000 MSS., and 40,000 letters. The number of readers in 1904 was over 50,000. Unfortunately, however, the confusion engendered by a defective organization has long been a byword among the people; there is no printed catalogue, quantities of books are buried in packing-cases and unavailable, the collection of foreign books is very poor, hardly any new works being purchased, and the building itself is quite inadequate and far from safe; but the site of a new one has now been purchased and the plans are agreed upon, so that eventually the whole collection will be transferred to more suitable quarters. The *Biblioteca Marucelliana*, founded in 1752, contains 150,000 books, including 620 incunabula, 17,000 engravings and 1500 MSS.; it is well managed and chiefly remarkable for its collection of illustrated works and art publications. The *Biblioteca Mediceo-Laurenziana*, founded in 1571, has its origin in the library of Cosimo de' Medici the Elder, and was enlarged by Piero, Giovanni and above all by Lorenzo the Magnificent. Various princes and private persons presented it with valuable gifts and legacies, among the most important of which was the collection of *editiones principes* given by Count d'Elci, in 1841, and the Ashburnham collection of MSS. purchased by the Italian Government in 1885. It contains nearly 10,000 MSS., including many magnificent illuminated missals and Bibles and a number of valuable Greek and Latin texts, 242 incunabula and 11,000 printed books, chiefly dealing with palaeography; it is in some ways the most important of the Florentine libraries. The *Biblioteca Riccardiana*, founded in the 16th century by Romolo Riccardi, contains nearly 4000 MSS., over 32,000 books and 650 incunabula, chiefly relating to Florentine history. The state archives are among the most complete in Italy, and contain over 450,000 *filze* and *registri* and 126,000 charters, covering the period from 726 to 1856.

Galleries of Fine Arts and Museums.

Few cities are as rich as Florence in collections of works of artistic and historic interest, although the great majority of them belong to a comparatively limited period—from the 13th to the 16th century. The chief art galleries are the Uffizi, the Pitti and Accademia. The two former are among the finest in the world, and are filled with masterpieces by Raphael, Andrea del Sarto, Perugino, Ghirlandaio, Botticelli, the Lippi, and many other Florentine, Umbrian, Venetian, Dutch and Flemish artists, as well as numerous admirable examples of antique, medieval and Renaissance sculpture. The Pitti collection is in the royal palace (formerly the 530
residence of the grand dukes), and a fine new stairway and vestibule have been constructed by royal munificence. In the Uffizi the pictures are arranged in strict chronological order. In the Accademia, which is rich in early Tuscan masters, the Botticelli and Perugino rooms deserve special mention. Other pictures are scattered about in the churches, monasteries and private palaces. Of the monasteries, that of St Mark should be mentioned, as containing many works of Fra Angelico, besides relics of Savonarola, while of the private collections the only one of importance is that of Prince Corsini. There is a splendid museum of medieval and Renaissance antiquities in the Bargello, the ancient palace of the Podestà, itself one of the finest buildings in the city; among its many treasures are works of Donatello, Ghiberti, Verrochio and other sculptors, and large collections of ivory, enamel and bronze ware. The Opera del Duomo contains models and pieces of sculpture connected with the cathedral; the Etruscan and Egyptian museum, the gallery of tapestries, the Michelangelo museum, the museum of natural history and other collections are all important in different ways.

Population.

The total population of Florence in 1905, comprising foreigners and a garrison of 5500 men, was 220,879. In 1861 it was 114,363; it increased largely when the capital of Italy was in Florence (1865-1872), but decreased or increased very slightly after the removal of the capital to Rome, and increased at a greater rate from 1881 onwards. At present the rate of increase is about 22 per 1000, but it is due to immigration, as the birth rate was actually below the death rate down to 1903, since when there has been a slight increase of the former and a decrease of the latter.

Administration.

Florence is the capital of a province of the same name, and the central government is represented by a prefect (*prefetto*), while local government is carried on by a mayor (*sindaco*) and an elective town council (*consiglio comunale*). The city is the seat of a court of cassation (for civil cases only), of a court of appeal, besides minor tribunals. It is the headquarters of an army corps, and an archiepiscopal see.

There are 22 public elementary schools for boys and 18 for girls (education being compulsory and gratuitous), with about 20,000 pupils, and 56 private schools with 5700 pupils. Secondary education is provided by one higher and four lower technical schools with 1375 pupils, three *ginnasii* or lower classical schools, and three *licei* or higher classical schools, with 1000 pupils, and three training colleges with over 700 pupils. Higher education is imparted at the university (*Istituto di studii superiori e di perfezionamento*), with 600 to 650 students; although only comprising the faculties of literature, medicine and natural science, it is, as regards the first-named faculty, one of the most important institutions in Italy. The original *Studio Fiorentino* was founded in the 14th century, and acquired considerable fame as a centre of learning under the Medici, enhanced by the presence in Florence of many learned Greeks who had fled from Constantinople after its capture by the Turks (1453). Although in 1472 some of the faculties and several of the professors were transferred to Pisa, it still retained importance, and in the 17th and 18th centuries it originated a number of learned academies. In 1859 after the annexation of Tuscany to the Italian kingdom it was revived and reorganized; since then it has become to some extent a national centre of learning and culture, attracting students from other parts of Italy, partly on account of the fact that it is in Florence that the purest Italian is spoken. The revival of classical studies on scientific principles in modern Italy may be said to have begun in Florence, and great activity has also been displayed in reviving the study of Dante; Dante lectures being given regularly by scholars and men of letters from all parts of the country, above the church of Or San Michele as in the middle ages, under the auspices of the *Società Dantesca*. Palaeography, history and Romance languages are among the other subjects to which especial importance is given. Besides the *Istituto di studii superiori* there is the *Istituto di scienze sociali* "*Cesare Alfieri*," founded by the marchese Alfieri di Sostegno for the education of aspirants to the diplomatic and consular services, and for students of economics and social sciences (about 50 students); an academy of fine arts, a conservatoire of music, a higher female training-college with 150 students, a number of professional and trade schools, and an academy of recitation. There are also many academies and learned societies of different kinds, of which one of the most important is the *Accademia della Crusca* for the study of the Italian language, which undertook the publication of a monumental dictionary.

Education.

Several of the Florence hospitals are of great antiquity, the most important being that of Santa Maria Nuova, which, founded by Folco Portinari, the father of Dante's Beatrice, has been thoroughly renovated according to modern scientific principles. There are numerous other hospitals both general and special, a foundling hospital dating from the 13th century (Santa Maria degli Innocenti), an institute for the blind, one for the deaf and dumb, &c. Most of the hospitals and other charitable institutions are endowed, but the endowments are supplemented by private contributions.

Charities, etc.

Florence is the centre of a large and fertile agricultural district, and does considerable business in wine, oil and grain, and supplies the neighbouring peasantry with goods of all kinds. There are no important industries, except a few flour-mills, some glass works, iron foundries, a motor car factory, straw hat factories, and power-houses supplying electricity for lighting and for the numerous tramcars. There are, however, some artistic industries in and around the city, of which the most important is the Ginori-Richard porcelain works, and the Cantagalli majolica works. There are many other smaller establishments, and the Florentine artificer seems to possess an exceptional skill in all kinds of work in which art is combined with technical ability. Another very important source of revenue is the so-called "tourist industry," which in late years has assumed immense proportions; the city contains a large number of hotels and boarding-houses which every year are filled to overflowing with strangers from all parts of the world.

Commerce and Industry.

(L. V.*)

History

Florentia was founded considerably later than Faesulae (Fiesole), which lies on the hill above it; indeed, as its name indicates, it was built only in Roman times and probably in connexion with the construction by C. Flaminius in 187 B.C. of a road from Bononia to Arretium (which later on formed part of the Via Cassia) at the point where this road crossed the river Arnus. We hear very little of it in ancient times; it appears to have suffered at the end of the war between Marius and Sulla, and in A.D. 15 (by which period it seems to have been already a colony) it successfully opposed the project of diverting part of the waters of the Clanis into the Arno (see Chiana). Tacitus mentions it, and Florus describes it as one of the *municipia splendidissima*. A bishop of Florence is mentioned in A.D. 313. A group of Italic cremation tombs *a pozzo* of the Villanova period were found under the pavement of the medieval Vicolo del Campidoglio. This took its name from the *Capitolium* of Roman times, the remains of which were found under the Piazza Luna; the three *cellae* were clearly traceable. The capitals of the columns were Corinthian, about 4 ft. in diameter, and it became clear that this temple had supplied building materials for S. Giovanni and S. Miniato. Fragments of a fine octagonal altar, probably belonging to the temple, were found. Remains of baths have been found close by, while the ancient amphitheatre has been found near S. Croce outside the Roman town, which formed a rectangle of about 400 by 600 yds., with four gates, the *Decumanus* being represented by the Via Strozzi and Via del Corso, and the *Cardo* by the Via Calcinara, while the Mercato Vecchio occupied the site of the Forum.

See L.A. Milani, "Reliquie di Firenze antica," in *Monumenti dei Lincei*, vi. (1896), 5 seq.

(T. As.)

The first event of importance recorded is the siege of the city by the Goths, A.D. 405, and its deliverance by the Roman general Stilicho. Totila besieged Florence in 542, but was repulsed by the imperial garrison under Justin, and later it was occupied by the Goths. We find the Longobards in Tuscany in 570, and mention is made of one *Gudibrandus Dux civitatis Florentinorum*, which suggests that Florence was the capital of a duchy (one of the regular divisions of the Longobard empire). Charlemagne was in Florence in 786 and conferred many favours on the city, which continued to grow in importance owing to its situation on the road from northern Italy to Rome. At the time of the agitation against simony and the corruption of the clergy, the head of the movement in Florence was San Giovanni Gualberto, of the monastery of San Salvi. The simoniacal election of Pietro Mezzabarba as bishop of Florence (1068) caused serious disturbances and a long controversy with Rome, which ended in the triumph, after a trial by fire, of the monk Petrus Igneus, champion of the popular reform movement; this event indicates the beginnings of a popular conscience among the Florentines. Under the Carolingian emperors Tuscany was a March or margraviate, and the marquises became so powerful as to be even a danger to the Empire. Under the emperor Otto I. one Ugo (d, 1001) was marquis, and the emperor Conrad II. (elected in 1024) appointed Boniface of Canossa marquis of Tuscany, a territory then extending from the Po to the borders of the Roman state. Boniface died in 1052, and in the following year the margraviate passed to his daughter, the famous countess Matilda, who ruled for forty years and played a prominent part in the history of Italy in that period. In the Wars of the Investitures Matilda was ever on the papal (afterwards called Guelph) side against the emperor and the faction afterwards known as Ghibelline, and she herself often led armies to battle. It is at this time that the people of Florence first began to acquire influence, and while the countess presided at the courts of justice in the name of the Empire, she was assisted by a group of great feudal nobles, judges, lawyers, &c., who formed, as elsewhere in Tuscany, the *boni homines* or *sapientes*. As the countess was frequently absent these *boni homines* gave judgment without her, thus paving the way for a free commune. The citizens found themselves in opposition to the nobility of the hills around the city, Teutonic feudatories of Ghibelline 531

The countess Matilda. Guelphs and Ghibellines.

sympathies, who interfered with their commerce. Florence frequently waged war with these nobles and with other cities on its own account, although in the name of the countess, and the citizens began to form themselves into groups and associations which were the germs of the *arti* or gilds. After the death of Countess Matilda in 1115 the *grandi* or *boni homines* continued to rule and administer justice, but in the name of the people—a change hardly noticed at first, but which marks the foundation of the commune. After 1138 the *boni homines* began to be called *consules*, while the population was divided into the *grandi* or *delle torri*, *i.e.* the noble families who had towers, and the *arti* or trade and merchant gilds. At first the *consules*, of whom there seem to have been twelve, two for each *sestiere* or ward, were chosen by the men of the towers, and assisted by a council of 100 *boni homines*, in which the *arti* were predominant; the government thus came to be in the hands of a few powerful families. The republic now proceeded to extend its power. In 1125 Fiesole was sacked and destroyed, but the feudal nobles of the *contado* (surrounding country), protected by the imperial margraves, were still powerful. The early margraves had permitted the Florentines to wage war against the Alberti family, whose castles they destroyed. The emperor Lothair when in Italy forced Florence to submit to his authority, but at his death in 1137 things returned to their former state and the Florentines fought successfully against the powerful counts Guidi. Frederick Barbarossa, however, elected emperor in 1152, made his authority felt in Tuscany, and appointed one Welf of Bavaria as margrave. Florence and other cities were forced to supply troops to the emperor for his Lombard campaigns, and he began to establish a centralized imperial bureaucracy in Tuscany, appointing a *potestas*, who resided at San Miniato (whence the name of "San Miniato al Tedesco"), to represent him and exercise authority in the *contado*; this double authority of the *consoli* in the town and the *potestas* or *podestà* outside generated confusion. By 1176 the Florentines were masters of all the territory comprised in the dioceses of Florence and Fiesole; but civil commotion within the city broke out between the *consoli* and the greater nobles, headed by the Alberti and strengthened by the many feudal families who had been forced to leave their castles and dwell in the city (1177-1180). In the end the Alberti, though not victorious, succeeded in getting occasionally admitted to the consulship. Florence now formed a league with the chief cities of Tuscany, made peace with the Guidi, and humbled the Alberti whose castle of Semifonte was destroyed (1202). Later we find a *potestas* within the city, elected for a year and assisted by seven councillors and seven *rectores super capitibus artium*. This represented the triumph of the feudal party, which had gained the support of the *arti minori* or minor gilds. The *potestates* subsequently were foreigners, and in 1207 the dignity was conferred on Gualfredotto of Milan; a new council was formed, the *consiglio del comune*, while the older senate still survived. The Florentines now undertook to open the highways of commerce towards Rome, for their city was already an important industrial and banking centre.

Beginnings of the commune.

War with the nobles.

The potestas.

Discord among the great families broke out again, and the attempt to put an end to it by a marriage between Buondelmonte de' Buondelmonti and a daughter of the Amidei, only led to further strife (1215), although the causes of these broils were deeper and wider, being derived from the general division between Guelphs and Ghibellines all over Italy. But the work of crushing the nobles of the *contado* and of asserting the city's position among rival communes continued. In 1222 Florence waged war successfully on Pisa, Lucca and Pistoia, and during the next few years against the Sienese with varying results; although the emperor supported the latter as Ghibellines, on his departure for Germany in 1235 they were forced to accept peace on onerous terms. During the interregnum (1241-1243) following on the death of Pope Gregory IX. the Ghibelline cause revived in Tuscany and imperial authority was re-established. The tumults against the Paterine heretics (1244-1245), among whom were many Ghibelline nobles favoured by the *podestà* Pace di Pesamigola, indicate a successful Guelphic reaction; but Frederick II., having defeated his enemies both in Lombardy and in the Two Sicilies, appointed his natural son, Frederick of Antioch, imperial vicar in Tuscany, who, when civil war broke out, entered the city with 1600 German knights. The Ghibellines now triumphed completely, and in 1249 the Guelph leaders were driven into exile—the first of many instances in Florentine history of exile *en masse* of a defeated party. The attempt to seize Montevarchi and other castles where the Guelph exiles were congregated failed, and in 1250 the burghers elected thirty-six *caporali di popolo*, who formed the basis of the *primo popolo* or body of citizens independent of the nobles, headed by the *capitano del popolo*. The Ghibellines being unable to maintain their supremacy, the city came to be divided into two almost autonomous republics, the *comune* headed by the *podestà*, and the *popolo* headed by the *capitano* and militarily organized into twenty companies; the central power was represented by twelve *anziani* or elders. The *podestà*, who was always a foreigner, usually commanded the army, represented the city before foreign powers, and signed treaties. He was assisted by the *consiglio speciale* of 90 and the *consiglio generale e speciale* of 300, composed of nobles, while the *capitano del popolo* had also two councils composed of burghers, heads of the gilds, *gonfalonieri* of the companies, &c. The *anziani* had a council of 36 burghers, and then there was the *parlamento* or general assembly of the people, which met only on great occasions. At this time the *podestà's* palace (the Bargello) was built, and the gold florin was first coined and soon came to be accepted as the standard gold piece throughout Europe. But, although greatly strengthened, the Guelphs, who now may be called the democrats as opposed to the Ghibelline aristocrats, were by no means wholly victorious, and in 1251 they had to defend themselves against a league of Ghibelline cities (Siena, Pisa and Pistoia) assisted by Florentine Ghibellines; the Florentine Uberti, who had been driven into exile after their plot of 1258, took refuge in Siena and encouraged that city in its hostility to Florence. Fresh disputes about the possession of Montepulciano and other places having arisen, the Florentines declared war once more. A Florentine army assisted by Guelphs of other towns was cunningly induced to believe that Siena would surrender at the first summons; but it was met by a Sienese army reinforced by Florentine exiles, including Farinata degli Uberti and other Ghibellines, and by the cavalry of Manfred (*q.v.*) of Sicily, led by Count Giordano and the count of Arras, with the result that the Florentines were totally routed at Montaperti on the 4th of September 1260. Count Giordano entered Florence, appointed Count Guido Novello *podestà*, and began a series of persecutions against the Guelphs. The Ghibellines even proposed to raze the walls of the city, but Farinata degli Uberti strongly opposed the idea, saying that "he had fought to regain and not to ruin his fatherland." 532

Comune and popolo.

Battle of Montaperti (1260).

During this new Ghibelline predominance (1260-1266) the old liberties were abolished, and the *popolo* was deprived of all share in the administration. But when Charles I. (*q.v.*) of Anjou descended into Italy as champion of the papacy, and Manfred was defeated and killed (1266), the *popolo*, who had acquired wealth in trade and industry, was ready to rise. After some disturbances Guido Novello and the Ghibellines were expelled, but it was not the *popolo* who triumphed; the pope and Charles were the real masters of the situation, and the Florentines found they had exchanged a foreign and Ghibelline protector for one who was foreign and Guelph. Nevertheless much of the old order was restored; the *podestà* who represented King Charles was assisted by 12 *buoni uomini*, and by the council of the 100 *buoni uomini del popolo*, "without the deliberation of whom," says Villani, "no great matter nor expenditure could be undertaken." Other bodies and magistrates were maintained, and the *capitano del popolo*, now called *capitano della massa di parte Guelfa*, tended to become a very important person. The property of the Ghibellines was confiscated, and a commission of six *capitani di parte Guelfa* appointed to administer it and in general to expend it for the persecution of the Ghibellines. The whole constitution of the republic, although of very democratic tendencies, seemed designed to promote civil strife and weaken the central power.

New constitution.

While the constitution was evolving in a manner which seemed to argue small political ability and no stability in the Florentines, the people had built up a wonderful commercial organization. Each of the seven *arti maggiori* or greater gilds was organized like a small state with its councils, statutes, assemblies, magistrates, &c., and in times of

Florentine trade and the gilds.

trouble constituted a citizen militia. Florentine cloth especially was known and sold all over Europe, and the Florentines were regarded as the first merchants of the age. If the life of the city went on uninterruptedly even during the many changes of government and the almost endemic civil war, it was owing to the solidity of the gilds, who could carry on the administration without a government.

Cardinal Latino.

After Charles's victory over Conradin in 1268 the Florentines defeated the Sienese (1269) and made frequent raids into Pisan territory. As Charles perpetually interfered in their affairs, always favouring the *grandi* or Guelph nobles, some of the Ghibellines were recalled as a counterpoise, which, however, only led to further civil strife. Rudolph of Habsburg, elected king of the Romans in 1273, having come to terms with Pope Nicholas III., Charles was obliged in 1278 to give up his title of imperial vicar in Tuscany, which he had held during the interregnum following on the death of Frederick II. In 1279 Pope Nicholas sent his nephew, the friar preacher Latino Frangipani Malabranca, whom he had created cardinal bishop of Ostia the same year, to reconcile the parties in Florence once more. Cardinal Latino to some extent succeeded, and was granted a kind of temporary dictatorship. He raised the 12 *buoni uomini* to 14 (8 Guelphs and 6 Ghibellines), to be changed every two months; and they were assisted by a council of 100. A force of 1000 men was placed at the disposal of the *podestà* and *capitano* (now both elected by the people) to keep order and oblige the *grandi* to respect the law. The Sicilian Vespers (*q.v.*) by weakening Charles strengthened the commune, which aimed at complete independence of emperors, kings and popes. After 1282 the *signoria* was composed of the 3 (afterwards 6) *priori* of the gilds, who ended by ousting the *buoni uomini*, while a *defensor artificum et artium* takes the place of the *capitano*; thus the republic became an essentially trading community, governed by the *popolani grassi* or rich merchants.

Battle of Campaldino (1289).

The republic now turned to the task of breaking the power of the Ghibelline cities of Pisa and Arezzo. In 1289 the Aretini were completely defeated by the Florentines at Campaldino, a battle made famous by the fact that Dante took part in it. War against the Pisans, who had been defeated by the Genoese in the naval battle of La Meloria in 1284, was carried on in a desultory fashion, and in 1293 peace was made. But the *grandi*, who had largely contributed to the victory of Campaldino, especially men like Corso Donati and Vieri de' Cerchi, were becoming more powerful, and Charles had increased their number by creating a great many knights; but their attempts to interfere with the administration of justice were severely repressed, and new laws were passed to reduce their influence. Among other internal reforms the abolition of the last traces of servitude in 1289, and the increase in the number of *arti*, first to 12 and then to 21 (7 *maggiori* and 14 *minori*) must be mentioned. This, however, was not enough for the Florentine democracy, who viewed with alarm the increasing power and arrogance of the *grandi*, who in spite of their exclusion from many offices were still influential and constituted independent clans within the state. The law obliged each member of the clan (*consorteria*) to *sodare* for all the other members, *i.e.* to give a pecuniary guarantee to ensure payment of fines for offences committed by any one of their number, a provision made necessary by the fact that the whole clan acted collectively. But as the laws were not always enforced new and severe ones were enacted. These were the famous *Ordinamenti della Giustizia* of 1293, by which all who were not of the *arti* were definitely excluded from the signory. The *priori* were to remain in office two months and elected the *gonfaloniere*, also for two months; there were the *capitudini* or councils of the gilds, and two *savi* for each *sestiere*, with 1000 soldiers at their disposal; the number of the *grandi* families was fixed at 38 (later 72). Judgment in matters concerning the *Ordinamenti* was delivered in a summary fashion without appeal. The leading spirit of this reform was Giano della Bella, a noble who by engaging in trade had become a *popolano*; the *grandi* now tried to make him unpopular with the *popolani grassi*, hoping that without him the *Ordinamenti* would not be executed, and opened negotiations with Pope Boniface VIII. (elected 1294), who aimed at extending his authority in Tuscany. A signory adverse to Giano having been elected, he was driven into exile in 1295. The *grandi* regained some of their power by corrupting the *podestà* and by the favour of the *popolo minuto* or unorganized populace; but their quarrels among themselves prevented them from completely succeeding, while the *arti* were solid.

Ordinamenti della Giustizia (1293).

The Bianchi and the Neri.

In 1295 a signory favourable to the *grandi* enacted a law attenuating the *Ordinamenti*, but now the *grandi* split into two factions, one headed by the Donati, which hoped to abolish the *Ordinamenti*, and the other by the Cerchi, which had given up all hope of their abolition; afterwards these parties came to be called *Neri* (Blacks) and *Bianchi* (Whites). A plot of the Donati to establish their influence over Florence with the help of Boniface VIII. having been discovered (May 1300), serious riots broke out between the Neri and the Bianchi. The pope's attempt to unite the *grandi* having failed, he summoned Charles of Valois to come to his assistance, promising him the imperial crown; in 1301 Charles entered Italy, and was created by the pope *paciaro* or peacemaker of Tuscany, with instructions to crush the Bianchi and the *popolo* and exalt the Neri. On the 1st of November Charles reached Florence, promising to respect its laws; but he permitted Corso Donati and his friends to attack the Bianchi, and the new *podestà*, Cante dei Gabrielli of Gubbio, who had come with Charles, punished many of that faction; among those whom he exiled was the poet Dante (1302). Corso Donati, who for some time was the most powerful man in Florence, made himself many enemies by his arrogance, and was obliged to rely on the *popolo grasso*, the irritation against him resulting in a rising in which he was killed (1308). In this same year Henry of Luxemburg was elected king of the Romans and with the pope's favour he came to Italy in 1310; the Florentine exiles and all the Ghibellines of Italy regarded him as a saviour and regenerator of the country, while the Guelphs of Florence on the contrary opposed both him and the pope as dangerous to their own liberties and accepted the protection of King Robert of Naples, disregarding Henry's summons to submission. In 1312 Henry was crowned emperor as Henry VII. in Rome, but instead of the universal ruler and pacifier which he tried to be, he was forced by circumstances into being merely a German kaiser who tried to subjugate free Italian communes. He besieged Florence without success, and died of disease in 1313. 533

Uguccione della Fagginola and Castruccio Castracani.

The Pisans, fearing the vengeance of the Guelphs now that Henry was dead, had accepted the lordship of Uguccione della Fagginola, imperial vicar in Genoa. A brave general and an ambitious man, he captured Lucca and defeated the Florentines and their allies from Naples at Montecatini in 1315, but the following year he lost both Pisa and Lucca and had to fly from Tuscany. A new danger now threatened Florence in the person of Castruccio Castracani degli Antelminelli (*q.v.*), who made himself lord of Lucca and secured help from Matteo Visconti, lord of Milan, and other Ghibellines of northern Italy. Between 1320 and 1323 he harried the Florentines and defeated them several times, captured Pistoia, devastated their territory up to the walls of the city in spite of assistance from Naples under Raymundo de Cardona and the duke of Calabria (King Robert's son); never before had Florence been so humiliated, but while Castruccio was preparing to attack Florence he died in 1328. Two months later the duke of Calabria, who had been appointed protector of the city in 1325, died, and further constitutional reforms were made. The former councils were replaced by the *consiglio del popolo*, consisting of 300 *popolani* and presided over by the *capitano*, and the *consiglio del comune* of 250 members, half of them nobles and half *popolani*, presided over by the *podestà*. The *priori* and other officers were drawn by lot from among the Guelphs over thirty years old who were declared fit for public office by a special board of 98 citizens (1329). The system worked well at first, but abuses soon crept in, and many persons were unjustly excluded from office; trouble being expected in 1335 a captain of the guard was created. But the first one appointed, Jacopo dei Gabrielli of Gubbio, used his dictatorial powers so ruthlessly that at the end of his year of office no successor was chosen.

The Florentines now turned their eyes towards Lucca; they might have acquired the city immediately after Castruccio's death for 80,000 florins, but failed to do so owing to differences of opinion in the signory; Martino della Scala, lord of Verona, promised it to them in 1335, but broke his word, and although their finances were not then very flourishing they allied themselves with Venice to make war on him. They were successful at first, but Venice made a truce with the Scala independently of the Florentines, and by the peace of 1339 they only obtained a part of Lucchese territory. At the same time they purchased from the Tarlati the protectorate over Arezzo for ten years. But misfortunes fell on the city: Edward III. of England repudiated the heavy debts contracted for his wars in France with the Florentine banking houses of Bardi and Peruzzi (1339), which eventually led to their failure and to that of many smaller firms, and shook Florentine credit all over the world; Philip VI. of France extorted large sums from the Florentine merchants and bankers in his dominions by accusing them of usury; in 1340 plague and famine wrought terrible havoc in Florence, and riots again broke out between the *grandi* and the *popolo*, partly on account of the late unsuccessful wars and the unsatisfactory state of the finances. To put an end to these disorders, Walter of Brienne, duke of Athens, was elected "conservator" and captain of the guard in 1342. An astute, dissolute and ambitious man, half French and half Levantine, he began his government by a policy of conciliation and impartial justice which won him great popularity. But as soon as he thought the ground was secure he succeeded in getting himself acclaimed by the populace lord of Florence for life, and on the 8th of September was carried in triumph to the Palazzo della Signoria. The *podestà* and the *capitano* assenting to this treachery, he dismissed the *gonfaloniere*, reduced the *priori* to a position of impotence, disarmed the citizens, and soon afterwards accepted the lordship of Arezzo, Volterra, Colle, San Gimignano and Pistoia. He increased his bodyguard to 800 men, all Frenchmen, who behaved with the greatest licence and brutality; by his oppressive taxes, and his ferocious cruelty towards all who opposed him, and the unsatisfactory treaties he concluded with Pisa, he accumulated bitter hatred against his rule. The *grandi* were disappointed because he had not crushed the *popolo*, and the latter because he had destroyed their liberties and interfered with the organization of the *arti*. Many unsuccessful plots against him were hatched, and having discovered one that was conducted by Antonio degli Adimari, the duke summoned the latter to the palace and detained him a prisoner. He also summoned 300 leading citizens on the pretext of wishing to consult them, but fearing treachery they refused to come. On the 26th of July 1343, the citizens rose in arms, demanded the duke's abdication, and besieged him in the palace. Help came to the Florentines from neighbouring cities, the *podestà* was expelled, and a *balìa* or provisional government of 14 was elected. The duke was forced to set Adimari and his other prisoners free, and several of his men-at-arms were killed by the populace; three of his chief henchmen, whom he was obliged to surrender, were literally torn to pieces, and finally on the 1st of August he had to resign his lordship. He departed from Florence under a strong guard a few days later, and the Fourteen cancelled all his enactments.

Attempt to capture Lucca.

The duke of Athens (1342-43).

The expulsion of the duke of Athens was followed by several measures to humble the *grandi* still further, while the *popolo minuto* or artisans began to show signs of discontent at the rule of the merchants, and the populace destroyed the houses of many nobles. As soon as order was restored a *balìa* was appointed to reform the government, in which task it was assisted by the Sienese and Perugian ambassadors and by Simone da Battifolle. The *priori* were reduced to 8 (2 *popolani grassi*, 3 *mediani* and 3 *artifici minuti*), while the *gonfaloniere* was to be chosen in turn from each of those classes; the *grandi* were excluded from the administration, but they were still admitted to the *consiglio del comune*, the *cinque di mercanzia*, and other offices pertaining to the commune; the *Ordinamenti* were maintained but in a somewhat attenuated form, and certain *grandi* as a favour were declared to be of the *popolo*. Florence was now a thoroughly democratic and commercial republic, and its whole policy was mainly dominated by commercial considerations: its rivalry with Pisa was due to an ambition to gain secure access to the sea; its strong Guelphism was the outcome of its determination to secure the bank-business of the papacy; and its desire to extend its territory in Tuscany to the necessity for keeping open the land trade routes. Florentine democracy, however, was limited to the walls of the city, for no one of the *contado* nor any citizen of the subject towns enjoyed political rights, which were reserved for the inhabitants of Florence alone and not by any means for all of them.

New constitution.

Florence was in the 14th century a city of about 100,000 inhabitants, of whom 25,000 could bear arms; there were 110 churches, 39 religious houses; the shops of the *arte della lana* numbered over 200, producing cloth worth 1,200,000 florins; Florentine bankers and merchants were found all over the world, often occupying responsible positions in the service of foreign governments; the revenues of the republic, derived chiefly from the city customs, amounted to some 300,000 florins, whereas its ordinary expenses, exclusive of military matters and public buildings, were barely 40,000. It was already a centre of art and letters and full of fine buildings, pictures and libraries. But now that the *grandi* were suppressed politically, the lowest classes came into prominence, "adventurers without sense or virtue and of no authority for the most part, who had usurped public offices by illicit and dishonest practices" (Matteo Villani, iv. 69); this paved the way for tyranny.

Statistics.

In 1347 Florence was again stricken with famine, followed the next year by the most terrible plague it had ever experienced, which carried off three-fifths of the population (according to Villani). Yet in spite of these disasters the republic was by no means crushed; it soon regained the suzerainty of many cities which had broken off all connexion with it after the expulsion of the duke of Athens, and purchased the overlordship of Prato from Queen Joanna of Naples, who had inherited it from the duke of Calabria. In 1351 Giovanni Visconti, lord and archbishop of Milan, having purchased Bologna and allied himself with sundry Ghibelline houses of Tuscany with a view to dominating Florence, the city made war on him, and in violation of its Guelph traditions placed itself under the protection of the emperor Charles IV. (1355) for his lifetime. This move, however, was not popular, and it enabled the *grandi*, who, although excluded from the chief offices, still dominated the *parte Guelfa*, to reassert themselves. They had in 1347 succeeded in enacting a very stringent law against all who were in any way tainted with Ghibellinism, which, they themselves being above suspicion in that connexion, enabled them to drive from office many members of the *popolo minuto*. In 1358 the *parte Guelfa* made these enactments still more stringent, punishing with death or heavy fines all who being Ghibellines held office, and provided that if trustworthy witnesses were forthcoming condemnations might be passed for this offence without hearing the accused; even a non-proved charge or an *ammonizione* (warning not to accept office) might entail disfranchisement. Thus the *parte*, represented by its 6 (afterwards 9) captains, came to exercise a veritable reign of terror, and no one knew when an accusation might fall on him. The leader of the *parte* was Piero degli Albizzi, whose chief rivals were the Ricci family. 534

The Great Plague (1348).

War with Milan (1351).

Italy at this time began to be overrun by bands of soldiers of fortune. The first of these bands with whom Florence came into contact was the Great Company, commanded by the count of Lando, which twice entered Tuscany but was expelled both times by the Florentine troops (1358-1359).

The condottieri.

In 1362 we find Florence at war with Pisa on account of commercial differences, and because the former had acquired the lordship of Volterra. The Florentines were successful until Pisa enlisted Sir John Hawkwood's English company; the latter won several battles, but were at last defeated at Cascina, and peace was made in 1364, neither side having gained much advantage. A fresh danger threatened the republic in 1367 when Charles IV., who had allied himself with Pope Urban V., Queen Joanna of Naples, and various north Italian despots to humble the Visconti, demanded that the Florentines should join the league. This they refused to do and armed themselves for defence, but eventually satisfied the emperor with a money payment.

The parte Guelfa.

The tyranny of the *parte Guelfa* still continued unabated, and the *capitani* carried an enactment by which no measure affecting the *parte* should be even discussed by the signory unless previously approved of by them. This infamous law, however, aroused so much opposition that some of the very men who had proposed it assembled in secret to discuss its abolition, and a quarrel between the Albizzi and the Ricci having weakened the *parte*, a *balìa* of 56 was agreed upon. Several of the Albizzi and the Ricci were excluded from office for five years, and a council called the Ten of Liberty was created to defend the laws and protect the weak against the strong. The *parte Guelfa* and the Albizzi still remained very influential and the attempts to abolish admonitions failed.

War with the church (1375-78).

In 1375 Florence became involved in a war which showed how the old party divisions of Italy had been obliterated. The papal legate at Bologna, Cardinal Guillaume de Noellet (d. 1394), although the church was then allied to Florence, was meditating the annexation of the city to the Holy See; he refused a request of the Florentines for grain from Romagna, and authorized Hawkwood to devastate their territory. Although a large part of the people disliked the idea of a conflict with the church, an alliance with Florence's old enemy Bernabò Visconti was made, war declared, and a *balìa* of 8, the *Otto della guerra* (afterwards called the "Eight Saints" on account of their good management) was created to carry on the campaign. Treaties with Pisa, Siena, Arezzo and Cortona were concluded, and soon no less than 80 towns, including Bologna, had thrown off the papal yoke. Pope Gregory XI. placed Florence under an interdict, ordered the expulsion of all Florentines from foreign countries, and engaged a ferocious company of Bretons to invade the republic's territory. The Eight levied heavy toll on church property and ordered the priests to disregard the interdict. They turned the tables on the pope by engaging Hawkwood, and although the Bretons by order of Cardinal Robert of Geneva (afterwards the anti-pope Clement VII.) committed frightful atrocities in Romagna, their captains were bribed by the republic not to molest its territory. By 1378 peace was made, partly through the mediation of St Catherine of Siena, and the interdict was removed in consideration of the republic's paying a fine of 200,000 florins to the pope.

Salvestro de' Medici.

During the war the Eight had been practically rulers of the city, but now the *parte Guelfa*, led by Lapo da Castiglionchio and Piero degli Albizzi, attempted to reassert itself by illicit interference in the elections and by a liberal use of "admonitions" (*ammonizioni*). Salvestro de' Medici, who had always opposed the *parte*, having been elected *gonfaloniere* in spite of its intrigues, proposed a law for the abolition of the admonitions, which was eventually passed (June 18, 1378), but the people had been aroused, and desired to break the power of the *parte* for good. Rioting occurred on the 21st of June, and the houses of the Albizzi and other nobles were burnt. The signory meanwhile created a *balìa* of 80 which repealed some of the laws promoted by the *parte*, and partly enfranchised the *ammoniti*. The people were still unsatisfied, the *arti minori* demanded further privileges, and the workmen insisted that their grievances against the *arti maggiori*, especially the wool trade by whom they were employed, be redressed. A large body of *ciompi* (wool carders) gathered outside the city and conspired to subvert the signory and establish a popular government. Although the plot, in which Salvestro does not seem to have played a part, was revealed, a good deal of mob violence occurred, and on the 21st of July the populace seized the *podestà's* palace, which they made their headquarters. They demanded a share in the government for the *popolo minuto*, but as soon as this was granted Tommaso Strozzi, as spokesman of the *ciompi*, obliged the signory to resign their powers to the Eight. Once the people were in possession of the palace, a *ciompo* named Michele di Lando took the lead and put a stop to disorder and pillage. He remained master of Florence for one day, during which he reformed the constitution, probably with the help of Salvestro de' Medici. Three new gilds were created, and nine priors appointed, three from the *arti maggiori*, three from the *minori*, and three from the new ones, while each of these classes in turn was to choose the *gonfaloniere* of justice; the first to hold the office was Michele di Lando. This did not satisfy the *ciompi*, and the disorders provoked by them resulted in a new government which reformed the two councils so as to exclude the lower orders. But to satisfy the people several of the *grandi*, including Piero degli Albizzi, were put to death, on charges of conspiracy, and many others were exiled. There was perpetual rioting and anarchy, and interference in the affairs of the government by the working men, while at the same time poverty and unemployment increased owing to the timidity of capital and the disorders, until at last in 1382 a reaction set in, and order was restored by the gild companies. Again a new constitution was decreed by which the *gonfaloniere* and half the *priori* were to be chosen from the *arti maggiori* and the other half from the *minori*; on several other boards the former were to be in the majority, and the three new gilds were abolished. The demagogues were executed or forced to fly, and Michele di Lando with great ingratitude was exiled. Several subsequent risings of the *ciompi*, largely of an economic character, were put down, and the Guelph families gradually regained much of their lost power, of which they availed 535
themselves to exile their opponents and revive the odious system of *ammonizioni*.

The riot of the ciompi (1378).

Meanwhile in foreign affairs the republic maintained its position, and in 1383 it regained Arezzo by purchase from the lieutenant of Charles of Durazzo. In 1390 Gian Galeazzo Visconti, having made himself master of a large part of northern Italy, intrigued to gain possession of Pisa and Siena. Florence, alone in resisting him, engaged Hawkwood, who with an army of 7000 men more than held his own against the powerful lord of Milan, and in 1392 a peace was concluded which the republic strengthened by an alliance with Pisa and several north Italian states. In 1393 Maso degli Albizzi was made *gonfaloniere*, and for many years remained almost master of Florence owing to his influential position in the *Arte della Lana*. A severe persecution was initiated against the Alberti and other families, who were disfranchised and exiled. Disorders and conspiracies against the merchant oligarchy continued, and although they were unsuccessful party passion was incredibly bitter, and the exiles caused the republic much trouble by intriguing against it in foreign states. In 1397-1398 Florence had two more wars with Gian Galeazzo Visconti, who, aspiring to the conquest of Tuscany, acquired the lordship of Pisa, Siena and Perugia. Hawkwood being dead, Florence purchased aid from the emperor Rupert. The Imperialists were beaten; but just as the Milanese were about to march on Florence, Visconti died. His territories were then divided between his sons and his *condottieri*, and Florence, ever keeping her eye on Pisa, now ruled by Gabriele Maria Visconti, made an alliance with Pope Boniface IX., who wished to regain Perugia and Bologna. War broke out once more, and the allies were successful, but as soon as Boniface had gained his ends he made peace, leaving the Florentines unsatisfied. In 1404 their attempt to capture Pisa single-handed failed, and Gabriele Maria placed himself under the protection of the French king. The Florentines then made overtures to France, who had supported the anti-popes all through the great schism, and suggested that they too would support the then anti-pope, Benedict XIII., in exchange for the sale of Pisa. This was agreed to, and in 1405 the city was sold to Florence for 260,000 florins; and Gino Capponi,[1] the Florentine commissioner, took possession of the citadel, but a few days later the citizens arose in arms and recaptured it from the mercenaries. There was great consternation in Florence at the news, and every man in the city "determined that he would go naked rather than not conquer Pisa" (G. Capponi). The next year that city, then ruled by Giovanni Gambacorti, was besieged by the Florentines, who blockaded the mouth of the Arno. After a six months' siege Pisa surrendered on terms (9th October 1406), and, although it was not sacked, many of the citizens were exiled and others forced to live in Florence, a depopulation from which it never recovered. Florence now acquired a great seaport and was at last able to develop a direct maritime trade.

Attempts to acquire Pisa (1402-6).

Except in connexion with the Pisan question the republic had taken no definite side in the great schism which had divided the church since 1378, but in 1408 she appealed both to Pope Gregory XII. and the anti-pope Benedict XIII. as well as to various foreign governments in favour of a settlement, and suggested a council within her own territory. Gregory refused, but after consulting a committee of theologians who declared him to be a heretic, the council promoted by Cardinal Cossa and other independent prelates met at Pisa. This nearly led to war with King Ladislas of Naples, because he had seized Rome, which he could only hold so long as the church was divided. The council deposed both popes and elected Pietro Filargi as Alexander V. (26th of June). But Ladislas still occupied the papal states, and Florence, alarmed at his growing power and ambition, formed a league with Siena, Bologna and Louis of Anjou who laid claim to the Neapolitan throne, to drive Ladislas from Rome. Cortona, Orvieto, Viterbo and other cities were recovered for Alexander, and in January 1410 Rome itself was captured by the Florentines under Malatesta dei Malatesti. Alexander having died in May before entering the Eternal City, Cardinal Cossa was elected as John XXIII.; Florence without offending him made peace with Ladislas, who had ceased to be dangerous, and purchased Cortona of the pope. In 1413 Ladislas attacked the papal states once more, driving John from Rome, and threatened Florence; but like Henry VII., Gian Galeazzo Visconti, and other enemies of the republic, he too died most opportunely (6th of August 1414). John having lost all authority after leaving Rome, a new council was held at Constance, which put an end to the schism in 1417 with the election of Martin V. The new pope came to Florence in 1419 as he had not yet regained Rome, which was held by Francesco Sforza for Queen Joanna II. of Naples, and remained there until the following year.

The council of Pisa (1408).

No important changes in the constitution took place during this period except the appointment of two new councils in 1411 to decide on questions of peace and war. The aristocratic faction headed by Maso degli Albizzi, a wise and popular statesman, had remained predominant, and at Maso's death in 1417 he was succeeded in the leadership of the party by Niccolò da Uzzano. In 1421 Giovanni de' Medici was elected *gonfaloniere* of justice, an event which marks the beginning of that wealthy family's power. The same year the republic purchased Leghorn from the Genoese for 100,000 florins, and established a body of "Consuls of the Sea" to superintend maritime trade. Although 11,000,000 florins had been spent on recent wars Florence continued prosperous and its trade increased.

In 1421 Filippo Maria Visconti, who had succeeded in reconquering most of Lombardy, seized Forlì; this induced the Florentines to declare war on him, as they regarded his approach as a menace to their territory in spite of the opposition of the peace party led by Giovanni de' Medici. The campaign was anything but successful, and the Florentines were defeated several times, with the result that their credit was shaken and several important firms failed. The pope too was against them, but when they induced the Venetians to intervene the tide of fortune changed, and Visconti was finally defeated and forced to accept peace on onerous terms (1427).

New war with the Visconti (1421-27).

The old systems of raising revenue no longer corresponded to the needs of the republic, and as early as 1336 the various loans made to the state were consolidated into one national debt (*monte*). Subsequently all extraordinary expenditure was met by forced loans (*prestanze*), but the method of distribution aroused discontent among the lower classes, and in 1427 a general *catasto* or assessment of all the wealth of the citizens was formed, and measures were devised to distribute the obligations according to each man's capacity, so as to avoid pressing too hardly on the poor. The *catasto* was largely the work of Giovanni de' Medici, who greatly increased his popularity thereby. He died in 1429.

Fiscal reforms (1427).

An attempt to capture Lucca led Florence, in alliance with Venice, into another costly war with Milan (1432-1433). The mismanagement of the campaign brought about a quarrel between the aristocratic party, led by Rinaldo degli Albizzi, and the popular party, led by Giovanni de' Medici's son Cosimo (1389-1464), although both had agreed to the war before it began. Rinaldo was determined to break the Medici party, and succeeded in getting Cosimo exiled. The Albizzi tried to strengthen their position by conferring exceptional powers on the *capitano del popolo* and by juggling with the election bags, but the Medici still had a great hold on the populace. Rinaldo's proposal for a *coup d'état* met with no response from his own party, and he failed to prevent the election of a pro-Medici signory in 1434. He and other leaders of the party were summoned to the palace to answer a charge of plotting against the state, to which he replied by collecting 800 armed followers. A revolution was only averted through the intervention of Pope Eugenius IV., who was then in Florence. A *parlamento* was summoned, and the *balìa* appointed decreed the return of Cosimo and the exile of Rinaldo degli Albizzi, Rodolfo Peruzzi, Niccolò Barbadori, and others, in spite of the feeble attempt of Eugenius to protect them. On the 6th of October 1434 Cosimo returned to Florence, and for the next three centuries the history of the city is identified with that of the house of Medici.[2] 536

Exile and return of Cosimo de' Medici (1433-34).

Cosimo succeeded in dominating the republic while remaining nominally a private citizen. He exiled those who opposed him, and governed by means of the *balìe*, which, re-elected every five years, appointed all the magistrates and acted according to his orders. In 1437 Florence and Venice were again at war with the Visconti, whose chief captain, Niccolò Piccinino (*q.v.*), on entering Tuscany with many Florentine exiles in his train, was signally defeated at Anghiari by the Florentines under Francesco Sforza (1440); peace was made the following year. The system of the *catasto*, which led to abuses, was abolished, and a progressive income-tax (*decima scalata*) was introduced with the object of lightening the burdens of the poor, who were as a rule Medicean, at the expense of the rich; but as it was frequently increased the whole community came to be oppressed by it in the end. Cosimo increased his own authority and that of the republic by aiding Francesco Sforza to become duke of Milan (1450), and he sided with him in the war against Venice (1452-1454). In 1452 the emperor Frederick III. passed through Florence on his way to be crowned in Rome, and was received as a friend. During the last years of Cosimo's life, affairs were less under his control, and the *gonfaloniere* Luca Pitti, a vain and ambitious man, introduced many changes, such as the abasement of the authority of the *podestà* and of the *capitano*, which Cosimo desired but was glad to attribute to others.

Cosimo's rule.

In 1464 Cosimo died and was succeeded, not without some opposition, by his son Piero, who was very infirm and gouty. Various plots against him were hatched, the anti-Medicean faction being called the Del Poggio party because the house of its leader Luca Pitti was on a hill, while the Mediceans were called the Del Piano party because Piero's house was in the town below; the other opposition leaders were Dietisalvi Neroni and Agnolo Acciaiuoli. But Piero's unexpected energy upset the schemes of his enemies. The death of Sforza led to a war for the succession of Milan, and the Venetians, instigated by Florentine exiles, invaded Tuscany. The war ended, after many indecisive engagements, in 1468, through the intervention of Pope Paul II. Piero died in 1469, leaving two sons, Lorenzo (1449-1492) and Giuliano (1453-1478). The former at once assumed the reins of government and became ruler of Florence in a way neither Cosimo nor Piero had ever attempted; he established his domination by means of *balìe* consisting of the signory, the *accoppiatori*, and 240 other members, all Mediceans, to be renewed every five years (1471). In 1472 a quarrel having arisen with Volterra on account of a dispute concerning the alum mines, Lorenzo sent an expedition against the city, which was sacked and many of the inhabitants massacred. Owing to a variety of causes an enmity arose between Lorenzo and Pope Sixtus IV., and the latter, if not an accomplice, at all events had knowledge of the Pazzi conspiracy against the Medici (1478). The result of the plot was that, although Giuliano was murdered, Lorenzo strengthened his position, and put to death or exiled numbers of his enemies. He was excommunicated by Sixtus, who, together with King Ferdinand of Naples, waged war against him; no great successes were registered on either side at

Piero de' Medici (the Gouty).

Lorenzo the Magnificent.

first, but eventually the Florentines were defeated at Poggio Imperiale (near Poggibonsi) and the city itself was in danger. Lorenzo's position was critical, but by his boldness in going to Naples he succeeded in concluding a peace with the king, which led to a reconciliation with the pope (1479-1480). He was received with enthusiasm on returning to Florence and became absolute master of the situation. In April 1480 a *balìa* was formed, and its most important act was the creation at Lorenzo's instance of the Council of Seventy; it was constituted for five years, but it became permanent, and all its members were Lorenzo's friends. From that time until his death the city was free from party strife under a *de facto* despotism, but after the Rinuccini conspiracy of that year the Council of Seventy passed a law declaring attempts on Lorenzo's life to be high treason. Owing to his political activity Lorenzo had neglected the business interests of his firm, and in order to make good certain heavy losses he seems to have appropriated public funds. His foreign policy, which was magnificent but expensive, rendered further forced loans necessary, and he also laid hands on the Monte delle Doti, an insurance institution to provide dowries for girls.

An attempt by the Venetians to seize Ferrara led to a general Italian war, in which Florence also took part on the side hostile to Venice, and when peace was made in 1484 the republic gained some advantages. The following year a revolt of the Neapolitan barons against King Ferdinand broke out, actively supported by Pope Innocent VIII.; Lorenzo remained neutral at first, but true to his policy of maintaining the balance of power and not wishing to see Ferdinand completely crushed, he ended by giving him assistance in spite of the king's unpopularity in Florence. Peace was made when the pope agreed to come to terms in 1486, and in 1487 Lorenzo regained Sarzana, which Genoa had taken from Florence nine years previously. The general disorders and ceaseless intrigues all over Italy required Lorenzo's constant attention, and he succeeded in making Florence "the needle of the balance of power in Italy." At this time the Dominican Fra Girolamo Savonarola (*q.v.*) was in Florence and aroused the whole city by his denunciations of ecclesiastical corruption and also of that of the Florentines. He opposed Lorenzo's government as the source of the immorality of the people, and to some extent influenced public opinion against him. Ill-health now gained on Lorenzo, and Savonarola, whom he had summoned to his bedside, refused to give absolution to the destroyer of Florentine liberties. Lorenzo, during whose rule Florence had become one of the greatest centres of art and literature in Europe, died in 1492.

Savonarola.

He was succeeded by his son Piero, who had none of his father's capacity and made a number of political blunders. When Charles VIII. of France came to Italy to conquer Naples Piero decided to assist the latter kingdom, although the traditional sympathies of the people were for the French king, and when Charles entered Florentine territory and captured Sarzana, Piero went to his camp and asked pardon for opposing him. The king demanded the cession of Pisa, Leghorn and other towns, which Piero granted, but on returning to Florence on the 8th of November 1494 he found the opposition greatly strengthened and his popularity forfeited, especially when the news of his disgraceful cessions to Charles became known. He was refused admittance to the palace, and the people began to shout "Popolo e libertà!" in opposition to the Medicean cry of "Palle, Palle!" (from the Medici arms). With a small escort he fled from the city, followed soon after by his brother Giovanni. That same day Pisa rose in revolt against the Florentines, and was occupied by Charles. The expulsion of the Medici produced some disorder, but Piero Capponi (*q.v.*) and other prominent citizens succeeded in keeping the peace. Ambassadors, one of whom was Savonarola, were sent to treat with the French king, but no agreement was arrived at until Charles entered Florence on the 17th of November at the head of 12,000 men. In spite of their French sympathies the citizens were indignant at the seizure of Sarzana, and while they gave the king a splendid welcome, they did not like his attitude of conqueror. Charles was impressed with the wealth and refinement of the citizens, and above all with the solid fortress-like appearance of their palaces. The signory appointed Piero Capponi, a man of great ability and patriotism, and experienced in diplomacy, the *gonfaloniere* Francesco Valori, the Dominican Giorgio Vespucci, and the jurisconsult and diplomatist Domenico Bonsi, syndics to conduct the negotiations with the French king. Charles's demands by no means pleased the citizens, and the arrogance and violence of his soldiers led to riots in which they were assailed with stones in the narrow streets. When the king began to hint at the recall of Piero de' Medici, whose envoys had gained his ear, the signory ordered the citizens to be ready to fly to arms. The proposal was dropped, but Charles demanded an immense sum of money before he would leave the city; long discussions followed, and when at last he presented an insolent ultimatum the syndics refused to accept it. The king said in a threatening tone, "Then we shall sound our trumpets," whereupon Capponi tore up the document in his face and replied, "And we shall ring our bells." The king, realizing what street fighting in Florence would mean, at once came to terms; he contented himself with 120,000 florins, agreeing to assume the title of "Protector and Restorer of the liberty of Florence," and to give up the fortresses he had taken within two years, unless his expedition to Naples should be concluded sooner; the Medici were to remain banished, but the price on their heads was withdrawn. But Charles would not depart, a fact which caused perpetual disturbance in the city, and it was not until the 28th of November, after an exhortation by Savonarola whom he greatly respected, that he left Florence.

Piero de' Medici.

Expulsion of the Medici (1494). Charles VIII. in Florence.

537

Piero Capponi.

It was now intended to re-establish the government on the basis of the old republican institutions, but it was found that sixty years of Medici rule had reduced them to mere shadows, and the condition of the government, largely controlled by a *balìa* of 20 *accoppiatori* and frequently disturbed by the summoning of the *parlamento*, was utterly chaotic. Consequently men talked of nothing save of changing the constitution, but unfortunately there was no longer an upper class accustomed to public affairs, while the lower class was thoroughly demoralized. Many proposals were made, none of them of practical value, until Savonarola, who had already made a reputation as a moral reformer, began his famous series of political sermons. In the prevailing confusion the people turned to him as their only hope, and gradually a new government was evolved, each law being enacted as the result of his exhortations. A Greater Council empowered to appoint magistrates and pass laws was formed, to which all citizens *netti di specchio* (who had paid their taxes) and *beneficiati* (*i.e.* who had sat in one of the higher magistracies or whose fathers, grandfathers, or great-grandfathers had done so) were eligible together with certain others. There were 3200 such citizens, and they sat one-third at a time for six months. The Greater Council was to elect another council of 80 citizens over forty years old, also to be changed every six months; this body, which the signory must consult once a week, together with the colleges and the signory itself, was to appoint ambassadors and commissaries of war, and deal with other confidential matters. The system of forced loans was abolished and a 10% tax on real property introduced in its stead, and a law of amnesty for political offenders enacted. Savonarola also proposed a court of appeal for criminal and political crimes tried by the *Otto di guardia e balìa*; this too was agreed to, but the right of appeal was to be, not to a court as Savonarola suggested, but to the Greater Council, a fact which led to grave abuses, as judicial appeals became subject to party passions. The *parlamenti* were abolished and a *monte di pietà* to advance money at reasonable interest was created. But in spite of Savonarola's popularity there was a party called the *Bigi* (greys) who intrigued secretly in favour of the return of the Medici, while the men of wealth, called the *Arrabbiati*, although they hated the Medici, were even more openly opposed to the actual régime and desired to set up an aristocratic oligarchy. The adherents of Savonarola were called the *Piagnoni*, or snivellers, while the *Neutrali* changed sides frequently.

The revived republic. Savonarola as a statesman.

A league between the pope, the emperor, Venice and Spain having been made against Charles VIII., the latter was forced to return to France. On his way back he passed through Florence, and; although the republic had refused to join the league, it believed itself in danger, as Piero de' Medici was in the king's train. Savonarola was again sent to the

League against Charles VIII.

French camp, and his eloquence turned the king from any idea he may have had of reinstating the Medici. At the same time Charles violated his promise by giving aid to the Pisans in their revolt against Florence, and did not restore the other fortresses. After the French had abandoned Italy, Piero de' Medici, encouraged by the league, enlisted a number of mercenaries and marched on Florence, but the citizens, fired by Savonarola's enthusiasm, flew to arms and prepared for an energetic resistance; owing to Piero's incapacity and the exhaustion of his funds the expedition came to nothing. At the same time the conditions of the city were not prosperous; its resources were strained by the sums paid to Charles and by the war; its credit was shaken, its trade paralysed, famine and plague visited the city, and the war to subjugate Pisa was proceeding unsatisfactorily. Worse still was the death in 1496 of one of its ablest and most disinterested statesmen, Piero Capponi. The league now attacked Florence, for Pope Alexander VI. hated Savonarola and was determined to destroy the republic, so as to reinstate the Medici temporarily and prepare the way for his own sons; the Venetians and Imperialists besieged Leghorn, and there was great misery in Florence. All this decreased Savonarola's popularity to some extent, but the enemy having been beaten at Leghorn and the league being apparently on the point of breaking up, the Florentines took courage and the friar's party was once more in the ascendant. Numerous processions were held, Savonarola's sermons against corruption and vice seemed to have temporarily transformed the citizens, and the carnival of 1497 remained famous for the burning of the "vanities" (*i.e.* indecent books and pictures and carnival masks and costumes). The friar's sermons against ecclesiastical corruption, and especially against the pope, resulted in his excommunication by the latter, in consequence of which he lost much of his influence and immorality spread once more. That same year Piero made another unsuccessful attempt on Florence. New Medici plots having been discovered, Bernardo del Nero and other prominent citizens were tried and put to death; but the party hostile to Savonarola gained ground and had the support of the Franciscans, who were hostile to the Dominican order. Pulpit warfare was waged between Savonarola and his opponents, and the matter ended in his being forbidden to preach and in a proposed ordeal by fire, which, however, never came off. The pope again and again demanded that the friar be surrendered to him, but without success, in spite of his threats of an interdict against the city. The Piagnoni were out of power, and a signory of Arrabbiati having been elected in 1498, a mob of Savonarola's opponents attacked the convent of St Mark where he resided, and he himself was arrested and imprisoned. The commission appointed to try him on charges of heresy and treason was composed of his enemies, including Doffo Spini, who had previously attempted to murder him; many irregularities were committed during the three trials, and the prisoner was repeatedly tortured. The outgoing signory secured the election of another which was of their way of thinking, and on the 22nd of May 1498 Savonarola was condemned to death and executed the following day.

Alexander VI. against Florence.

Trial and execution of Savonarola (1498).

The pope having been satisfied, the situation in Florence was less critical for the moment. The war against Pisa was renewed, and in 1499 the city might have been taken but for the dilatory tactics of the Florentine commander Paolo Vitelli, who was consequently arrested on a charge of treason and put to death. Louis XII. of France, who now sent an army into Italy to conquer the Milanese, obtained the support of the Florentines. Cesare Borgia, who had seized many cities in Romagna, suddenly demanded the reinstatement of the Medici in Florence, and the danger was only warded off by appointing him captain-general of the Florentine forces at a large salary (1501). The weakness of the government becoming every day more apparent, several constitutional changes were made, and many old institutions, such as that of the *podestà* and *capitano del popolo*, were abolished; finally in 1502, in order to give more stability to the government, the office of *gonfaloniere*, with the right of proposing laws to the signory, was made a life appointment. The election fell on Piero Soderini (1448-1522), an honest public-spirited man of no particular party, but lacking in strength of character. One useful measure which he took was the institution of a national militia at the suggestion of Niccolò Machiavelli (1505). In the meanwhile the Pisan war dragged on without much headway being made. In 1503 both Piero de' Medici and Alexander VI. had died, eliminating two dangers to the republic. Spain, who was at war with France over the partition of Naples, helped the Pisans as the enemies of Florence, France's ally (1501-1504), but when the war was over the Florentines were able to lay siege to Pisa (1507), and in 1509 the city was driven by famine to surrender and became a dependency of Florence once more. 538

Piero Soderini.

Pope Julius II., after having formed the league of Cambrai with France and Spain against Venice, retired from it in 1510, and raised the cry of "Fuori i Barbari" (out with the barbarians), with a view to expelling the French from Italy. King Louis thereupon proposed an oecumenical council so as to create a schism in the Church, and demanded that it be held in Florentine territory. After some hesitation the republic agreed to the demand, and the council was opened at Pisa, whereupon the pope immediately placed Florence under an interdict. At the request of the Florentines the council removed to Milan, but this did not save them from the pope's wrath. A Spanish army under Raymundo de Cardona and accompanied by Cardinal Giovanni de' Medici and his brother Giuliano entered the republic's territory and demanded 100,000 florins, the dismissal of Soderini, and the readmission of the Medici. Soderini offered to resign, but the Greater Council supported him and preparations for defence were made. In August the Spaniards took Prato by storm and committed hideous atrocities on the inhabitants; Florence was in a panic, a group of the *Ottimati*, or nobles, forced Soderini to resign and leave the city, and Cardona's new terms were accepted, viz. the readmission of the Medici, a fine of 150,000 florins, and an alliance with Spain. On the 1st of September 1512 Giuliano and Giovanni de' Medici, and their nephew Lorenzo, entered Florence with the Spanish troops; a *parlamento* was summoned, and a packed *balìa* formed which abolished the Greater Council and created a constitution similar to that of Lorenzo the Magnificent. Giuliano became *de facto* head of the government, but he did not pursue the usual vindictive policy of his house, although he resorted to the Laurentian method of amusing the citizens with splendid festivities. In 1513, on the death of Julius II., Giovanni de' Medici was elected pope as Leo X., an event which greatly enhanced the importance of the house. In March 1514 Giuliano died, and was succeeded by Lorenzo, who was also created duke of Urbino. At his death in 1519 Cardinal Giulio de' Medici (son of the Giuliano murdered in the Pazzi conspiracy) took charge of the government; he met with some opposition and had to play off the Ottimati against the Piagnoni, but he did not rule badly and maintained at all events the outward forms of freedom. In 1523 he was created pope as Clement VII. and sent his relatives Ippolito and Alessandro, both minors and bastards, to Florence under the tutorship of Cardinal Silvio Passerini. Ippolito was styled the *Magnifico* and destined to be ruler of the republic, but Cardinal Passerini's regency proved most unpopular, and the city was soon seething with discontent. Revolts broke out and Passerini showed himself quite unequal to coping with the situation. The Ottimati were mostly anti-Medicean, and by 1527 the position was untenable. When Filippo Strozzi, and above all his wife, threw their influence in the scales against the Medici, and the magistrates declared for their expulsion from power, Passerini, Ippolito and Alessandro left Florence (17th of May 1527). A *Consiglio degli Scelti* was summoned, and a constitution similar to that of Savonarola's time was established. The Greater Council was revived and Niccolò Capponi created *gonfaloniere* for a year. But Florence was torn by factions—the Ottimati who desired an oligarchy, the Palleschi or Mediceans who generally supported them, the Adirati who opposed Capponi for his moderation, the Arrabbiati who were strongly anti-Medicean, and the Popolani who opposed the Ottimati. "It is almost impossible that a state so disorganized and corrupt as Florence then was should produce men of parts and character, but if by chance any such should arise they would be hated and persecuted, their dispositions would be soured by indignation, or they would be hunted from their country or die of grief" (Benedette Varchi). Capponi did his best to reform the city and save the situation, and while

Schismatic council of Pisa (1510).

Return of the Medici (1512).

Second expulsion of the Medici (1527).

adopting Savonarola's tone in internal affairs, he saw the dangers in the foreign situation, realizing that a reconciliation between the pope and the emperor Charles V. would prove disastrous for Florence, for Clement would certainly seize the opportunity to reinstate his family in power. Having been re-elected *gonfaloniere* in spite of much opposition in 1528, Capponi tried to make peace with the pope, but his correspondence with the Vatican resulted in a quite unjustified charge of high treason, and although acquitted he had to resign office and leave the city for six months. Francesco Carducci was elected *gonfaloniere* in his place, and on the 29th of June 1529 the pope and the emperor concluded a treaty by which the latter agreed to re-establish the Medici in Florence. Carducci made preparations for a siege, but a large part of the people were against him, either from Medicean sympathies or fear, although the Frateschi, as the believers in Savonarola's views were called, supported him strongly. A body called the *Nove della Milizia*, of whom Michelangelo Buonarroti was a member, was charged with the defence of the city, and Michelangelo (*q.v.*) himself superintended the strengthening of the fortifications. A most unfortunate choice for the chief command of the army was the appointment of Malatesta Baglioni. In August an imperial army under Philibert, prince of Orange, advanced on the city. In September Malatesta surrendered Perugia, and other cities fell before the Imperialists. All attempts to come to terms with the pope were unsuccessful, and by October the siege had begun. Although alone against papacy and empire, the citizens showed the greatest spirit and devotion, and were successful in many sorties. The finest figure produced by these events was that of Francesco Ferruccio (*q.v.*); by his defence of Empoli he showed himself a first-class soldier, and was appointed commissioner-general. He executed many rapid marches and counter-marches, assaulting isolated bodies of the enemy unexpectedly, and harassing them continually. But Malatesta was a traitor at heart and hindered the defence of the city in every way. Ferruccio, who had recaptured Volterra, marched to Gavinana above Pistoia to attack the Imperialists in the rear. A battle took place at that spot on the 3rd of August, but in spite of Ferruccio's heroism he was defeated and killed; the prince of Orange also fell in that desperate engagement. Malatesta contributed to the defeat by preventing a simultaneous attack by the besieged. The sufferings from famine within the city were now very great, and an increasingly large part of the people favoured surrender. The signory, at last realizing that Malatesta was a traitor, dismissed him; but it was too late, and he now behaved as though he were governor of Florence; when the troops attempted to enforce the dismissal he turned his guns on them. On the 9th of August the signory saw that all hope was lost and entered into negotiations with Don Ferrante Gonzaga, the new imperial commander. On the 12th the capitulation was signed: Florence was to pay an indemnity of 80,000 florins, the Medici were to be recalled, the emperor was to establish the new government, "it being understood that liberty is to be preserved." Baccio Valori, a Medicean who had been in the imperialist camp, now took charge, and the city was occupied by foreign troops. A *parlamento* was summoned, the usual packed *balìa* created, and all opposition silenced. The city was given over to Pope Clement, who, disregarding the terms of the capitulation, had Carducci and Girolami (the last *gonfaloniere*) hanged, and established Alessandro de' Medici, the natural son of Lorenzo, duke of Urbino, as head of the republic on the 5th of July 1531. The next year the signory was abolished, Alessandro created *gonfaloniere* for life, and his lordship made hereditary in his family by imperial patent. Thus Florence lost her liberty, and came to be the capital of the duchy (afterwards grand-duchy) of Tuscany (see TUSCANY). 539

The siege of Florence.

Surrender of Florence (1530).

The Medici dynasty ruled in Tuscany until the death of Gian Gastone in 1737, when the grand-duchy was assigned to Francis, duke of Lorraine. But it was governed by a regency until 1753, when it was conferred by the empress Maria Theresa on his son Peter Leopold. During the Napoleonic wars the grand-duke Ferdinand III. of Habsburg-Lorraine was driven from the throne, and Tuscany was annexed to the French empire in 1808. In 1809 Florence was made capital of the kingdom of Etruria, but after the fall of Napoleon in 1814 Ferdinand was reinstated. He died in 1833, and was succeeded by Leopold II. In 1848 there was a liberal revolutionary movement in Florence, and Leopold granted a constitution. But civil disorders followed, and in 1849 the grand-duke returned under an Austrian escort. In 1859, after the Franco-Italian victories over the Austrians in Lombardy, by a bloodless revolution in Florence Leopold was expelled and Tuscany annexed to the Sardinian kingdom.

The Grand-Duchy of Tuscany.

In 1865 Florence became the capital of the kingdom of Italy, but after the occupation of Rome in 1870 during the Franco-Prussian war, the capital was transferred to the Eternal City (1871).

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(L. V.*)

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1 The historian, not to be confounded with the modern historian and statesman of the same name (*q.v.*).

2 The history of Florence from 1434 to 1737 will be found in greater detail in the article MEDICI, save for the periods from 1494 to 1512 and from 1527 to 1530, during which the republic was restored. For the period from 1530 to 1860 see also under TUSCANY.

FLORES, an island in the Atlantic Ocean, belonging to Portugal, and forming part of the Azores archipelago. Pop. (1900) 8137; area, 57 sq. m. Flores and the adjacent island of Corvo (pop. 806; area, 7 sq. m.) constitute the westernmost group of the Azores, and seem but imperfectly to belong to the archipelago, from the rest of which they are widely severed. They lie also out of the usual track of navigators; but to those who, missing their course, are led thither, Flores affords good shelter in its numerous bays. Its poultry is excellent; and the cattle are numerous, but small. It derives its name from the abundance of the flowers that find shelter in its deep ravines. Its capital is Santa Cruz das Flores (2247). In 1591 Flores was the station of the English fleet before the famous sea fight between Sir R. Grenville's ship "Revenge" and a Spanish fleet of 53 vessels. See AZORES.

FLORES, an island of the Dutch East Indies, a member of the chain extending east of Java. Its length is 224 m., its greatest breadth 37 m., and its area 5850 sq. m. The existence of slate, chalk, and sandstone, eruptive rock, volcanoes and heights stretching west and east, indicates a similar structure to that of the other islands of the chain. Several volcanoes are active. Among the loftier summits are, on the south coast, Gunong Rokka (7940 ft.) and Keo (6560 ft.); with the lesser but constantly active Gunong Api, forming a peninsula; and at the south-east, Lobetobi (7120 ft.). The thickly wooded interior is little explored. The coasts have deep bays and extensive rounded gulfs, where are situated the principal villages (*kampongs*). On the north coast are Bari, Reo, Maumer and Geliting; on the east, Larantuka; and on the south, Sikka and Endeh. The rivers, known only at their mouths, seem to be unnavigable. The mean temperature is 77° to 80° F., and the yearly rainfall 43 to 47 in. For administrative purposes the island is divided into West Flores (Mangerai), attached to the government of Celebes, and Middle and East Flores (Larantuka and dependencies), attached to the residency of Timor. The population is estimated at 250,000. The people live by trade, fishing, salt-making, shipbuilding, and the cultivation of rice, maize, and palms in the plain, but there is little industry or commerce. Some edible birds' nests, rice, sandalwood and cinnamon are exported to Celebes and elsewhere. The inhabitants of the coast-districts are mainly of Malay origin. The aborigines, who occupy the interior, are of Papuan stock. They are tall and well-built, with dark or black skins. The hair is frizzly. They are pure savages; their only religion is a kind of nature-worship. They consider the earth holy and inviolable; thus in severe droughts they only dig the river-beds for water as a last resource. Portugal claimed certain portions of the island until 1859.

FLOREZ, ENRIQUE (1701-1773), Spanish historian, was born at Valladolid on the 14th of February 1701. In his fifteenth year he entered the order of St Augustine, was afterwards professor of theology at the university of Alcala, and published a *Cursus theologiae* in five volumes (1732-1738). He afterwards devoted himself to historical studies. Of these the first-fruit was his *Clave Historial*, a work of the same class as the French *Art de vérifier les dates*, and preceding it by several years. It appeared in 1743, and passed through many editions. In 1747 was published the first volume of *España Sagrada, teatro geografico-historico de la Iglesia de España*, a vast compilation of Spanish ecclesiastical history which obtained a European reputation, and of which twenty-nine volumes appeared in the author's lifetime. It was continued after his death by Manuel Risco and others, and further additions have been made at the expense of the Spanish government. The whole work in fifty-one volumes was published at Madrid (1747-1886). Its value is considerably increased by the insertion of ancient chronicles and documents not easily accessible elsewhere. Florez was a good numismatist, and published *Medallas de las Colonias* in 2 vols. (1757-1758), of which a third volume appeared in 1773. His last work was the *Memorias de las reynas Catolicas*, 2 vols. (1770). Florez led a retired, studious and unambitious life, and died at Madrid on the 20th of August 1773.

See F. Mendez, *Noticia de la vida y escritos de Henrique Florez* (Madrid, 1780).

FLORIAN, SAINT, a martyr honoured in Upper Austria. In the 8th century Puoche was mentioned as the place of his tomb, and on the site was built the celebrated monastery of canons regular, St Florian, which still exists. His *Acta* are of considerable antiquity, but devoid of historical value. Their substance is borrowed from the *Acta* of St Irenaeus of Sirmium. The cult of St Florian was introduced into Poland, together with the relics of the saint, which were brought thither in 1183 by Giles, bishop of Modena. Casimir, duke of Poland, dedicated a church at Cracow to him. He is represented in various ways, especially as a warrior holding in his hand a vessel from which he pours out flames. His protection is often sought against fire. His day in the calendar is the 4th of May.

See *Acta Sanctorum*, May, i. 461-467; B. Krusch, *Scriptores rerum Merovingicarum*, iii. 65-68; C. Cahier, *Caractéristiques des saints*, p. 490 (Paris, 1867).

(H. De.)

FLORIAN, JEAN PIERRE CLARIS DE (1755-1794), French poet and romance writer, was born on the 6th of March 1755 at the château of Florian, near Sauve, in the department of Gard. His mother, a Spanish lady named Gilette de Salgues, died when he was quite a child. His uncle and guardian, the marquis of Florian, who had married a niece of Voltaire, introduced him at Ferney and in 1768 he became page at Anet in the household of the duke of Penthièvre, who remained his friend throughout his life. Having studied for some time at the artillery school at Bapaume he obtained from his patron a captain's commission in a dragoon regiment, and in this capacity it is said he displayed a boisterous 540 behaviour quite incongruous with the gentle, meditative character of his works. On the outbreak of the French Revolution he retired to Sceaux, but he was soon discovered and imprisoned; and though his imprisonment was short he survived his release only a few months, dying on the 13th of September 1794.

Florian's first literary efforts were comedies; his verse epistle *Voltaire et le serf du Mont Jura* and an eclogue *Ruth* were crowned by the French Academy in 1782 and 1784 respectively. In 1782 also he produced a one-act prose comedy, *Le Bon Ménage*, and in the next year *Galatée*, a romantic tale in imitation of the *Galatea* of Cervantes. Other short tales and comedies followed, and in 1786 appeared *Numa Pompilius*, an undisguised imitation of Fénelon's *Télémaque*. In 1788 he became a member of the French Academy, and published *Estelle*, a pastoral of the same class as *Galatée*. Another romance, *Gonzalve de Cordoue*, preceded by an historical notice of the Moors, appeared in 1791, and his famous collection of *Fables* in 1792. Among his posthumous works are *La Jeunesse de Florian, ou Mémoires d'un jeune Espagnol* (1807), and an abridgment (1799) of *Don Quixote*, which, though far from being a correct representation of the original, had great and merited success.

Florian imitated Salomon Gessner, the Swiss idyllist, and his style has all the artificial delicacy and sentimentality of the Gessnerian school. Perhaps the nearest example of the class in English literature is afforded by John Wilson's (Christopher North's) *Lights and Shadows of Scottish Life*. Among the best of his fables are reckoned "The Monkey showing the Magic Lantern," "The Blind Man and the Paralytic," and "The Monkeys and the Leopard."

The best edition of Florian's *Œuvres complètes* appeared in Paris in 16 volumes, 1820; his *Œuvres inédites* in 4 volumes, 1824.

See “Vie de Florian,” by L.F. Jauffret, prefixed to his *Œuvres posthumes* (1802); A.J.N. de Rosny, *Vie de Florian* (Paris, An V.); Sainte-Beuve, *Causeries du lundi*, t. iii.; A. de Montvaillant, *Florian, sa vie, ses œuvres* (1879); and *Lettres de Florian à Mme de la Briche*, published, with a notice by the baron de Barante in *Mélanges* published (1903) by the Société des bibliophiles français.

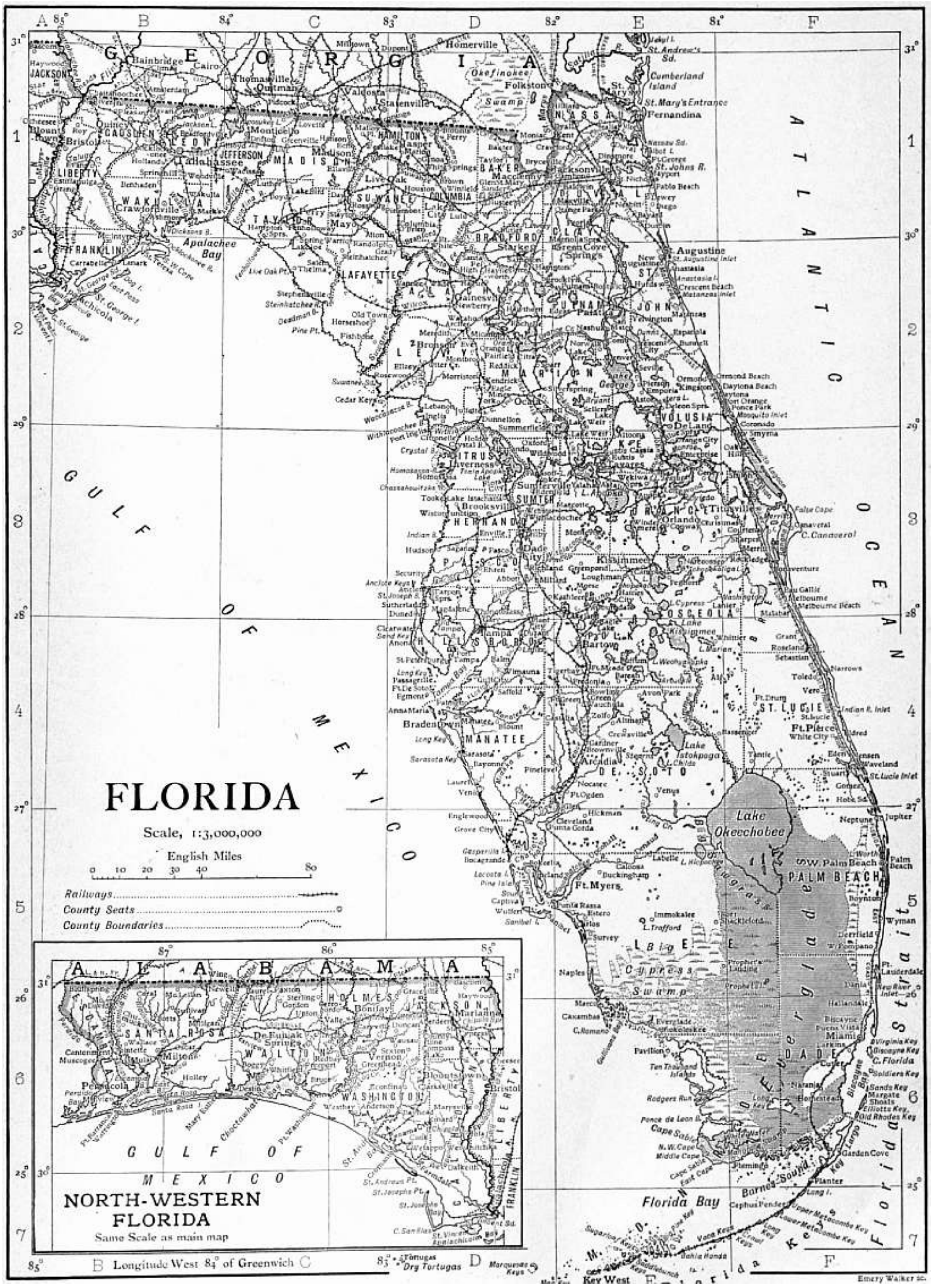
FLORIANOPOLIS (formerly *Desterro*, *Nossa Senhora do Desterro* and *Santa Catharina*, and still popularly known under the last designation), a city and port of Brazil and the capital of the state of Santa Catharina, on the western or inside shore of a large island of the same name, 485 m. S.S.W. of Rio de Janeiro, in 27° 30′ S., 48° 30′ W. Pop. (1890) 11,400, including many Germans; (1902, estimate) 16,000; of the municipality, including a large rural district and several villages (1890), 30,687. The harbour is formed by the widening of the strait separating the island from the mainland, which is nearly 2 m. wide at this point. It is approached by narrow entrances from the N. and S., which are defended by small forts. The island is mountainous and wooded, and completely shelters the harbour from easterly storms. The surroundings are highly picturesque and tropical in character, but the town itself is poorly built and unattractive. Its public buildings include the president’s official residence, arsenal, lyceum, hospital and some old churches. The climate is warm for the latitude, but the higher elevations of the vicinity are noted for their mild climate and healthfulness. There are some German colonies farther up the coast whose products find a market here, and a number of small settlements along the mainland coast add something to the trade of the town. The more distant inland towns are partly supplied from this point, but difficult mountain roads tend to restrict the trade greatly. There is a considerable trade in market produce with Rio de Janeiro, but the exports are inconsiderable. Santa Catharina was formerly one of the well-known whaling stations of the South Atlantic, and is now a secondary military and naval station.

The island of Santa Catharina was originally settled by the Spanish; Cabeza de Vaca landed here in 1542 and marched hence across country to Asuncion, Paraguay. The Spanish failed to establish a permanent colony, however, and the Portuguese took possession. The island was captured by a Spanish expedition under Viceroy Zeballos in 1777. A boundary treaty of that same year restored it to Portugal. In 1894 Santa Catharina fell into the possession of revolutionists against the government of President Floriano Peixoto. With the collapse of the revolution the city was occupied by the government forces, and its name was then changed to Florianopolis in honour of the president of the republic.

FLORIDA, the most southern of the United States of America, situated between 24° 30′ and 31° N. lat. and 79° 48′ and 87° 38′ W. long. It is bounded N. by Georgia and Alabama, E. by the Atlantic Ocean, S. by the Strait of Florida, which separates it from Cuba, and by the Gulf of Mexico, and W. by Alabama and the Gulf. The Florida Keys, a chain of islands extending in a general south-westerly direction from Biscayne Bay, are included in the state boundaries, and the city of Key West, on an island of the same name, is the seat of justice of Monroe county. The total area of the state is 58,666 sq. m., of which 3805 sq. m. are water surface. The coast line is greater than that of any other state, extending 472 m. on the Atlantic and 674 m. on the Gulf Coast.

The peculiar outline of Florida gives it the name of “Peninsula State.” The average elevation of the surface of the state above the sea-level is less than that of any other state except Louisiana, but there is not the monotony of unbroken level which descriptions and maps often suggest. The N.W. portion of the state is, topographically, similar to south-eastern Alabama, being a rolling, hilly country; the eastern section is a part of the Atlantic coastal plain; the western coast line is less regular than the eastern, being indented by a number of bays and harbours, the largest of which are Charlotte Harbour, Tampa Bay and Pensacola Bay. Along much of the western coast and along nearly the whole of the eastern coast extends a line of sand reefs and narrow islands, enclosing shallow and narrow bodies of water, such as Indian river and Lake Worth—called rivers, lakes, lagoons, bays and harbours. In the central part of the state there is a ridge, extending N. and S. and forming a divide, separating the streams of the east coast from those of the west. Its highest elevation above sea-level is about 300 ft. The central region is remarkable for its large number of lakes, approximately 30,000 between Gainesville in Alachua county, and Lake Okeechobee. They are due largely to sinkholes or depressions caused by solution of the limestone of the region. Many of the lakes are connected by subterranean channels, and a change in the surface of one lake is often accompanied by a change in the surface of another. By far the largest of these lakes, nearly all of them shallow, is Lake Okeechobee, a body of water about 1250 sq. m. in area and almost uniformly shallow, its depth seldom being greater than 15 ft. Caloosahatchee river, flowing into the Gulf of Mexico near Charlotte Harbour, is its principal outlet. Among the other lakes are Orange, Crescent, George, Weir, Harris, Eustis, Apopka, Tohopekaliga, Kissimmee and Istokpoga. The chief feature of the southern portion of the state is the Everglades (*q.v.*), the term “Everglade State” being popularly applied to Florida. Within the state there are many swamps, the largest of which are the Big Cypress Swamp in the S. adjoining the Everglades on the W., and Okefinokee Swamp, extending from Georgia into the N.E. part of the state.

A peculiar feature of the drainage of the state is the large number of subterranean streams and of springs, always found to a greater or less extent in limestone regions. Some of them are of great size. Silver Spring and Blue Spring in Marion county, Blue Spring and Orange City Mineral Spring in Volusia county, Chipola Spring near Marianna in Jackson county, Espiritu Santo Spring near Tampa in Hillsboro county, Magnolia Springs in Clay county, Suwanee Springs in Suwanee county, White Sulphur Springs in Hamilton county, the Wekiva Springs in Orange county, and Wakulla Spring, Newport Sulphur Spring and Panacea Mineral Spring in Wakulla county are the most noteworthy. Many of the springs have curative properties, one of them, the Green Cove Spring in Clay county, discharging about 3000 gallons of sulphuretted water per minute. Not far from St Augustine a spring bursts through the sea itself with such force that the ocean breakers roll back from it as from a sunken reef. The springs often merge into lakes, and lake systems are usually the sources of the rivers, Lake George being the principal source of the St Johns, and Lake Kissimmee of the Kissimmee, while a number of smaller lakes are the source of the Oklawaha, one of the most beautiful of the Floridian rivers.



(Click to enlarge.)

Of the rivers the most important are the St Johns, which flows N. from about the middle of the peninsula, empties into the Atlantic a short distance below Jacksonville, and is navigable for about 250 m. from its mouth, the Withlacoochee, flowing in a general north-westerly direction from its source in the N.E. part of Polk county, and forming near its entrance into the Gulf of Mexico the boundary between Levy and Citrus counties, and four rivers, the Escambia, the Choctawatchee, the Apalachicola, and the Suwanee, having their sources in other states and traversing the north-western part of Florida. On account of its sand reefs, the east coast has not so many harbours as the west coast. The most important harbours are at Fernandina, St Augustine, and Miami on the E. coast, and at Tampa, Key West and Pensacola on the W. coast.

The soils of Florida have sand as a common ingredient.[1] They may be divided into three classes: the pine lands, which often have a surface of dark vegetable mould, under which is a sandy loam resting on a substratum of clay, marl or limestone—areas of such soil are found throughout the state; the "hammocks," which have soil of similar ingredients and are interspersed with the pine lands—large areas of this soil occur in Levy, Alachua, Citrus, Hernando, Pasco, Gadsden, Leon, Madison, Jefferson and Jackson counties; and the alluvial swamp lands, chiefly in E. and S. Florida, the richest class, which require drainage to fit them for cultivation.

As regards climate Florida may be divided into three more or less distinct zones. North and west of a line passing through Cedar Keys and Fernandina the climate is distinctly "southern," similar to that of the Gulf states; from this line to another extending from the mouth of the Caloosahatchee to Indian river inlet the climate is semi-tropical, and is well suited to the cultivation of oranges; S. of this the climate is sub-tropical, well adapted to the cultivation of pineapples. Since the semi-tropical and sub-tropical zones are nearer the course of the Gulf Stream, and are swept by the trade winds, their temperatures are more uniform than those of the zones of southern climate; indeed, the extremes of heat (103° F.) and cold (13° F.) are felt in the region of southern climate. The mean annual temperature of the state is 70.8° F., greater in the sub-tropical than in the other climate zones, and the Atlantic coast is in general warmer than the Gulf Coast. The rainfall averages 52.09 in. per annum. On account of its warm climate, Florida has many resorts for health and pleasure, which are especially popular in the season from January to April; the more important are St Augustine, Ormond, Daytona, Palm Beach, Miami, Tampa, White Springs, Hampton Springs, Worthington Springs and Orange Springs.

No metals have ever been discovered in Florida. The principal minerals are rock phosphate and (recently more important) land and river pebble phosphate, found in scattered deposits in a belt on the "west coast" about 30 m. wide and extending from Tallahassee to Lake Okeechobee. The centre of the quarries is Dunnellon in Marion county, and pebble phosphate is found in Hillsboro, Polk, De Soto, Osceola, Citrus and Hernando counties. Although the economic value of the phosphate deposits was first realized about 1889, between 1894 and 1907 Florida produced, each year, more than half of all the phosphate rock produced in the whole United States, the yield of Florida (1,357,365 long tons) in 1907 being valued at $6,577,757; that of the whole country at $10,653,558. Florida is also the principal source in the United States for fuller’s earth, a deposit of which, near Quincy, was first discovered in 1893; and clay (including kaolin) is also mined to some extent. Other minerals that have been discovered but have not been industrially developed are gypsum, lignite and cement rock. The lack of a thorough geological survey has perhaps prevented the discovery of other minerals—certainly it is responsible for a late recognition of the economic value of the known mineral resources.

The flora of N. Florida is similar to that of south-eastern North America; that of S. Florida seems to be a link between the vegetation of North America and that of South America and the West Indies, for out of 247 species of S. Florida that have been examined, 187 are common to the West Indies, Mexico and South America. The forests cover approximately 37,700 sq. m., chiefly in the northern part of the state, including about half of the peninsula, yellow pine being predominant, except in the coastal marsh lands, where cypress, found throughout the state, particularly abounds. About half of the varieties of forest trees in the United States are found, and among the peculiar species are the red bay or “Florida Mahogany,” satinwood and cachibou, and the Florida yew and savin, both almost extinct. The lumber industry is important: in 1905 the total factory product of lumber and timber was valued at $10,901,650, and lumber and planing mill products were valued at $1,690,455. In 1900 this was the most valuable industry in the state; in 1905 it was second to the manufacture of tobacco. The fauna is similar in general to that of the southern United States. Among the animals are the puma, manatee (sea cow), alligator and crocodile, but the number of these has been greatly diminished by hunting. Ducks, wild turkeys, bears and wild cats (lynx) are found, but in decreasing numbers.

The fisheries are very valuable; the total number of species of fish in Florida waters is about 600, and many species found on one coast are not found on the other. The king fish and tarpon are hunted for sport, while mullet, shad, redsnappers, pompano, trout, sheepshead and Spanish mackerel are of great economic value. The sponge and oyster fisheries are also important. The total product of the fisheries in 1902 was valued at about $2,000,000.

Industry and Commerce.—The principal occupation is agriculture, in which 44% of the labouring population was engaged in 1900, but only 12.6% of the total land surface was enclosed in farms, of which only 34.6% was improved, and the total agricultural product for 1899 was valued at $18,309,104. As the number of farms increased faster than the cultivated area from 1850 to 1900, the average size of farms declined from 444 acres in 1860 to 140 in 1880 and to 106.9 in 1900, the largest class of farms being those with an acreage varying from 20 to 50 acres. Nearly three-fourths of the farms, in 1900, were cultivated by their owners, but the cash tenantry system showed an increase of 100% since 1890, being most extensively used in the cotton counties. One-third of the farms were operated by negroes, but one-half of these farms were rented, and the value of negro farm property was only one-eighth that of the entire farm property of the state. According to the state census of 1905 only 1,621,362 acres were improved; of 45,984 farms, 31,233 were worked by whites.

Fruits normally form the principal crop; the total value for 1907-8 of the fruit crops of the state (including oranges, lemons, limes, grape-fruit, bananas, guavas, pears, peaches, grapes, figs, pecans, &c.) was $6,160,299, according to the report of the State Department of Agriculture. The discovery of Florida’s adaptability to the culture of oranges about 1875 may be taken as the beginning of the state’s modern industrial development. But the unusual severity of the winters of 1887, 1894 and 1899 (the report of the Twelfth Census which gives the figures for this year being therefore misleading) destroyed three-fourths of the orange trees, and caused an increased attention to stock-raising, and to various agricultural products. Orange culture has recovered much of its importance, but it is carried on in the more southern counties of the state. The cultivation of pineapples, in sub-tropical Florida, is proving successful, the product far surpassing that of California, the only other state in the Union in which pineapples are grown. Grape-fruit, guavas and lemons are also successfully produced in this part of the state. The cultivation of strawberries and vegetables (cabbage, cauliflower, beets, beans, tomatoes, egg-plant, cucumbers, water-melons, celery, &c.) for northern markets, and of orchard fruits, especially plums, pears and prunes, has likewise proved successful. In 1907-8, according to the State Department of Agriculture, the total value of vegetable and garden products was $3,928,657. In 1903, according to the statistics of the United States Department of Agriculture, Indian corn ranked next to fruits (as given in the state reports), but its product as compared with that of various other states is unimportant—in 1907 it amounted to 7,017,000 bushels only; rice is the only other cereal whose yield in 1899 was greater than that of 1889, but the Florida product was surpassed (in 1899) by that of the Carolinas, Georgia, Louisiana and Texas; in 1907 the product of rice in Florida (69,000 bushels) was less than that of Texas, Louisiana, South Carolina, Arkansas and Georgia severally. Tobacco culture, which declined after 1860 on account of the competition of Cuba and Sumatra, has revived since 1885 through the introduction of Cuban and Sumatran seed; the product of 1907 (6,937,500 ℔) was more than six times that of 1899, the product in 542
1899 (1,125,600 ℔) being more than twice that of 1889 (470,443 ℔), which in turn was more than twenty times that for 1880 (21,182 ℔)—the smallest production recorded for many decades. In 1907 the average farm price of tobacco was 45 cents per ℔ higher than that of any other state. In 1899, 84% of the product was raised in Gadsden county. The sweet potato and pea-nut crops have also become very valuable; on the other hand the Census of 1900 showed a decline in acreage and production of cotton. In 1907 the acreage (265,000 acres) was less than in any cotton-growing state except Missouri and Virginia; the crop for 1907-1908 was 49,794 bales. Sea-island cotton of very high grade is grown in Alachua county. The production of sugar, begun by the early Spanish settlers, declined, but that of syrup increased. Pecan nuts are a promising crop, and many groves were planted after 1905. In 1900 there were more than 1,900,000 acres of land in the state unoccupied. The low lands of the South are being drained partly by the state and partly by private companies. Irrigation, introduced in 1888 by the orange growers, has been adopted by other farmers, especially the tobacco-growers of Gadsden county, and so the evil effects of the droughts, so common from February to June, are avoided. The value of farm property in the southern counties, which have been developed very recently, shows a steady increase, that of Hillsboro county surpassing the other counties of the state. In 1907-8, according to the state Department of Agriculture, the total value of all field crops (cotton, cereals, sugar-cane, hay and forage, sweet potatoes, &c.) was $11,856,340, and the total value of all farm products (including live stock, $20,817,804, poultry and products, $1,688,433, and dairy products, $1,728,642) was $46,371,320.

The manufactures of Florida, as compared with those of other states, are unimportant. Their product in 1900 was more than twice the product in 1890, and the product in 1905 (from establishments under the factory system only) was $50,298,290, *i.e.* 47.1% greater than in 1900. The most important industries were those that depended upon the forests, their product amounting to nearly 45% of the entire manufactured product of the state. The lumber and timber products were valued in 1905 at $10,901,650, almost twice their valuation in 1890, and an increase of 1.2% over the product of 1900. The manufacture of turpentine and rosin, material for which is obtained from the pine forests, had increased greatly in importance between 1890 and 1900, the product in 1890 being valued at only $191,859, that of 1900 at $6,469,605, and from the latter sum it increased in 1905 to $9,901,905, an increase of more than one-half. In 1900 the state ranked second and in 1905 first of all the states of the country in the value of this product; in 1905 the state’s product amounted to 41.4% of that of the entire country. The manufacture of cigars and cigarettes (almost entirely of cigars, few cigarettes being manufactured), carried on chiefly by Cubans at Key West and Tampa, also increased in importance between 1890 and 1900, the products in the latter year being valued at $10,735,826, or more than one-quarter more than in 1890, and in 1905 there was a further increase of 56.2%, the gross value being $16,764,276, or nearly one-third of the total factory product of the state. In 1900 Florida ranked fourth in the manufacture of tobacco among the states of the Union, being surpassed by New York, Pennsylvania and Ohio; in 1905 it ranked third (after New York and Pennsylvania). Most of the tobacco used is imported from Cuba, though, as has been indicated, the production of the state has greatly increased since 1880. In the manufacture of fertilizers, the raw material for which is derived from the phosphate beds, Florida's aggregate product in 1900 was valued at $500,239, and in 1905 at $1,590,371, an increase of 217.9% in five years.

Florida's industrial progress has been mainly since the Civil War, for before that conflict a large part of the state was practically undeveloped. An important influence has been the railways. In 1880 the total railway mileage was 518 m.; in 1890 it was 2489 m.; in 1900, 3255 m., and in January 1909, 4,004.92 m. The largest system is the Atlantic Coast Line, the lines of which in Florida were built or consolidated by H.B. Plant (1819-1899) and once formed a part of the so-called "Plant System" of railways. The Florida East Coast Railway is also the product of one man's faith in the country, that of Henry M. Flagler (b. 1830). The Seaboard Air Line, the Louisville & Nashville, and the Georgia Southern & Florida are the other important railways. The Southern railway penetrates the state as far as Jacksonville, over the tracks of the Atlantic Coast Line. A state railway commission, whose members are elected by the people, has power to enforce its schedule of freight rates except when such rates would not pay the operating expenses of the railway. In 1882 the Florida East Coast Line Canal and Transportation Co. was organized to develop a waterway from Jacksonville to Biscayne Bay by connecting with canals the St Johns, Matanzas, and Halifax rivers, Mosquito Lagoon, Indian river, Lake Worth, Hillsboro river, New river, and Snake Creek; in 1908 this vast undertaking was completed. The development of marine commerce has been retarded by unimproved harbours, but Fernandina and Pensacola harbours have always been good. Since 1890 much has been done by the national Government, aided in many cases by the local authorities and by private enterprise, to improve the harbours and to extend the limits of river navigation. With the increase of trade between the United States and the West Indies following the Spanish-American War (1898), the business of the principal ports, notably of Fernandina, Tampa and Pensacola, greatly increased.

Population.—The population of Florida in 1880 was 269,493; in 1890, 391,422, an increase of 45.2%; and in 1900, 528,542, or a further increase of 35%; and in 1905, by a state census, 614,845; and in 1910, 752,619. In 1900, 95.5% were native born, 43.7% were coloured (including 479 Chinese, Japanese and Indians), and in 1905 the percentages were little altered. The Seminole Indians, whose number is not definitely known, live in and near the Everglades. The urban population on the basis of places having a population of 4000 or more was 16.6% of the total in 1900 and 22.7% in 1905, the percentage for Florida, as for other Southern States, being small as compared with the percentage for most of the other states of the Union. In 1900 there were 92, and, in 1905, 125 incorporated cities, towns and villages; but only 14 (in 1905, 22) of these had a population of over 2000, and only 4 (in 1905, 8) a population of more than 5000. The four in 1900 were: Jacksonville (28,429); Pensacola (17,747); Key West (17,114); and Tampa (15,839). The eight in 1905 were Jacksonville (35,301), Tampa (22,823), Pensacola (21,505), Key West (20,498), Live Oak (7200), Lake City (6409), Gainesville (5413), and St Augustine (5121). Tallahassee is the capital of the state. In 1906 the Baptists were the strongest religious denomination; the Methodists ranked second, while the Roman Catholic, Presbyterian and Protestant Episcopal churches were of relatively minor importance.

Government.—The present constitution was framed in 1885 and was ratified by the people in 1886. Its most important feature, when compared with the previous constitution of 1868, is its provision for the choice of state officials other than the governor (who was previously chosen by election) by elections instead of by the governor's appointment, but the governor, who serves for four years and is not eligible for the next succeeding term, still appoints the circuit judges, the state attorneys for each judicial circuit and the county commissioners; he may fill certain vacancies and may suspend, and with the Senate remove officers not liable to impeachment. The governor is a member of the Board of Pardons, the other members being the attorney-general, the secretary of state, the comptroller and the commissioner of agriculture; he and the secretary of state, attorney-general, comptroller, treasurer, superintendent of public instruction, and commissioner of agriculture comprise a Board of Commissioners of State Institutions; he is also a member of the Board of Education. The office of lieutenant-governor was abolished by the present constitution. The legislature meets biennially, the senators being chosen for four, the representatives for two years. By an amendment of 1896 the Senate consists of not more than 32, and the House of Representatives of not more than 68 members; by a two-thirds vote of members present the legislature may pass a bill over the governor's veto. The three judges of the Supreme Court and the seven of the circuit court serve for six years, those of the county courts for four years, and justices of the peace (one for each justice district, of which the county commissioners must form at least two in each county) hold office for four years. The constitutional qualifications for suffrage are: the age of twenty-one years, citizenship in the United States or presentation of naturalization certificates at registration centres, residence in the state one year and in the county six months, and 543
registration. To these requirements the payment of a poll-tax has been added by legislative enactment, such an enactment having been authorized by the constitution. Insane persons and persons under guardianship are excluded by the constitution, and "all persons convicted of bribery, perjury, larceny or of infamous crime, or who shall make or become directly or indirectly interested in any bet or wager the result of which shall depend upon any election," or who shall participate as principal, second or challenger in any duel, are excluded by legislative enactment.

Amendments to the constitution may be made by a three-fifths vote of each house of the legislature, ratified by a majority vote of the people. A revision of the Constitution may be made upon a two-thirds vote of all members of both Houses of the legislature, if ratified by a majority vote of the people; a Constitutional Convention is then to be provided for by the legislature, such convention to meet within six months of the passage of the law therefor, and to consist of a number equal to the membership of the House of Representatives, apportioned among the counties, as are the members of this House.

A homestead of 160 acres, or of one-half of an acre in an incorporated town or city, owned by the head of a family residing in the state, with personal property to the value of $1000 and the improvements on the real estate, is exempt from enforced sale except for delinquent taxes, purchase money, mortgage or improvements on the property. The wife holds in her own name property acquired before or after marriage; the intermarriage of whites and negroes (or persons of negro descent to the fourth generation) is prohibited. All these are constitutional provisions. By legislative enactment whites and blacks living in adultery are to be punished by imprisonment or fine; divorces may be secured only after two years' residence in the state and on the ground of physical incapacity, adultery, extreme cruelty, habitual indulgence in violent temper, habitual drunkenness, desertion for one year, previous marriage still existing, or such relationship of the parties as is within the degrees for which marriage is prohibited by law. Legitimacy of natural children can be established by subsequent marriage of the parents, and the age of consent is sixteen years.

The bonded debt was incurred during the Reconstruction Period (1865-1875). In 1871 7% 30 year bonds to the extent of $350,000 were issued and in 1873 another issue of 6% 30 year bonds to the value of $925,000 was made. Most of these were held by the Educational Fund at the time of their maturity. By 1901 all but $267,700 of the issue of 1871 had been retired and this amount was then refunded with 3% 50 year bonds which were taken by the Educational Fund. In 1903 $616,800 of the 1873 issue was held by the Educational Fund and $148,000 by individuals. The first part of this claim was refunded by a new bond issue, also taken by the Educational Fund, the second was paid from an Indian war claim of $692,946, received from the United States government in 1902, when $132,000 bonds of 1857, held by the United States government, were also extinguished. The bonded debt was thus reduced to $884,500; and on the 1st of January 1909 the debt, consisting of refunding bonds held as educational funds, amounted to $601,567.

Penal System.—There is no penitentiary; the convicts are hired to the one highest bidder who contracts for their labour, and who undertakes, moreover, to lease all other persons convicted during the term of the lease, and sub-leases the prisoners. In 1889 the convicts were placed under the care of a supervisor of convicts, and in 1905 the law was amended so that one or more supervisors could be appointed at the will of the governors. In 1908 there were four supervisors and one state prison physician, and there are special laws designed to prevent abuses in the system. In 1908 the state received $208,148 from the lease of convicts. Decrepit prisoners were formerly leased, but in 1906 the lease excluded such as were thought unfit by the state prison physician. Women convicts were still leased with the men in 1908; of the 446 convicts committed in that year, there were 15 negro females, 356 negro males and 75 white males. In the same year 54 escaped, and 27 were recaptured. The leased convicts are employed in the turpentine and lumber industries and in the phosphate works. The 1232 convicts "on hand" at the close of 1908 were held in 38 camps, 4 being the minimum, and 160 the maximum number, at a camp. In 1908 two central hospitals for the prisoners were maintained by the lessee company. County prison camps are under the supervision of the governor and the supervisors of convicts. The state supervisors must inspect each state prison camp and each county prison camp every thirty days.

Education.—As early as 1831 an unsuccessful attempt was made to form an adequate public school fund; the first real effort to establish a common school system for the territory was made after 1835; in 1840 there were altogether 18 academies and 51 common schools, and in 1849 the state legislature made an appropriation in the interest of the public instruction of white pupils, and this was supplemented by the proceeds of land granted by the United States government for the same purpose. In 1852 Tallahassee established a public school; and in 1860 there were, according to a report of the United States census, 2032 pupils in the public schools of the state, and 4486 in "academies and other schools." The Civil War, however, interrupted the early progress, and the present system of common schools dates from the constitution of 1868 and the school law of 1869. The school revenue derived from the interest of a permanent school fund, special state and county taxes, and a poll-tax, in 1907-1908 amounted to $1,716,161; the per capita cost for each child of school age was $6.11 (white, $9.08; negro, $2.24), and the average school term was 108 days (112 for whites, 99 for negroes). The state constitution prescribes that "white and colored children shall not be taught in the same school, but impartial provision shall be made for both." The percentage of enrolment in 1907-1908 was 60 (whites, 66; negroes, 52). The percentage of attendance to enrolment was 70%,—68% for white and 74% for negro schools. Before 1905 the state provided for higher education by the Florida State College, at Tallahassee, formerly the West Florida Seminary (founded in 1857); the University of Florida, at Lake City, which was organized in 1903 by enlarging the work of the Florida Agricultural College (founded in 1884); the East Florida Seminary, at Gainesville (founded 1848 at Ocala); the normal school (for whites) at De Funiak Springs; and the South Florida Military Institute at Bartow; but in 1905 the legislature passed the Buckman bill abolishing all these state institutions for higher education and establishing in their place the university of the state of Florida and a state Agricultural Experiment Station, both now at Gainesville, and the Florida Female College at Tallahassee, which has the same standards for entrance and for graduation as the state university for men. Private educational institutions in Florida are John B. Stetson University at De Land (Baptist); Rollins College (1885) at Winter Park (non-sectarian), with a collegiate department, an academy, a school of music, a school of expression, a school of fine arts, a school of domestic and industrial arts, and a business school; Southern College (1901), at Sutherland (Methodist Episcopal, South); the Presbyterian College of Florida (1905), at Eustis; Jasper Normal Institute (1890), at Jasper, and the Florida Normal Institute at Madison. The negroes have facilities for advanced instruction in the Florida Baptist Academy, and Cookman Institute (Methodist Episcopal, South), both at Jacksonville, and in the Normal and Manual Training School (Congregational), at Orange Park. There are a school for the Blind, Deaf, and Dumb (1885) at St. Augustine, a hospital for the insane at Chattahoochee and a reform school at Marianna, all wholly supported by the state, and a Confederate soldiers' and sailors' home at Tallahassee, which is partially supported by the state.

History.—The earliest explorations and attempts at colonization of Florida by Europeans were made by the Spanish. The Council of the Indies claimed that since 1510 fleets and ships had gone to Florida, and Florida is shown on the Cantino map of 1502. In 1513 Juan Ponce de Leon (*c.* 1460-1521), who had been with Christopher Columbus on his second voyage and had later been governor of Porto Rico, obtained a royal grant authorizing him to discover and settle "Bimini,"—a fabulous island believed to contain a marvellous fountain or spring whose waters would restore to old men their youth or 544
at least had wonderful curative powers. Soon after Easter Day he came in sight of the coast of Florida, probably near the mouth of the St Johns river. From the name of the day in the calendar, *Pascua Florida*, or from the fact that many flowers were found on the coast, the country was named Florida. De León seems to have explored the coast, to some degree, on both sides of the peninsula, and to have turned homeward fully convinced that he had discovered an immense island. He returned to Spain in 1514, and obtained from the king a grant to colonize "the island of Bimini and the island of Florida," of which he was appointed adelantado, and in 1521 he made another expedition, this one for colonization as well as for discovery. He seems to have touched at the island of Tortugas, so named on account of the large number of turtles found there, and to have landed at several places, but many of his men succumbed to disease and he himself was wounded in an Indian attack, dying soon afterward in Cuba. Meanwhile, in 1516, another Spaniard, Diego Miruelo, seems to have sailed for some distance along the west coast of the peninsula. The next important exploration of Florida was that of Panfilo de Narvaez. In 1527 he sailed from Cuba with about 600 men (soon reduced to less than 400), landed (early in 1528) probably at the present site of Pensacola, and for six months remained in the country, he and his men suffering terribly from exposure, hunger and fierce Indian attacks. In September, his ships being lost and his force greatly reduced in number, he hastily constructed a crazy fleet, re-embarked probably at Apalachee Bay, and lost his life in a storm probably near Pensacola Bay. Only four of his men, including Nuñez Cabeza de Vaca, succeeded after eight years of Indian captivity and of long and weary wanderings, in finding their way to Spanish settlements in Mexico. Florida was also partially explored by Ferdinando de Soto (*q.v.*) in 1539-1540. In the summer of 1559 another attempt at colonization was made by Tristan de Luna, who sailed from Vera Cruz, landed at Pensacola Bay, and explored a part of Florida and (possibly) Southern Alabama. Somewhere in that region he desired to make a permanent settlement, but he was abandoned by most of his followers and gave up his attempt in 1561.

In the following year, Jean Ribaut (1520-1565), with a band of French Huguenots, landed first near St Augustine and then at the mouth of the St Johns river, which he called the river of May, and on behalf of France claimed the country, which he described as "the fairest, fruitfullest and pleasantest of all the world"; but he made his settlement on an island near what is now Beaufort, South Carolina. In 1564 René de Laudonnière (? -*c.* 1586), with another party of Huguenots, established Fort Caroline at the mouth of the St Johns, but the colony did not prosper, and in 1565 Laudonnière was about to return to France when (on the 28th of August) he was reinforced by Ribaut and about 300 men from France. On the same day that Ribaut landed, a Spanish expedition arrived in the bay of St Augustine. It was commanded by Pedro Menéndez de Avilés (1523-1574), one of whose aims was to destroy the Huguenot settlement. This he did, putting to death almost the entire garrison at Fort Caroline "not as Frenchmen, but as Lutherans," on the 20th of September 1565. The ships of Ribaut were soon afterwards wrecked near Matanzas Inlet; he and most of his followers surrendered to Menéndez and were executed. Menéndez then turned his attention to the founding of a settlement which he named St Augustine (*q.v.*); he also explored the Atlantic coast from Cape Florida to St Helena, and established forts at San Mateo (Fort Caroline), Avista, Guale and St Helena. In 1567 he returned to Spain in the interest of his colony.

The news of the destruction of Fort Caroline, and the execution of Ribaut and his followers, was received with indifference at the French court; but Dominique de Gourgues (*c.* 1530-1593), a friend of Ribaut but probably a Catholic, organized an expedition of vengeance, not informing his men of his destination until his three ships were near the Florida coast. With the co-operation of the Indians under their chief Saturiba he captured Fort San Mateo in the spring of 1568, and on the spot where the garrison of Fort Caroline had been executed, he hanged his Spanish prisoners, inscribing on a tablet of pine the words, “I do this not as unto Spaniards but as to traitors, robbers and murderers.” Feeling unable to attack St Augustine, de Gourgues returned to France.

The Spanish settlements experienced many vicissitudes. The Indians were hostile and the missionary efforts among them failed. In 1586 St Augustine was almost destroyed by Sir Francis Drake and it also suffered severely by an attack of Captain John Davis in 1665. Not until the last decade of the 17th century did the Spanish authorities attempt to extend the settlements beyond the east coast. Then, jealous of the French explorations along the Gulf of Mexico, they turned their attention to the west coast, and in 1696 founded Pensacola. When the English colonies of the Carolinas and Georgia were founded, there was constant friction with Florida. The Spanish were accused of inciting the Indians to make depredations on the English settlements and of interfering with English commerce and the Spanish were in constant fear of the encroachments of the British. In 1702, when Great Britain and Spain were contending in Europe, on opposite sides, in the war of the Spanish Succession, a force from South Carolina captured St Augustine and laid siege to the fort, but being unable to reduce it for lack of necessary artillery, burned the town and withdrew at the approach of Spanish reinforcements. In 1706 a Spanish and French expedition against Charleston, South Carolina, failed, and the Carolinians retaliated by invading middle Florida in 1708 and again in 1722. In 1740 General James Edward Oglethorpe, governor of Georgia, supported by a naval force, made an unsuccessful attack upon St Augustine; two years later a Spanish expedition against Savannah by way of St Simon’s Island failed, and in 1745 Oglethorpe again appeared before the walls of St Augustine, but the treaty of Aix-la-Chapelle in 1748 prevented further hostilities. Pensacola, the other centre of Spanish settlement, though captured and occupied (1719-1723) by the French from Louisiana, had a more peaceful history.

By the treaty of Paris in 1763 Florida was ceded to England in return for Havana. The provinces of East Florida and West Florida were now formed, the boundaries of West Florida being 31° N. lat. (when civil government was organized in 1767, the N. line was made 32° 28′), the Chattahoochee, and the Apalachicola rivers, the Gulf of Mexico, Mississippi Sound, Lakes Borgne, Pontchartrain and Maurepas, and the Mississippi river. A period of prosperity now set in. Civil in place of military government was instituted; immigration began; and Andrew Turnbull, an Englishman, brought over a band of about 1500 Minorcans (1769), whom he engaged in the cultivation of indigo at New Smyrna. Roads were laid out, some of which yet remain; and in the last three years of English occupation the government spent $580,000 on the two provinces. Consequently, the people of Florida were for the most part loyal to Great Britain during the War of American Independence. In 1776, the Minorcans of New Smyrna refused to work longer on the indigo plantations; and many of them removed to St Augustine, where they were protected by the authorities. Several plans were made to invade South Carolina and Georgia, but none matured until 1778, when an expedition was organized which co-operated with British forces from New York in the siege of Savannah, Georgia. In the following year, Spain having declared war against Great Britain, Don Bernardo de Galvez (1756-1794), the Spanish governor at New Orleans, seized most of the English forts in West Florida, and in 1781 captured Pensacola.

By the treaty of Paris (1783) Florida reverted to Spain, and, no religious liberty being promised, many of the English inhabitants left East and West Florida. A dispute with the United States concerning the northern boundary was settled by the treaty of 1795, the line 31° N. lat. being established.

The westward expansion of the United States made necessary American ports on the Gulf of Mexico; consequently the acquisition of West Florida as well as of New Orleans was one of the aims of the negotiations which resulted in the 545
Louisiana Purchase of 1803. After the cession of Louisiana to the United States, the people of West Florida feared that that province would be seized by Bonaparte. They, therefore, through a convention at Buhler’s Plains (July 17, 1810), formulated plans for a more effective government. When it was found that the Spanish governor did not accept these plans in good faith, another convention was held on the 26th of September which declared West Florida to be an independent state, organized a government and petitioned for admission to the American Union. On the 27th of October President James Madison, acting on a theory of Robert R. Livingston that West Florida was ceded by Spain to France in 1800 along with Louisiana, and was therefore included by France in the sale of Louisiana to the United States in 1803, declared West Florida to be under the jurisdiction of the United States. Two years later the American Congress annexed the portion of West Florida between the Pearl and the Mississippi rivers to Louisiana (hence the so-called Florida parishes of Louisiana), and that between the Pearl and the Perdido to the Mississippi Territory.

In the meantime war between Great Britain and the United States was imminent. The American government asked the Spanish authorities of East Florida to permit an American occupation of the country in order that it might not be seized by Great Britain and made a base of military operations. When the request was refused, American forces seized Fernandina in the spring of 1812, an action that was repudiated by the American government after protest from Spain, although it was authorized in official instructions. About the same time an attempt to organize a government at St Mary’s was made by American sympathizers, and a petty civil war began between the Americans, who called themselves “Patriots,” and the Indians, who were encouraged by the Spanish. In 1814 British troops landed at Pensacola to begin operations against the United States. In retaliation General Andrew Jackson captured the place, but in a few days withdrew to New Orleans. The British then built a fort on the Apalachicola river, and there directed expeditions of Indians and runaway negroes against the American settlements, which continued long after peace was concluded in 1814. In 1818 General Jackson, believing that the Spanish were aiding the Seminole Indians and inciting them to attack the Americans, again captured Pensacola. By the treaty of 1819 Spain formally ceded East and West Florida to the United States; the treaty was ratified in 1821, when the United States took formal possession, but civil government was not established until 1822.

Indian affairs furnished the most serious problems of the new Territory of Florida. The aborigines, who seemed to have reached a stage of civilization somewhat similar to that of the Aztecs, were conquered and exterminated or absorbed by Creeks about the middle of the 18th century. There was a strong demand for the removal of these Creek Indians, known as Seminoles, and by treaties at Payne’s Landing in 1832 and Fort Gibson in 1833 the Indian chiefs agreed to exchange their Florida lands for equal territory in the western part of the United States. But a strong sentiment against removal suddenly developed, and the efforts of the United States to enforce the treaty brought on the Seminole War (1836-42), which resulted in the removal of all but a few hundred Seminoles whose descendants still live in southern Florida.

In 1845 Florida became a state of the American Union. On the 10th of January 1861 an ordinance of secession, which declared Florida to be a “sovereign and independent nation,” was adopted by a state convention, and Florida became one of the Confederate States of America. The important coast towns were readily captured by Union forces; Fernandina, Pensacola and St Augustine in 1862, and Jacksonville in 1863; but an invasion of the interior in 1864 failed, the Union forces being repulsed in a battle at Olustee (on the 20th of February 1864). In 1865 a provisional governor was appointed by President Andrew Johnson, and a new state government was organized. The legislature of 1866 rejected the Fourteenth Amendment to the Federal Constitution, and soon afterwards Florida was made a part of the Third Military District, according to the Reconstruction Act of 1867. Negroes were now registered as voters by the military authorities, and another Constitutional Convention met in January and February 1868. A factional strife in the dominant party, the Republican, now began; fifteen delegates withdrew from the convention; the others framed a constitution, and then resolved themselves into a political convention. The seceding members with nine others then returned and organized; but the factions were reconciled by General George M. Meade. A new constitution was framed and was ratified by the electors, and Florida passed from under a quasi-military to a full civil government on the 4th of July 1868.

The factional strife in the Republican party continued, a number of efforts being made to impeach Governor Harrison Reed (1813-1899). The decisive year of the Reconstruction Period was 1876. The Canvassing Board, which published the election returns, cast out some votes, did not wait for the returns from Dade county, and declared the Republican ticket elected. George F. Drew (1827-1900), the Democratic candidate for governor, then secured a mandamus from the circuit court restraining the board from going behind the face of the election returns; this was not obeyed and a similar mandamus was therefore obtained from the supreme court of Florida, which declared that the board had no right to determine the legality of a particular vote. According to the new count thus ordered, the Democratic state ticket was elected. By a similar process the board's decision in favour of the election of Republican presidential electors was nullified, and the Democratic electors were declared the successful candidates; but the electoral commission, appointed by Congress, reversed this decision. (See Electoral Commission.)

Since 1876 Florida has been uniformly Democratic in politics.

American Governors of Florida.

Territorial Governors.

Andrew Jackson	1821-1822
William P. Duval	1822-1834
John H. Eaton	1834-1835
Richard K. Call	1835-1840
Robert R. Reid	1840-1841
Richard K. Call	1841-1844
John Branch	1844-1845

State Governors.

William D. Moseley	1845-1849	Democrat
Thomas Brown	1849-1853	Whig
James E. Broome	1853-1857	Democrat
Madison S. Perry	1857-1861	″
John Milton	1861-1865	″
William Marvin	1865	Provisional
David S. Walker	1865-1868	Democrat
Harrison Reed	1868-1872	Republican
Ossian B. Hart	1873-1874	″
Marcellus L. Stearns	1874-1877	″
George F. Drew	1877-1881	Democrat
William D. Bloxham	1881-1885	″
Edward A. Perry	1885-1889	″
Francis P. Fleming	1889-1893	″
Henry L. Mitchell	1893-1897	″
William D. Bloxham	1897-1901	″
William S. Jennings	1901-1905	″
Napoleon B. Broward	1905-1909	″
Albert W. Gilchrist	1909-	″

Bibliography.—Physical and economic conditions are discussed in a pamphlet (591 pp.) published by the State Department of Agriculture, *Florida, a Pamphlet Descriptive of its History, Topography, Climate, Soil, &c.* (Tallahassee, 1904); in *Climate, Soil and Resources of Florida* (United States Department of Agriculture, Washington, 1882); *A Preliminary Report on the Soils of Florida* (United States Department of Agriculture, Division of Soils, Bulletin 13, 1898); C.L. Norton's *Handbook of Florida* (2nd edition, New York, 1892); the volumes of the Twelfth Census of the United States (for 1900) which treat of Agriculture and Manufactures, and the Special Report on Mines and Quarries for 1902. J.N. MacGonigle's "Geography of Florida" (*National Geographic Magazine*, vol. 7), T.D.A. Cockerell's "West Indian Fauna in Florida" (*Nature*, vol. 46), L.F. Pourtales's "Flora and Fauna of the Florida Keys" (*American Naturalist*, vol. 11), and C.F. Millspaugh's *Flora of the Sand Keys of Florida* (Chicago, 1907), a Field Columbian Museum publication, are of value. To sportsmen, C.B. Cory's *Hunting and Fishing in Florida* (Boston, 1896) and A.W. and J.A. Dimock's *Florida Enchantments* (New York, 1908) are of interest. For administration, see Wilbur F. Yocum's *Civil Government of Florida* (De Land, Florida, 1904); and the *Revised Statutes of Florida* (1892). The standard history is that by G.R. Fairbanks, *History of Florida* (Philadelphia, 1871). This should be supplemented by D.G. Brinton's *Notes on the Floridian Peninsula, its Literary History, Indian Tribes and Antiquities* (Philadelphia, 1859), which has an excellent descriptive bibliography of the early explorations; Woodbury Lowery, *The Spanish Settlements within the Present Limits of the United States* (New York, vol. i., 1901; vol. ii., sub-title *Florida*, 1905); R.L. Campbell's Historical Sketches of Colonial Florida (Cleveland, 1892), which treats at length of the history of Pensacola; H.E. Chambers's *West Florida and its Relation to the Historical Cartography of the United States* (Johns Hopkins Studies in Historical and Political Science, Series 16, No. 5); and Herbert B. Fuller's The *Purchase of Florida; its History and Diplomacy* (Cleveland, O., 1906). The only published collections of documents relating to the state are Buckingham Smith's *Colleccion de varios documentos para la historia de la Florida y tierras adyacentes* (London, 1857), and Benjamin F. French's *Historical Collections of Louisiana* (New York, 1846-1875). 546

1 Almost everywhere limestone is the underlying rock, but siliceous sands, brought out by the Atlantic rivers to the N.E., are carried the whole length of the Florida coast by marine action.

FLORIDABLANCA, DON JOSE MOÑINO Y REDONDO, Count of (1728-1808), Spanish statesman, was born at Murcia in 1728. He was the son of a retired army officer, and received a good education, which he completed at the university of Salamanca, especially applying himself to the study of law. For a time he followed the profession of an advocate, and acquired a high reputation. A more public career was opened to him by the marquis of Esquilache, then chief minister of state, who sent him ambassador to Pope Clement XIV. Successful in his mission, he was soon after appointed by Charles III. successor to his patron, and his administration was one of the most brilliant Spain had ever seen. He regulated the police of Madrid, reformed many abuses, projected canals, established many societies of agriculture and economy and many philanthropical institutions, and gave encouragement to learning, science and the fine arts. Commerce flourished anew under his rule, and the long-standing disputes with Portugal about the South American colonies were settled. He sought to strengthen the alliance of Spain with Portugal by a double marriage between the members of the royal houses, designing by this arrangement to place ultimately a Spanish prince on the throne of

Portugal. But in this he failed. Floridablanca was the right-hand man of King Charles III. in his policy of domestic reform, and was much under the influence of French *philosophes* and economic writers. Like other reformers of that school he was a strong supporter of the royal authority and a convinced partisan of benevolent despotism. The French Revolution frightened him into reaction, and he advocated the support of the first coalition against France. He retained his office for three years under Charles IV.; but in 1792, through the influence of the favourite Godoy, he was dismissed and imprisoned in the castle of Pampeluna. Here he was saved from starvation only by the intervention of his brother. He was afterwards allowed to retire to his estates, and remained in seclusion till the French invasion of 1808. He was then called by his countrymen to take the presidency of the central junta. But his strength failed him, and he died at Seville on the 20th of November of the same year. He left several short treatises on jurisprudence.

See *Obras originales del Conde de Floridablanca*, edited, with biographical introduction, by A. Ferrer del Rio; in the *Biblioteca de Rivadeneyra*, vol. lix.

FLORIDOR [Josias de Soulas, Sieur de Prinefosse] (d. *c.* 1671), French actor, was born in Brie early in the 17th century, the son of a gentleman of German family who had moved to France, married there, and become a Roman Catholic. The son entered the French army, but after being promoted ensign, quitted the army for the theatre, where he took the name of Floridor. His first Paris appearance was in 1640. Three years later he was called to the company at the Hôtel de Bourgogne, where he played all the leading parts in tragedy and comedy and became the head of his profession. He was a man of superb physique and excellent carriage, with a flexible and sonorous voice, and manners of rare distinction and elegance. He was much liked at court, and Louis XIV. held him in particular esteem. He died in 1671 or 1672.

FLORIN, the name applied to several coins of the continent of Europe and to two coins struck in England at different times. The word comes through the Fr. *florin* from the Ital. *fiorino*, flower, Lat. *flos*, *florem*. Fiorino was the Italian name of a gold coin issued at Florence in 1252, weighing about fifty-four grains. This coin bore on the obverse a lily, from which it took its name of “the flower,” on the reverse the Latin name of the city *Florentia*, from which it was also known as a “florence.” “Florin” and “florence” seem to have been used in English indiscriminately as the name of this coin. The Florentine florin was held in great commercial repute throughout Europe, and similar coins were struck in Germany, other parts of Italy, France, &c. The English gold florin was introduced by Edward III. in 1343, half and quarter florins being struck at the same time. This gold florin weighed 108 grains and was to be current for six shillings. It was found, however, to be overvalued in proportion to the silver currency and was demonetized the following year. The florin did not again appear in the English coinage until 1849, when silver coins with this name, having a nominal value of two shillings (one-tenth of a pound), were struck. When first issued the “Dei gratia” was omitted from the inscription, and they were frequently referred to as the “Godless” or “graceless” florins. The D.G. was added in 1852. In 1887 a double florin or four shilling piece was issued, but its coinage was discontinued in 1890. The total value of double florins issued during these years amounted to £533,125. (See also Numismatics.)

FLORIO, GIOVANNI (1553?-1625), English writer, was born in London about 1553. He was of Tuscan origin, his parents being Waldenses who had fled from persecution in the Valtelline and taken refuge in England. His father, Michael Angelo Florio, was pastor of an Italian Protestant congregation in London in 1550. He was attached to the household of Sir William Cecil, but dismissed on a charge of immorality. He dedicated a book on the Italian language to Henry Herbert, and may have been a tutor in the family of William Herbert, earl of Pembroke. Anthony à Wood says that the Florios left England on the accession of Queen Mary, but returned after her death. The son resided for a time at Oxford, and was appointed, about 1576 tutor to the son of Richard Barnes, bishop of Durham, then studying at Magdalen College. In 1578 Florio published a work entitled *First Fruits, which yield Familiar Speech, Merry Proverbs, Witty Sentences, and Golden Sayings* (4to). This was accompanied by *A Perfect Induction to the Italian and English Tongues*. The work was dedicated to the earl of Leicester. Three years later Florio was admitted a member of Magdalen College, and became a teacher of French and Italian in the university. In 1591 appeared his *Second Fruits, to be gathered of Twelve Trees, of divers but delightsome Tastes to the Tongues of Italian and English men*; to which was annexed the *Garden of Recreation, yielding six thousand Italian Proverbs* (4to). These manuals contained an outline of the grammar, a selection of dialogues in parallel columns of Italian and English, and longer extracts from classical Italian writers in prose and verse. Florio had many patrons; he says that he “lived some years” with the earl of Southampton, and the earl of Pembroke also befriended him. His Italian and English dictionary, entitled *A World of Words*, was published in folio in 1598. After the accession of James I., Florio was named French and Italian tutor to Prince Henry, and afterwards became a gentleman of the privy chamber and clerk of the closet to the queen, whom he also instructed in languages. His *magnum opus* is the admirable translation of the *Essayes on Morall, Politike, and Millitarie Discourses of Lo. Michaell de Montaigne*, published in folio in 1603 in three books, each dedicated to two noble ladies. A second edition in 1613 was dedicated to the queen. Special interest attaches to the first edition from the circumstance that of the several copies in the British Museum library one bears the autograph of Shakespeare—long received as genuine but now supposed to be by an 18th-century hand—and another that of Ben Jonson. It was suggested by Warburton that Florio is satirized by Shakespeare under the character of Holofernes, the pompous pedant of *Love’s Labour’s Lost*, but it is much more likely, especially as he was one of the earl of Southampton’s protégés, that he was among the personal friends of the dramatist, who may well have gained his knowledge of Italian and French from him. He had married the sister of the poet Daniel, and had friendly relations with many writers of his day. Ben Jonson sent him a copy of *Volpone* with the inscription, “To his loving father and worthy friend Master John Florio, Ben Jonson seals this testimony of his friendship and love.” He is characterized by Wood, in *Athenae Oxonienses*, as a very useful man in his profession, zealous for his religion, and deeply attached to his adopted country. He died at Fulham, London, in the autumn of 1625. 547

FLORIS, FRANS, or more correctly Frans de Vriendt, called Floris (1520-1570), Flemish painter, was one of a large family trained to the study of art in Flanders. Son of a stonecutter, Cornelis de Vriendt, who died at Antwerp in 1538, he began life as a student of sculpture, but afterwards gave up carving for painting. At the age of twenty he went to Liége and took lessons from Lambert Lombard, a pupil of Mabuse, whose travels in Italy had transformed a style truly Flemish into that of a mongrel Leonardesque. Following in the footsteps of Mabuse, Lambert Lombard had visited Florence, and caught the manner of Salviati and other pupils of Michelangelo and Del Sarto. It was about the time when Schoreel, Coxcie and Heemskerk, after migrating to Rome and imitating the masterpieces of Raphael and Buonarroti, came home to execute Dutch-Italian works beneath the level of those produced in the peninsula itself by Leonardo da Pistoia, Nanaccio and Rinaldo of Mantua. Fired by these examples, Floris in his turn wandered across the Alps, and appropriated without assimilation the various mannerisms of the schools of Lombardy, Florence and Rome. Bold, quick and resolute, he saw how easy it would be to earn a livelihood and acquire a name by drawing for engravers and painting on a large scale after the fashion of Vasari. He came home, joined the gild of Antwerp in 1540, and quickly opened a school from which 120 disciples are stated to have issued. Floris painted strings of large pictures for the country houses of Spanish nobles and the villas of Antwerp patricians. He is known to have illustrated the fable of Hercules in ten compositions, and the liberal arts in seven, for Claes Jongeling, a merchant of Antwerp, and adorned the duke of Arschot’s palace of Beaumont with fourteen colossal panels. Comparatively few of his works have descended to us, partly because they came to be contemned for their inherent defects, and so were suffered to perish, partly because they were soon judged by a different standard from that of the Flemings of the 16th century. The earliest extant canvas by Floris is the “Mars and Venus ensnared by Vulcan” in the Berlin Museum (1547), the latest a “Last Judgment” (1566) in the Brussels gallery. Neither these nor any of the intermediate works at Alost, Antwerp, Copenhagen, Dresden, Florence, Léau, Madrid, St Petersburg and Vienna display any charm of originality in composition or in form. Whatever boldness and force they may possess, or whatever principles they may embody, they are mere appropriations of Italian models spoiled in translation or adaptation. Their technical execution reveals a rapid hand, but none of the lustre of bright colouring; and Floris owed much of his repute to the cleverness with which his works were transferred to copper by Jerome Cock and Theodore de Galle. Whilst Floris was engaged on a Crucifixion of 27 ft., and a Resurrection of equal size, for the grand prior of Spain, he was seized with illness, and died on the 1st of October 1570 at Antwerp.

FLORUS, Roman historian, flourished in the time of Trajan and Hadrian. He compiled, chiefly from Livy, a brief sketch of the history of Rome from the foundation of the city to the closing of the temple of Janus by Augustus (25 b.c.). The work, which is called *Epitome de T. Livio Bellorum omnium annorum DCC Libri duo*, is written in a bombastic and rhetorical style, and is rather a panegyric of the greatness of Rome, whose life is divided into the four periods of infancy, youth, manhood and old age. It is often wrong in geographical and chronological details; but, in spite of its faults, the book was much used in the middle ages. In the MSS. the writer is variously given as Julius Florus, Lucius Anneus Florus, or simply Annaeus Florus. From certain similarities of style he has been identified with Publius Annius Florus, poet, rhetorician and friend of Hadrian, author of a dialogue on the question whether Virgil was an orator or poet, of which the introduction has been preserved.

The best editions are by O. Jahn (1852), C. Halm (1854), which contain the fragments of the Virgilian dialogue. There is an English translation in Bohn’s *Classical Library*.

FLORUS, JULIUS, poet, orator, and jurist of the Augustan age. His name has been immortalized by Horace, who dedicated to him two of his *Epistles* (i. 3; ii. 2), from which it would appear that he composed lyrics of a light, agreeable kind. The statement of Porphyrion, the old commentator on Horace, that Florus himself wrote satires, is probably erroneous, but he may have edited selections from the earlier satirists (Ennius, Lucilius, Varro). Nothing is definitely known of his personality, except that he was one of the young men who accompanied Tiberius on his mission to settle the affairs of Armenia. He has been variously identified with Julius Florus, a distinguished orator and uncle of Julius Secundus, an intimate friend of Quintilian (*Instit.* x. 3, 13); with the leader of an insurrection of the Treviri (Tacitus, *Ann.* iii. 40); with the Postumus of Horace (*Odes*, ii. 14) and even with the historian Florus.

FLORUS, PUBLIUS ANNIUS, Roman poet and rhetorician, identified by some authorities with the historian Florus (*q.v.*). The introduction to a dialogue called *Virgilius orator an poëta* is extant, in which the author (whose name is given as Publius Annius Florus) states that he was born in Africa, and at an early age took part in the literary contests on the Capitol instituted by Domitian. Having been refused a prize owing to the prejudice against African provincials, he left Rome in disgust, and after travelling for some time set up at Tarraco as a teacher of rhetoric. Here he was persuaded by an acquaintance to return to Rome, for it is generally agreed that he is the Florus who wrote the well-known lines quoted together with Hadrian’s answer by Aelius Spartianus (*Hadrian* 16). Twenty-six trochaic tetrameters, *De qualitate vitae*, and five graceful hexameters, *De rosis*, are also attributed to him. Florus is important as being the first in order of a number of 2nd-century African writers who exercised a considerable influence on Latin literature, and also the first of the *poëtae neoterici* or *novelli* (new-fashioned poets) of Hadrian’s reign, whose special characteristic was the use of lighter and graceful metres (anapaestic and iambic dimeters), which had hitherto found little favour.

The little poems will be found in E. Bährens, *Poëtae Latini minores* (1879-1883); for an unlikely identification of Florus with the author of the *Pervigilium Veneris* (*q.v.*) see E.H.O. Müller, De *P. Annio Floro poëta et de Pervigilio Veneris* (1855), and, for the poet’s relations with Hadrian, F. Eyssenhardt, *Hadrian und Florus* (1882); see also F. Marx in Pauly-Wissowa’s *Realencyclopädie*, i. pt. 2 (1894).

FLOTOW, FRIEDRICH FERDINAND ADOLF VON, Freiherr (1812-1883), German composer, was born on his father’s estate at Teutendorf, in Mecklenburg, on the 27th of April 1812. Destined originally for the diplomatic profession, his passion for music induced his father to send him to Paris to study under Reicha. But the outbreak of the revolution in 1830 caused his return home, where he busied himself writing chamber-music and operetta until he was able to return to Paris. There he produced *Pierre et Cathérine, Rob Roy, La Duchesse de Guise*, but made his first real success with Le *Naufrage de la Méduse* at the Renaissance Théâtre in 1838. Greater, however, was the success which attended *Stradella* (1844) and *Martha* (1847), which made the tour of the world. In 1848 Flotow was again driven home by the Revolution, and in the course of a few years he produced *Die Grossfürstin* (1850), *Indra* (1853), *Rübezahl* (1854), *Hilda* (1855) and *Albin* (1856). From 1856 to 1863 he was director (Intendant) of the Schwerin opera, but in the latter year he returned to Paris, where in 1869 he produced *L’Ombre*. From that time to the date of his death he lived in Paris or on his estate near Vienna. He died on the 24th of January 1883. Of his concert-music only the *Jubelouvertüre* is now ever heard. His 548
strength lay in the facility of his melodies.

FLOTSAM, JETSAM and **LIGAN**, in English law, goods lost at sea, as distinguished from goods which come to land, which are technically designated *wreck*. Jetsam (the same word as *jettison*, from Lat. *jactare*, to throw) is when goods are cast into the sea, and there sink and remain under water; flotsam (*floatson*, from *float*, Lat. *flottare*) is where they continue floating on the surface of the waves; ligan (or *lagan*, from *lay* or *lie*) is where they are sunk in the sea, but tied to a cork or buoy in order to be found again. Flotsam, jetsam and ligan belong to the sovereign in the absence only of the true owner. Wreck, on the other hand (*i.e.* goods cast on shore), was by the common law adjudged to the sovereign in any case, because it was said by the loss of the ship all property was gone out of the original owner. This singular distinction which treated goods washed ashore as lost, and goods on and in the sea as not lost, is no doubt to be explained by the primitive practice of plundering wrecked ships. (See Wreck.)

FLOUNDER, a common term for flat-fish. The name is also more specially given to certain varieties, according to local usage. Thus the *Pleuronectes flesus* is the common flounder of English terminology, found along the coasts of northern Europe from the Bristol Channel to Iceland. It is particularly partial to fresh water, ascending the Rhine as far as Cologne. It rarely exceeds a length of 12 in. or a weight of 1½ ℔ In American terminology the principal fish of the name are the “summer flounders” or “deep-sea flounders,” also known in America as “plaice” (*Paralichthys dentatus*), as long as 3 ft. and as heavy as 15 ℔; the “four-spotted flounders” (*Paralichthys oblongus*); the “common” or “winter” flounder (*Pseudopleuronectes americanus*); the “diamond flounder” (*Hysopsetta guttulata*); and the “pole flounder” (*Glyptocephalus cynoglossus*).

FLOUR and **FLOUR MANUFACTURE.** The term “flour” (Fr. *fleur*, flower, *i.e.* the best part) is usually applied to the triturated farinaceous constituents of the wheat berry (see Wheat); it is, however, also used of other cereals and even of leguminoids when ground into a fine powder, and of many other substances in a pulverulent state, though in these cases it is usual to speak of rye flour, bean flour, &c. The flour obtained from oats is generally termed oatmeal. In Great Britain wheaten flour was commonly known in the 16th and 17th centuries as meal, and up to the beginning of the 19th century, or perhaps later, the term mealing trade was not infrequently used of the milling trade.

Primitive grinding.

The ancestor of the millstone was apparently a rounded stone about the size of a man’s fist, with which grain or nuts were pounded and crushed into a rude meal. These stones are generally of hard sandstone and were evidently used against another stone, which by dint of continual hammering was broken into hollows. Sometimes the crusher was used on the surface of rocks. St Bridget’s stone, on the shore of Lough Macnean, is supposed to have been a primitive Irish mill; there are many depressions in the face of the table-like rock, and it is probable that round this stone several women (for in early civilization the preparation of flour was peculiarly the duty of the women) would stand and grind, or rather pound, meal. Many such stones, known as Bullan stones, still exist in Ireland. Similar remains are found in the Orkneys and Shetlands, and it is on record that some of these stones have been used for flour-making within historic times. Richard Bennett in his *History of Corn Milling* remarks that the Seneca Indians to this day boil maize and crush it into a paste between loose stones. In the same way the Omahas pound this cereal in holes in the rocks, while the Oregon Indians parch and pound the capsules of the yellow lily, much after the fashion described by Herodotus in his account of the ancient Egyptians. In California the Indian squaws make a sort of paste by crushing acorns between a round stone or “muller,” and a cuplike hollow in the surface of a rock. Crushing stones are of different shapes, ranging from the primitive ball-like implement to an elongated shape resembling the pestle of a mortar. Mullers of the latter type are not infrequent among prehistoric remains in America, while Dr Schliemann discovered several specimens of the globular form on the reputed site of the city of Troy, and also among the ruins of Mycenae. As a matter of fact stone mullers survived in highly civilized countries into modern days, if indeed they are now altogether extinct.

Saddle-stone.

The saddle-stone is the connecting link between the primitive pounder, or muller, and the quern, which was itself the direct ancestor of the millstones still used to some extent in the manufacture of flour. The saddle-stone, the first true grinding implement, consisted of a stone with a more or less concave face on which the grain was spread, and in and along this hollow surface it was rubbed and ground into coarse meal. Saddle-stones have been discovered in the sand caves of Italy, among the lake dwellings of Switzerland, in the dolmens of France, in the pit dwellings of the British Isles, and among the remains of primitive folk all the world over. The Romans of the classical period seem to have distinguished the saddle-stone from the quern. We find allusions to the *mola trusatilis*, which may be translated “the thrusting mill”; this would fairly describe a backwards and forwards motion. The *mola versatilis* evidently referred to the revolving millstone or quern. In primitive parts of the world the saddle-stone is not yet extinct, as for instance in Mexico. It is known as the *metata*, and is used both for grinding maize and for making the maize cakes known as tortillas. The same implement is apparently still in use in some parts of South America, notably in Chile.

According to Richard Bennett, the quern, the first complete milling machine, originated in Italy and is in all probability

Quern. not older than the 2nd century B.C. This is, however, a controverted point. Querns are still used in most primitive countries, nor is it certain that they have altogether disappeared from remoter districts of Scotland and Ireland. Whatever was their origin, they revolutionized flour milling. The rotary motion of millstones became the essential principle of the trituration of grain, and exists to-day in the rolls of the roller mill. The early quern appears to have differed from its descendants in that it was somewhat globular in shape, the lower stone being made conical, possibly with the idea that the ground flour should be provided with a downward flow to enable it to fall from the stones. This type did not, however, persist. Gradually the convexity disappeared and the surface of the two stones became flat or very nearly so. In the upper stone was a species of funnel, through which the grain passed as through a hopper, making its way thence, as the stone revolved, into the space between the running and the bed stone. The ground meal was discharged at the periphery. The runner, or upper stone, was provided with a wooden handle by which the stone was revolved. The typical Roman mill of the Augustan age may be seen at Pompeii. Here, in what is believed to have been a public *pistrinum* or mill, were found four pairs of millstones. The circular base of these mills is 5 ft. in diameter and 1 ft. high, and upon it was fastened the *meta*, a blunt cone about 2 ft. high, on which fitted the upper millstone or *catillus*, also conical. These mills were evidently rotated by slave labour, as there was no room for the perambulation of a horse or donkey, while the side-lugs in which the handle-bars were inserted are plainly visible. Slave labour was generally used up to the introduction of Christianity, but was finally abolished by the emperor Constantine, though even after his edict mills continued to be driven by criminals.

Use of power. The Romans are credited by some authorities with having first applied power to the driving of millstones, which they connected with water-wheels by a horizontal spindle through the intervention of bevel gearing. But long after millstones had been harnessed to water power slave labour was largely employed as a motive force. The watermill of the Romans was introduced at a relatively early period into Britain. Domesday Book shows that England was covered by mills of a kind at the time of the Norman conquest, and mentions some 500 mills in 549
the counties of Norfolk and Suffolk alone. No doubt the *mola* of Domesday Book consisted of one pair of stones connected by rude gearing with a water-wheel. Windmills are said to have been introduced by the Crusaders, who brought them from the East. Steam power is believed to have been first used in a British flour mill towards the close of the 18th century, when Boulton & Watt installed a steam engine in the Albion Flour Mills in London, erected under the care of John Rennie. Another great engineer, Sir William Fairbairn, in the early days of the 19th century, left the impress of his genius on the mill and all its accessories. He was followed by other clever engineers, and in the days immediately preceding the roller period many improvements were introduced as regards the balancing and driving of millstones. The introduction of the blast and exhaust to keep the stones cool was a great step in advance, while the substitution of silk gauze for woollen or linen bolting cloth, about the middle of the 19th century, marked another era in British milling. Millstones, as used just before the introduction of roller milling, were from 4 to 4½ ft. in diameter by some 12 in. in thickness, and were usually made of a siliceous stone, known as buhr-stone, much of which came from the quarry of La Ferté-sous-Jouarre, in France.

Roller milling. Nine-tenths, or perhaps ninety-nine hundredths, of all the flour consumed in Great Britain is made in roller mills, that is, mills in which the wheat is broken and floured by means of rollers, some grooved in varying degrees of fineness, some smooth, their work being preceded and supplemented by a wide range of other machinery. All roller mills worthy of the name are completely automatic, that is to say, from the time the raw material enters the mill warehouse till it is sacked, either in the shape of finished flour or of offals, it is touched by no human hand.

The history of roller milling extends back to the first half of the 19th century. Roller mills, that is to say, machines fitted with rolls set either horizontally, or vertically, or obliquely, for the grinding of corn, are said to have been used as far back as the 17th century, but if this be so it is certain that they were only used in a tentative manner. Towards the middle of the 19th century the firm of E.R. & F. Turner, of Ipswich, began to build roller mills for breaking wheat as a preliminary to the conversion of the resultant middlings on millstones. The rolls were made of chilled iron and were provided with serrated edges, which must have exercised a tearing action on the integuments of the berry. These mills were built to the design of a German engineer, of the name of G.A. Buchholz, and were exhibited at the London exhibition of 1862, but they never came into general use. It has also been stated that as early as 1823 a French engineer, named Collier, of Paris, patented a roller mill, while five years later a certain Malar took out another French patent, the specification of which speaks of grooves and differential speeds. But the direct ancestors of the roller mills of the present day were brought out some time in the third decade of the 19th century by a Swiss engineer named Sulzberger. His apparatus was rather cumbrous, and the chilled iron rolls with which it was fitted consumed a large amount of power relatively to the work effected. But the Pester Walz-Mühle, founded in 1839 by Count Szechenyi, a Hungarian nobleman, which took its name from the roller mills with which it was equipped by Sulzberger, was for many years a great success; some of its roller mills are said to have been kept at work for upwards of forty years, and one at least is preserved in the museum at Budapest.

Hungarian practice. It may be noted that Hungarian wheat is hard and flinty and well adapted for treatment by rolls. Moreover, gradual reduction, as now understood, was more or less practised in Hungary, even before the introduction of roller milling. Though millstones, and not rolls, were used, yet the wheat was not floured at one operation, as in typical low or flat grinding, but was reduced to flour in several successive operations. In the first break the stones would be placed just wide enough apart to “end” the wheat, and in each succeeding operation the stones were brought closer together. But Hungarian milling was not then automatic in the sense in which British millers understand the word. For a long time a great deal of hand labour was employed in the merchant mills of Budapest in carrying about products from one machine to another for further treatment. This practice may have been partly due to the cheap labour available, but it was also the deliberate policy of Hungarian millers to handle in this way the middlings and fine “dunst,” because it was maintained that only thus could certain products be delivered to the machine by which they were to be treated in the perfection of condition. The results were good so far as the finished products were concerned, but in the light of modern automatic milling the system appears uneconomical. Not only did it postulate an inordinately large staff, but it further increased the labour bill by the demand it made on the number of sub-foremen who were occupied in classifying, largely by touch, the various products, and directing the labourers under them. Hungarian milling still differs widely from milling as practised in Great Britain in being a longer system. This is due to the more minute subdivision of products, a necessary consequence of the large number of grades of flour and offals made in Hungary, where there are many intermediate varieties of middlings and “dunst” for which no corresponding terms are available in an English miller’s vocabulary.

Semolina, middlings, dunst. It will be convenient here to explain the meaning of three terms constantly used by millers, namely, *semolina*, *middlings* and *dunst*. These three products of roller mills are practically identical in composition, but represent different stages in the process of reducing the endosperm of the wheat to flour. A wheat berry is covered by several layers of skin, while under these layers is the floury kernel or endosperm. This the break or grooved rolls tend to tear and break up. The largest of these more or less cubical particles are known as semolina, whilst the medium-sized are called middlings and the smallest sized termed dunst. The last is a German word, with several meanings, but is used in this particular sense by German and Austrian millers, from whom it was doubtless borrowed by the pioneers of roller milling in England. If we were to lay a sample of fairly granular flour beside a sample of small dunst the two would be easy to distinguish, but place a magnifying glass over the flour and it would look very like the dunst. If we were to repeat this experiment on dunst and fine middlings, the former would under the glass present a strong resemblance to the middlings. The same effect would be produced by the putting side by side of large middlings and small semolina. This is a broad description of semolina, middlings and dunst. Semolina and middlings are more apt to vary in appearance than dunst, because the latter is the product of the later stages of the milling process and represents small particles of the floury kernel tolerably free from such impurities as bran or fluff. The flour producing middlings must not be confounded with the variety of wheat offal which is also known to many English millers as middlings. This consists of husk or bran, more or less comminuted, and with a certain proportion of floury particles adherent. It is only fit for feeding beasts.

Porcelain rolls.

The spread of roller milling on the continent of Europe was undoubtedly accelerated by the invention of porcelain rolls, by Friedrich Wegmann, a Swiss miller, which were brought into general use in the seventh decade of the 19th century, and are still widely employed. They are admirably fitted for the reduction of semolina, middlings and dunst into flour; and for reducing pure middlings, that is, middlings containing no bran or wheat husk, there is perhaps nothing that quite equals them. They were introduced into Great Britain in 1877, or thereabouts, and were used for several years, but ultimately they almost disappeared from British mills. This was partly due to the fact that as made at that date they were rather difficult to work, as it was not easy to keep the rolls perfectly parallel. Another drawback was their inadaptability to over-heavy feeds, to which the British, and perhaps still more the American, miller is frequently obliged to resort. However, since the beginning of the 20th century some of the most advanced flour mills in England have again taken to using porcelain rolls for some part of their reduction process. 550

Roller milling in England.

The birth of roller milling in Great Britain may be said to date from 1872, when Oscar Oexle, a German milling engineer, erected a set of roller mills in the Tradeston Mills, in Glasgow. This was long before the introduction of automatic roller mills. But the foundations of the millstone system were not seriously disturbed till 1877, when a party of leading British and Irish millers visited Vienna and Budapest with the object of studying roller milling in its native home. In 1878 J.H. Carter installed in the mill of J. Boland, of Dublin, what was probably the first complete automatic roller plant erected in the United Kingdom, and in 1881 a milling exhibition held at the Royal Agricultural Hall, London, showed the automatic roller system in complete operation. From that time the roller system made great progress. By 1885 many of the leading British millers had installed full roller plants, and in the succeeding ten years small roller plants were installed in many country mills. For a time there was a transition stage in which there was in operation a number of so-called “combined” plants, that is to say, mills in which the wheat was broken on millstones or disk mills, while the middlings were reduced by smooth rolls; but these gradually dropped out of being.

Well-found British flour mills at the present time are probably the best fitted in the world, and as a whole have nothing to fear from comparison with their American competitors. It is true that American millers were rather quicker to copy Hungarian milling methods so far as gradual reduction was concerned. But from about 1880 the British miller was quite awake to his position and was straining every nerve to provide himself with a plant capable of dealing with every kind of wheat. It has often been said that he commands the wheat of the whole world. This is true in a sense, but it is not true that he can always command the exact kind of wheat he requires at the price required to meet foreign competition. Therein he is at a disadvantage. But engineers have done their best to meet this weak point, and by their assistance he is able to compete under almost all conditions with the millers of the whole world.

Processes of Milling.—Fully to appreciate the various processes of modern milling, it must be remembered not only that the wheat as delivered at the mill is dusty and mixed with sand and even more objectionable refuse, but also that it contains many light grains and seeds of other plants. It is not therefore sufficient for the miller to be able to reduce the grain to flour on the most approved principles; he must also have at command the means of freeing it from foreign substances, and further of “conditioning” it, should it be damp or over dry and harsh. Again, his operations must be conducted with reference to the structure of the wheat grain. The wheat berry is a fruit, not a seed, the actual seed being the germ or embryo, a kidney-shaped body which is found at the base of the berry and is connected with the plumule or root. The germ is tough in texture and is in roller milling easily separated from the rest of the berry, being flattened instead of crushed by the rolls and thus readily sifted from the stock. The germ contains a good deal of fatty matter, which, if allowed to remain, would not increase the keeping qualities of the flour. Botanists distinguish five skins on the berry—epidermis, epicarp, endicarp, episperm and embryous membrane—but for practical purposes the number of integuments may be taken as three. The inner skin is often as thick as the outer and second skins together, which are largely composed of woody fibre; it contains the cerealin or aleurone cells, but although these are made up of a certain proportion of proteids, on account of the discolouring and diastasic action of the cerealin in flour they are best eliminated. The endosperm, or floury kernel, coming next to the inner skin, consists of starch granules which are caught as it were in the minute meshes of a net. This network is the gluten, and it may be noted that these meshes are not of equal consistency throughout the berry, but are usually finer and more dense near the husk than in the interior of the kernel. This glutinous portion is of great importance to the baker because on its quantity and quality depends the “strength” or rising power of the flour, and the aim of modern roller milling is to retain it as completely as possible, a matter of some difficulty owing to its close adherence to the husk, especially in the richest wheats. Another organ of the wheat berry which has a most important bearing on the work of the miller is the placenta, which is in effect a cord connecting the berry with its stalk or straw. The placenta serves to filter the food which the plant sucks up from the ground; it passes up the crease of the berry, and is enfolded in the middle skin, being protected on the outer side by the first and having the third or inner skin on its other side. A good deal of the matters filtered by the placenta are mineral in their nature, and such portions as are not digested remain in the crease. This is the matter which millers call “crease dirt.” It is highly discolouring to flour, and must be carefully eliminated. The fuzzy end of the berry known as the beard also has a distinct function; its hairs are in reality tubes which serve to carry off superfluous moisture. They have, in common with the bran, no nutritive value. (See also Wheat.)

In the old “flat” or “low” milling the object was to grind as perfectly as possible, at one operation, the central substance of the grain, constituting the flour, and to separate it from the embryo and outer skins constituting the bran. In “high” milling, on the other hand, the grinding is effected in a series of operations, the aim being to get as much semolina and middlings as possible from the wheat, and to make as little flour as possible during the earlier or “breaking” part of the process. It is impossible altogether to avoid the production of flour at this stage, but properly set and worked break-rolls will make as little as 15% of “break-flour,” which is of less value, being contaminated with crease dirt, and also because it is weak owing to the absence of the gluten cells which adhere more readily to the middlings. Whole wheaten flour, sometimes called Graham flour, consists of the entire grain ground up to a uniform mass.

Dry cleaning.

Wheat cleaning has been well called the foundation of all good milling. In the screen house, as the wheat-cleaning department of the mill is termed, will be found an array of machinery almost equal in range and variety to that in the mill itself. The wheat, drawn by an elevator from the barge, or hoisted in sacks, is first treated by a machine known as a warehouse separator. This apparatus accomplishes its work by means of flat sieves, some of which will be of much coarser mesh than others, and of air currents, the adjustment of which is a more delicate task than might appear. The warehouse separator serves to free dirty wheat of such impurities as lumps of earth, stones, straws and sand, not to mention small seeds, also some maize, oats and barley. Great care has to be exercised in

all operations of the screen house lest wheat should pass away with the screenings. Besides the warehouse separator, which is made in different types and sizes, grading and sorting cylinders, and what are known as cockle and barley cylinders, are much used in the screen house. These cylinders are provided with indents so shaped and of such size as to catch seeds which are smaller than wheat, and reject grains, as of barley or oats, which are longer than wheat. Sorting cylinders should be followed by machines known as scourers, the function of which is to free the wheat from adherent impurities. These machines are of different types, but all depend on percussive action. A vertical scourer consists of a number of steel or iron beaters attached to a vertical spindle which revolves inside a metallic woven or perforated casing, the whole being fitted with an effectual exhaust. Scourers with horizontal spindles are also in great favour. Not every wheat is suitable for scouring, but some wheats are so mingled with impurities that a severe action between the beaters and the perforated case is absolutely necessary. The most efficient scourer is that which frees the wheat from the greatest amount of impurity with a minimum of abrasion. The beaters should be adjustable to suit different kinds of wheat. Scourers are followed by brush machines which are similar to the last and are of three distinct types: solid, divided and cone brushes. In the solid variety the brush surface is continuous around the circumference of a revolving cylinder; in divided brushes there is often a set of beaters or bars covered with brush but leaving intermediate spaces; while the cone brush consists of beaters covered with fibre arranged like cones around a vertical spindle. The object of all these brushes, the cylinder containing them being fitted with an exhaust fan, is to polish the wheat and remove adhering impurities which the percussive action of the scourer may have failed to eliminate, also to remove the beard or fuzzy end and any loose portions of the outer husk. But the miller must be careful not to overdo the scouring action and unnecessarily abrade the berry, else he will have trouble with his flour, the triturated bran breaking under the rolls and producing powder which will discolour the break flour. To remove such metallic fragments as nails, pieces of wire, &c., magnets are used. These may either be of horseshoe shape, in which case they are usually set at the head of the wheat spouts, or they 551
may consist of magnetized plates set at angles over which the wheat will slide. It is not a bad plan to place the magnets just before the first set of break-rolls, where they should ensure the arrest of steel and iron particles, which might otherwise get between the rolls and spoil the edges of their grooves, and also do damage to the sifting machines. Mention must also be made of the automatic scales which are used to check the milling value of the wheat. In principle these machines are all the same, though details of construction may vary. Each weigher is set for a given weight of grain. As soon as the receiving hopper has poured through a valve into the recipient or skip, which is hung at one end of a beam scale, a load of grain sufficient to overcome the weight hung at the other end of the beam, the inlet of grain is automatically cut off and the skip is discharged, automatically returning to take another charge. Each weighing is automatically recorded on a dial. In this way a record can be kept of the gross weight of the uncleaned wheat entering the warehouse and of the net weight of the cleaned wheat. The difference between the two weighings will, of course, represent the loss by cleaning. The percentage of flour obtained from a given wheat can be ascertained in the mill itself. In practice the second weigher is placed just before the first break.

Wet cleaning and conditioning.

The cleansing of wheat by washing only became a fine art at the close of the 19th century, though it was practised in the north of England some twenty years earlier. Briefly it may be said that certain wheats are washed to free them from extraneous matters such as adherent earth and similar impurities which could not be removed by dry cleaning without undue abrasion. Such wheats are Indians, Persians and hard Russians, and these require not only washing but also conditioning, by which is meant mellowing, before going to the rolls. With another class of wheats, such as the softer Russians and Indians, spring Americans and Canadians, hard American winters, Californians and the harder River Plates, washing and conditioning by heat is also desirable, though care must be exercised not to let the moisture penetrate into the endosperm or floury portion of the kernel. In a third and distinct class fall soft wheats, such as many kinds of Plates, soft Russians and English wheat. It is generally admitted that while wheat of the first two divisions will benefit from the application of both moisture and heat, wheat of the third class must be washed with great circumspection. The object of washing machines is to agitate the wheat in water till the adherent foreign matters are washed off and any dirt balls broken up and drained off in the waste water. To this end some washers are fitted with Archimedean worm conveyors set either at an inclined angle or horizontally or vertically; or the washer may consist of a barrel revolving in a tank partly filled with water. Another function of washing machines is to separate stones of the same size which are found in several varieties of wheat. This separation is effected by utilizing a current of water as a balance strong enough to carry wheat but not strong enough to carry stones or bodies of greater specific gravity than wheat. This current may be led up an inclined worm or may flow horizontally over a revolving tray. The washer is followed by a whizzer, which is an apparatus intended to free the berry by purely mechanical means from superfluous moisture. The typical whizzer is a vertical column fed at the bottom and delivering at the top. The wet wheat ascends by centrifugal force in a spiral direction round the column to the top, and by the time it is discharged from the spout at the top it has thrown off from its outer skin almost all its moisture, the water escaping through the perforated cover of the machine. But there still remains a certain amount of water which has penetrated the integuments more or less deeply, and to condition the berry it is treated by a combination of hot and cold air. The wheat is passed between perforated metal plates and subjected to a draught first of hot and then of cold air. The perforated plates are usually built in the shape of a column, or leg as it is often called, and this is provided with two air chambers, an upper one serving as a reservoir for hot, and the lower for cold air. The air from both chambers is discharged by pressure through the descending layers of wheat, which should not be more than an inch thick; the air is drawn in by a steel-plate fan, which is often provided with a divided casing, one side being used for cold, and the other for hot air. Coupled with the hot air side is a heater consisting of a series of circulating steam-heated pipes. The temperature of the heated air can be regulated by the supply of steam to the heater. This process of washing and conditioning, one of the most important in a flour mill, is characteristically British; millers have to deal with wheats of the most varied nature, and one object of conditioning is to bring hard and harsh, soft and weak wheats as nearly as possible to a common standard of condition before being milled. Wheat is sometimes washed to toughen the bran, an end which can also be attained by damping it from a spraying pipe as it passes along an inclined worm. Another way of toughening bran is to pass wheat through a heated cylinder, while again another process known as steaming consists of injecting steam into wheat as it passes through a metal hopper. Here the object is to cleanse to some extent, and to warm and soften (by the condensation of moisture on the grain), but these processes are imperfect substitutes for a full washing and conditioning plant. Hard wheats will not be injured by a fairly long immersion in water, always provided the subsequent whizzing and drying are efficiently carried out. The second class of semi-hard wheats already mentioned must be run more quickly through the washer and freed from the water as rapidly as possible. Still more is this necessary with really soft wheats, such as soft River Plates and the softer English varieties. Here an immersion of only a few seconds is desirable, while the moisture left by the water must be immediately and energetically thrown off by the whizzer before the grain enters the drier. Treated thus, soft wheats may be improved by washing. It is claimed that hard wheats, like some varieties of Indians, are positively improved in flavour by conditioning, and this is probably true; certain it is that English country millers, in seasons when native wheat was scarce and dear, and Indian wheat was abundant and cheap, have found the latter, mellowed by conditioning, to be an excellent substitute.

Effect of damp.

Wheats which have been exposed to the action of water during harvest do not necessarily yield unsound flour; the matter is a question of the amount of moisture absorbed. But it must be remembered that it is not so much the water itself which degrades the constituents of the wheat (starch and gluten) as the chemical changes which the dampness produces. Hence perhaps the best remedy which can be found for damp wheat is to dry it as soon as it has been harvested, either by kiln or steam drier at a heat not exceeding 120° F., until the moisture has been reduced to 10% of the whole grain. The flour made from wheat so treated may be weak, but will not usually be unsound. The practice of drying damp flour has also good results. Long before the roller milling period it was found that only flour which had been dried (in a kiln) could safely be taken on long sea voyages, especially when the vessel had to navigate warm latitudes. It may be noted that in the days of millstone milling it was far more difficult to produce good keeping flour. The wheat berry being broken up and triturated in one operation, the flour necessarily contained a large proportion of branny particles in which cerealin, an active diastasic constituent, was present in very sensible proportions. Again, the elimination of the germ by the roller process is favourable to the production of a sounder flour, because the germ contains a large amount of oleaginous matter and has a strong diastasic action on imperfectly matured starches. The tendency of flours containing germ to become rancid is well marked. During the South African War of 1899-1902 the British army supply department had a practical proof of the diastasic action of branny particles in flour. Soldiers’ bread is not usually of white colour, and the military authorities not unnaturally believed that comparatively low-grade flour, if sound, was eminently suitable for use in the field bakeries. But in the climate of South Africa flour of this description soon developed considerable acidity. Ultimately the supply department gave up buying any but the driest patent flours, and it is understood that the most suitable flour proved to be certain patents milled in Minneapolis, U.S.A., from hard spring wheat. Not only did they contain a minimum of branny and fibrous matters, but they were also the driest that could be found.

Break-rolls.

After being cleaned the wheat berry is split and broken up into increasingly fine pieces by fluted rolls or “breaks.” In the earlier years of roller milling it was usual to employ more breaks than is now the case. The first pair of break-rolls used to be called the splitting rolls, because their function was supposed to be to split the berry longitudinally down its crease, so as to give the miller an opportunity of removing the dirt between the two lobes of the berry by means of a brush machine. The dirt was in many cases no more than the placenta already described, which shrivelling up took, like all vegetable fibre, a dark tint. The neat split along the crease was not, however, achieved in more than 10% of the berries so treated. Where such rolls are still in use they are really serving as a sort of adjunct to the wheat-cleaning system. Four or five breaks are now thought sufficient, but three breaks are not recommended, except in very short systems for small country mills. Rolls are now used up to 60 in. in length, though in one of the most approved systems they never exceed 40 in.; they are made of chilled iron, and for the breaking of wheat are provided with grooving cut at a slight twist, the spiral averaging ¼ in. to the foot length, though for the last set of break-rolls, which clean up the bran, the spiral is sometimes increased to ½ in. per foot. The grooves should have sharp edges because they do better work than when blunt, giving larger semolina and middlings, with bran adherent in big flakes; small middlings, that is, little pieces of the endosperm torn away by blunt grooves, and comminuted bran, make the production of good class flour almost impossible; cut bran, moreover, brings less money. The break-rolls should never work by pressure, but nip the material fed between them at a given point; to cut or shear, not to flatten and crush, is their function. Rolls may be set either horizontally or vertically; an oblique setting has also come into favour. The feed is of the utmost importance to the correct working of a roller mill. The material should be fed in an even stream, not too thick, and leaving no part of the roll uncovered. The two rolls of each pair are run at unequal speeds, 2½ to 1 being the usual ratio on the three first breaks, while the last break is often speeded at 3 to 1 or 3½ to 1; in one of the oblique mills the difference is obtained by making the diameter of one roll 13 and of the other 10 in. and running them at equal speed. For break-rolls up to 36 in. in length 9 in. is the usual diameter; for longer rolls 10 in. is the standard. To do good work rolls
552
must run in perfect parallelism; otherwise some parts of the material will pass untouched, while others will be treated too severely.

Scalpers.

The products of the break-rolls are treated by what are known as scalpers, which are simply machines for sorting out these products for further treatment. Scalpers may either be revolving reels or flat sieves. The sieve is the favourite form of scalper on account of its gentle action. Scalping requires a separating and sifting, not a scouring action. The break products are usually separated on a sieve covered with wire or perforated zinc plates. Generally speaking, two sieves are in one frame and are run at a slight incline. The throughs of the top sieve fall on the sieve below, while the rejections or overtails of the first sieve are fed to the next break. The “throughs,” or what has passed this sieve, are graded by the next sieve, the tailings going to a purifier, while the throughs may be freed from what flour adheres to them by a centrifugal dressing machine and then treated by another purifier. A form of scalper which has come into general use on the continent of Europe, and to a lesser extent in Great Britain and America, is known as the plansifter. This machine, of Hungarian origin, is simply a collection of superimposed flat sieves in one box, and will scalp or sort out any kind of break stock very efficiently. A system of grading the tailings, that is, the rejections of the scalpers, introduced by James Harrison Carter (Carter-Zimmer patent), was known as pneumatic sorting. Its object was to supplement the work of the scalpers by classifying the tailings by means of air-currents. To this end each scalper was followed by a machine arranged somewhat like a gravity purifier; that is to say, a current of air drawn through the casing of the sorter allowed the heaviest and best material to drop down straight, while the lighter stuff was deposited in one or other of further compartments formed by obliquely placed adjustable cant boards. So searching was this grading, that from the first sorter of a four-break plant four separations would be obtained, the first going to the second break, the second joining the first separation from the second sorter and being fed to the third break, while the third went with the best separation of the third sorter to the fourth break, and the last separation from all the sorters went straight into the bran sack. The work of the break-rolls was greatly simplified and reduced by this sorting process, as each particle of broken wheat went exactly to that pair of break-rollers for which it was suitable, instead of all the material being run indiscriminately through all the break-rollers and thereby being cut up with the necessary result of increasing the production of small bran.

Purifiers.

The object of the purifier, a machine on which milling engineers have lavished much thought and labour, is to get away from the semolina and middlings as much impure matter as possible, that those products may be pure, as millers say, for reduction to flour by the smooth rolls. The purifiers used in British mills take advantage of the fact that the more valuable portions of the wheat berry are heavier than the less valuable particles, such as bran and fibrous bodies, and a current of air is employed to weigh these fragments of the wheat berry as in a balance and to separate them while they pass over a silk-covered sieve. To this end the semolina or middlings are fed on a sieve vibrated by an eccentric and set at a slight downward angle. This sieve is installed in an air-tight longitudinal wooden chamber with glass windows on either side, through which the process of purifying can be watched. Upwards through this sieve a fan constantly draws a current of air, which, raising the stock upwards, allows the heavier and better material to remain below while the lighter particles are lifted off and fall on side platforms or channels, whence they are carried forward and delivered separately. The good material drops through the meshes of the silk, and is collected by a worm. It is usual to clothe the sieve in sections with several different meshes of silk so that stock of almost identical value, but differing size, may be treated with uniform accuracy. In good purifiers the strength of the current can be regulated at will in each section. The tailings of a purifier do not usually exceed 10 to 15% of the feed. The clothing of purifier sheets must be nicely graduated to the clothing of the preceding machines. Repurification and even tertiary purification may be necessary under certain conditions. In Hungary and other parts of Europe, gravity purifiers are much in use. Here the material is guided along an open sieve set at a slight angle, while an air-current is drawn up at an acute angle. Under the sieve may be arranged a series of inclined boards, the position of which can be varied as required. The heaviest and most valuable products resist the current and drop straight down, while lighter material is carried off to further divisions.

Smooth rolls.

From the purifier all the stock except the tailings, which may require other treatment, should go to the smooth rollers to be made into flour, but here the rollerman will have to exercise great care and discretion. Many of the remarks already made in regard to break-rolls apply to smooth rolls, notably in respect of parallelism. But instead of a cutting action, the smooth rolls press the material fed to them into flour. This pressure, however, must be applied with great discrimination, large semolina with impurities attached requiring quite different treatment from that called for by small pure middlings. The pressure on the stock must be just sufficient and no more. Reduction rolls are usually run at a differential speed of about 2 to 3. The feed must be carefully graded, because to pass stock of varying size through a pair of smooth rolls would be fatal to good work. Scratch rolls very finely grooved are used for cracking impure semolina or for reducing the tailings of purifiers. The latter often hold fragments of bran, which are best detached by rolls grooved about 36 to the inch and run at a differential of 3 to 1. The reduction requires even more roll surface than the break system. To do first-class work a mill should have at least 35 to 40 in. on the breaks and 50 in. on the reduction for each sack of 280 ℔ of flour per hour. Many engineers consider 100 to 110 in. on the break, scratch and smooth rolls not too much.

Dressing.

The dressing out of the flour from the stock reduced on smooth rolls is generally effected by centrifugal machines, which consist of a slowly revolving cylinder provided with an internal shaft on which are keyed a number of iron beaters that run at a speed of about 200 revolutions a minute, and fling the feed against the silk clothing of the cylinder. What goes through the silk is collected by a worm conveyor at the bottom of the machine. Most centrifugals have so-called "cut-off" sheets, with internal divisions in the tail end; these are intended to separate some intermediate products, which, having been freed from floury particles, are treated on some other machine, such as a pair of rolls either direct or after a purifier. The centrifugal is undoubtedly an efficient flour separator, but the plansifters already mentioned are also good flour-dressers, especially in dry climates. A plansifter mill will have no centrifugals, except one or two at the tail end where the material gets more sticky and requires more severe treatment.

The yield of flour obtained in a British roller mill averages 70 to 73% of the wheat berry. The residue, with the exception of a very small proportion of waste, is offal, which is divided into various grades and sold. Profitable markets for British-made bran have been found in Scandinavia, and especially in Denmark. In millstone milling the yield of flour probably averaged 75 to 80%, but a certain proportion of this was little more than offal. The length of the flour yield taken by British millers varies in different parts of the kingdom, because demand varies. In one locality high-class patents may be at a premium; in another the call is for a straight grade, *i.e.* a flour containing as much of the farinaceous substance as can be won from the wheat berry. In one district there is a sale for rich offals, that is, offals with plenty of flour adhering; in another there may be no demand for such offals. Hence, though the general principles of roller milling as given above hold good all over the country, yet in practice the work of each mill is varied more or less to suit the peculiarities of the local trade.

Bleaching of flour.

Early in the 19th century a French chemist, J.J.E. Poutet, discovered that nitrous acid and oxides of nitrogen act on some fluid and semi-fluid vegetable oils, removing their yellow tinge and converting a considerable portion of their substance into a white solid. The importance of this discovery, when the physical constitution of wheat is considered, is obvious, but it was years before any attempt was made to bleach flour. The first attempts at bleaching seem to have been made on the wheat itself rather than on the flour. In 1879 a process was patented for bleaching grain by means of chlorine gas, and about 1891 a suggestion was made for bleaching grain by means of electrolysed sea-water. In 1895 a scheme was put forward for treating grain with sulphurous acid, and about two years later it was proposed to subject both grain and flour to the influence of electric currents. In 1893 a patent was granted for the purification of flour by means of fresh air or oxygen, and three years later another inventor proposed to employ the Röntgen rays for the same purpose. In 1898 Emile Frichot took out a patent for using ozone and ozonized air for flour-bleaching. The patent (No. 1661 of 1901) taken out by J. & S. Andrews of Belfast recited that flour is known to improve greatly if kept for some time after grinding, and the purpose of the invention it covered was to bring about this improvement or conditioning not only immediately after grinding, but also to a greater extent than can be effected by keeping. The process consisted in subjecting the flour to the action of a suitable gaseous oxidizing medium; the inventors preferred air carrying a minute quantity of nitric acid or peroxide of nitrogen, but they did not confine themselves to those compounds, having found that chlorine, bromine and other substances capable of liberating oxygen were also more or less efficacious. They claimed that while exercising no deleterious action their treatment made the flour whiter, improved its baking qualities, and rendered it less liable to be attacked by mites or other organisms. Under the patent, No. 14006 of 1903, granted to J.N. Alsop of Kentucky the flour was treated with atmospheric air which had been subjected to the action of an arc or flaming discharge of electricity, with the purpose of purifying it and improving its nutritious properties. The Andrews and Alsop patents became the objects of extended litigation in the English courts, and it was held that the gaseous medium employed by Alsop was substantially the same as that employed by Andrews, though produced electrically instead of chemically, and therefore that the Alsop process was an infringement of the Andrews patent. Various other patents for more or less similar processes have also been taken out.

(G. F. Z.)

553

FLOURENS, GUSTAVE (1838-1871), French revolutionist and writer, a son of J.P. Flourens (1794-1867), the physiologist, was born at Paris on the 4th of August 1838. In 1863 he undertook for his father a course of lectures at the Collège de France, the subject of which was the history of mankind. His theories as to the manifold origin of the human race, however, gave offence to the clergy, and he was precluded from delivering a second course. He then went to Brussels, where he published his lectures under the title of *Histoire de l'homme* (1863); he next visited Constantinople and Athens, took part in the Cretan insurrection of 1866, spent some time in Italy, where an article of his in the *Popolo d'Italia* caused his arrest and imprisonment, and finally, having returned to France, nearly lost his life in a duel with Paul de Cassagnac, editor of the *Pays*. In Paris he devoted his pen to the cause of republicanism, and at length, having failed in an attempt to organize a revolution at Belleville on the 7th of February 1870, found himself compelled to flee from France. Returning to Paris on the downfall of Napoleon, he soon placed himself at the head of a body of 500 tirailleurs. On account of his insurrectionary proceedings he was taken prisoner at Créteil, near Vincennes, by the provisional government, and confined at Mazas on the 7th of December 1870, but was released by his men on the night of January 21-22. On the 18th of March he joined the Communists. He was elected a member of the commune by the 20th arrondissement, and was named colonel. He was one of the most active leaders of the insurrection, and in a sortie against the Versailles troops in the morning of the 3rd of April was killed in a hand-to-hand conflict at Rueil, near Malmaison. Besides his *Science de l'homme* (Paris, 1869), Gustave Flourens was the author of numerous fugitive pamphlets.

See C. Prolès, *Les Hommes de la révolution de 1871* (Paris, 1898).

FLOURENS, MARIE JEAN PIERRE (1794-1867), French physiologist, was born at Maureilhan, near Béziers, in the department of Hérault, on the 15th of April 1794. At the age of fifteen he began the study of medicine at Montpellier, where in 1823 he received the degree of doctor. In the following year he repaired to Paris, provided with an introduction from A.P. de Candolle, the botanist, to Baron Cuvier, who received him kindly, and interested himself in his welfare. At Paris Flourens engaged in physiological research, occasionally contributing to literary publications; and in 1821, at the Athénée there, he gave a course of lectures on the physiological theory of the sensations, which attracted much attention amongst men of science. His paper entitled *Recherches expérimentales sur les propriétés et les fonctions du système nerveux dans les animaux vertébrés*, in which he, from experimental evidence, sought to assign their special functions to the cerebrum, corpora quadrigemina and cerebellum, was the subject of a highly commendatory report by Cuvier, adopted by the French Academy of Sciences in 1822. He was chosen by Cuvier in 1828 to deliver for him a course of lectures on natural history at the Collège de France, and in the same year became, in succession to L.A.G. Bosc, a member of the Institute, in the division “Économie rurale.” In 1830 he became Cuvier’s substitute as lecturer on human anatomy at the Jardin du Roi, and in 1832 was elected to the post of titular professor, which he vacated for the professorship of comparative anatomy created for him at the museum of the Jardin the same year. In 1833 Flourens, in accordance with the dying request of Cuvier, was appointed a perpetual secretary of the Academy of Sciences; and in 1838 he was returned as a deputy for the arrondissement of Béziers. In 1840 he was elected, in preference to Victor Hugo, to succeed J.F. Michaud at the French Academy; and in 1845 he was created a commander of the legion of honour, and in the next year a peer of France. In March 1847 Flourens directed the attention of the Academy of Sciences to the anaesthetic effect of chloroform on animals. On the revolution of 1848 he withdrew completely from political life; and in 1855 he accepted the professorship of natural history at the Collège de France. He died at Montgeron, near Paris, on the 6th of December 1867.

Besides numerous shorter scientific memoirs, Flourens published—*Essai sur quelques points de la doctrine de la révulsion et de la dérivation* (Montpellier, 1813); *Expériences sur le système nerveux* (Paris, 1825); *Cours sur la génération, l’ovologie, et l’embryologie* (1836); *Analyse raisonnée des travaux de G. Cuvier* (1841); *Recherches sur le développement des os et des dents* (1842); *Anatomie générale de la peau et des membranes muqueuses* (1843); *Buffon, histoire de ses travaux et de ses idées* (1844); *Fontenelle, ou de la philosophie moderne relativement aux sciences physiques* (1847); *Théorie expérimentale de la formation des os* (1847); *Œuvres complètes de Buffon* (1853); *De la longévité humaine et de la quantité de vie sur le globe* (1854), numerous editions; *Histoire de la découverte de la circulation du sang* (1854); *Cours de physiologie comparée* (1856); *Recueil des éloges historiques* (1856); *De la vie et de l’intelligence* (1858); *De la raison, du génie, et de la folie* (1861); *Ontologie naturelle* (1861); *Examen du livre de M. Darwin sur l’Origine des Espèces* (1864). For a list of his papers see the Royal Society’s *Catalogue of Scientific Papers*.

FLOWER, SIR WILLIAM HENRY (1831-1899), English biologist, was born at Stratford-on-Avon on the 30th of November 1831. Choosing medicine as his profession, he began his studies at University College, London, where he showed special aptitude for physiology and comparative anatomy and took his M.B. degree in 1851. He then joined the Army Medical Service, and went out to the Crimea as assistant-surgeon, receiving the medal with four clasps. On his return to England he became a member of the surgical staff of the Middlesex hospital, London, and in 1861 succeeded J.T. Quekett as curator of the Hunterian Museum of the Royal College of Surgeons of England. In 1870 he also became Hunterian professor, and in 1884, on the death of Sir Richard Owen, was appointed to the directorship of the Natural History Museum at South Kensington. He died in London on the 1st of July 1899. He made valuable contributions to structural anthropology, publishing, for example, complete and accurate measurements of no less than 1300 human skulls, and as a comparative anatomist he ranked high, devoting himself especially to the study of the mammalia. He was also a leading authority on the arrangement of museums. The greater part of his life was spent in their administration, and in consequence he held very decided views as to the principles upon which their specimens should be set out. He insisted on the importance of distinguishing between collections intended for the use of specialists and those designed for the instruction of the general public, pointing out that it was as futile to present to the former a number of merely typical forms as to provide the latter with a long series of specimens differing only in the most minute details. His ideas, which were largely and successfully applied to the museums of which he had charge, gained wide approval, and their influence entitles him to be looked upon as a reformer who did much to improve the methods of museum arrangement and management. In addition to numerous original papers, he was the author of *An Introduction to the Osteology of the Mammalia* (1870); *Fashion in Deformity* (1881); *The Horse: a Study in Natural History* (1890); *Introduction to the Study of Mammals, Living and Extinct* (1891); *Essays on Museums and other Subjects* (1898). He also wrote many articles for the ninth edition of the *Encyclopaedia Britannica*.

FLOWER (Lat. *flos*, *floris*; Fr. *fleur*), a term popularly used for the bloom or blossom of a plant, and so by analogy for the fairest, choicest or finest part or aspect of anything, and in various technical senses. Here we shall deal only with its botanical interest. It is impossible to give a rigid botanical definition of the term “flower.” The flower is a characteristic feature of the highest group of the plant kingdom—the flowering plants (Phanerogams)—and is the name given to the association of organs, more or less leaf-like in form, which are concerned with the production of the fruit or seed. In modern botanical works the group is often known as the seed-plants (Spermatophyta). As the seed develops from the ovule which has been fertilized by the pollen, the essential structures for seed-production are two, viz. the pollen-bearer or *stamen* and the ovule-bearer or *carpel*. These are with few exceptions foliar structures, known in comparative morphology as sporophylls, because they bear the spores, namely, the microspores or pollen-grains which are developed in the microsporangia or pollen-sacs, and the megaspore, which is contained in the ovule or megasporangium.

In Gymnosperms (*q.v.*), which represent the more primitive type of seed-plants, the micro- or macro-sporophylls are 554 generally associated, often in large numbers, in separate cones, to which the term “flower” has been applied. But there is considerable difference of opinion as to the relation between these cones and the more definite and elaborate structure known as the flower in the higher group of seed-plants—the Angiosperms (*q.v.*)—and it is to this more definite structure that we generally refer in using the term “flower.”

Flowers are produced from flower-buds, just as leaf-shoots arise from leaf-buds. These two kinds of buds have a resemblance to each other as regards the arrangement and the development of their parts; and it sometimes happens, from injury and other causes, that the part of the axis which, in ordinary cases, would produce a leaf-bud, gives origin to a flower-bud. A flower-bud has not in ordinary circumstances any power of extension by the continuous development of its apex. In this respect it differs from a leaf-bud. In some cases, however, of monstrosity, especially seen in the rose (fig. 1), the central part is prolonged, and bears leaves or flowers. In such cases the flowers, so far as their functional capabilities are concerned, are usually abortive. This phenomenon is known as proliferation of the floral axis.

Flower-buds, like leaf-buds, are produced in the axil of leaves, which are called *bracts*.

The term *bract* is properly applied to the leaf from which the primary floral axis, whether simple or branched, arises, while the leaves which arise on the axis between the bract and the outer envelope of the flower are *bracteoles* or *bractlets*. Bracts sometimes do not differ from the ordinary leaves, as in *Veronica hederifolia*, *Vinca*, *Anagallis* and *Ajuga*. In general as regards their form and appearance they differ from ordinary leaves, the difference being greater in the upper than in the lower branches of an inflorescence. They are distinguished by their position at the base of the flower or flower-stalk. Their arrangement is similar to that of the leaves. When the flower is sessile the bracts are often applied closely to the calyx, and may thus be confounded with it, as in the order Malvaceae and species of *Dianthus* and winter aconite (*Eranthis*), where they have received the name of *epicalyx* or *calyculus*. In some Rosaceous plants an epicalyx is present, due to the formation of stipulary structures by the sepals. In many cases bracts act as protective organs, within or beneath which the young flowers are concealed in their earliest stage of growth.

Bracts.

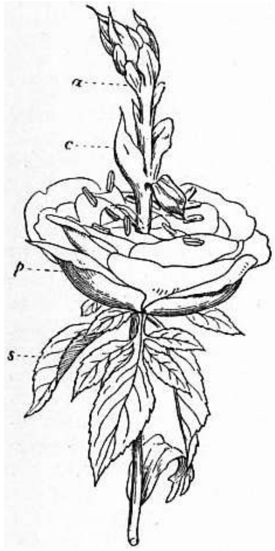
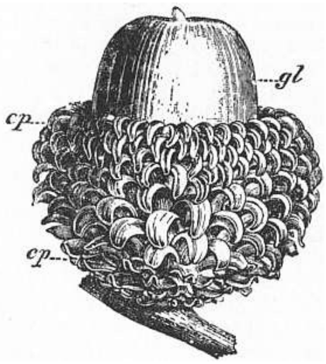


Fig. 1.—Proliferous Rose.

s, Sepals transformed into leaves.
p, Petals multiplied at the expense of the stamens, which are reduced in number.
c, Coloured leaves representing abortive carpels.
a, Axis prolonged, bearing an imperfect flower at its apex.

When bracts become coloured, as in *Amherstia nobilis*, *Euphorbia splendens*, *Erica elegans* and *Salvia splendens*, they may be mistaken for parts of the corolla. They are sometimes mere scales or threads, and at other times are undeveloped, giving rise to the *ebracteate* inflorescence of Cruciferae and some Boraginaceae. Sometimes they are empty, no flower-buds being produced in their axil. A series of empty coloured bracts terminates the inflorescence of *Salvia Horminum*. The smaller bracts or bracteoles, which occur among the subdivisions of a branching inflorescence, often produce no flower-buds, and thus anomalies occur in the floral arrangements. Bracts are occasionally persistent, remaining long attached to the base of the peduncles, but more usually they are deciduous, falling off early by an articulation. In some instances they form part of the fruit, becoming incorporated with other organs. Thus, the cones of firs and the stroboli of the hop are composed of a series of spirally arranged bracts covering fertile flowers; and the scales on the fruit of the pine-apple are of the same nature. At the base of the general umbel in umbelliferous plants a whorl of bracts often exists, called a *general involucre*, and at the base of the smaller umbels or umbellules there is a similar leafy whorl called an *involucel* or *partial involucre*. In some instances, as in fool’s-parsley, there is no general involucre, but simply an involucel; while in other cases, as in fennel or dill (fig. 15), neither involucre nor involucel is developed. In Compositae the name involucre is applied to the bracts surrounding the head of flowers (fig. 2, *i*), as in marigold, dandelion, daisy, artichoke. This involucre is frequently composed of several rows of leaflets, which are either of the same or of different forms and lengths, and often lie over each other in an imbricated manner. The leaves of the involucre are spiny in thistles and in teazel (*Dipsacus*), and hooked in burdock. Such whorled or verticillate bracts generally remain separate (*polyphyllous*), but may be united by cohesion (*gamophyllous*), as in many species of *Bupleurum* and in *Lavatera*. In Compositae besides the involucre there are frequently chaffy and setose bracts at the base of each flower, and in Dipsacaceae a membranous tube surrounds each flower. These structures are of the nature of an epicalyx. In the acorn the *cupule* or cup (fig. 3) is formed by a growing upwards of the flower-stalk immediately beneath the flower, upon which scaly or spiny protuberances appear; it is of the nature of bracts. Bracts also compose the husky covering of the hazel-nut.

Fig. 2.—Head (capitulum) of Marigold (*Calendula*), showing a congeries of flowers, enclosed by rows of bracts, *i*, at the base, which are collectively called an involucre.



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

Fig. 3.—Cupule of *Quercus Aegilops*. *cp*, Cupule; *gl*, fruit. (After Duchartre.)

When bracts become united, and overlie each other in several rows, it often happens that the outer ones do not produce flowers, that is, are empty or sterile. In the artichoke the outer imbricated scales or bracts are in this condition, and it is from the membranous white scales or bracts (*paleae*) forming the choke attached to the edible receptacle that the flowers are produced. The sterile bracts of the daisy occasionally produce capitula, and give rise to the hen-and-chickens daisy. In place of developing flower-buds, bracts may, in certain circumstances, as in proliferous or viviparous plants, produce leaf-buds.

A sheathing bract enclosing one or several flowers is called a *spathe*. It is common among Monocotyledons, as *Narcissus* (fig. 4), snow-flake, *Arum* and palms. In some palms it is 20 ft. long, and encloses 200,000 flowers. It is often associated with that form of inflorescence termed the *spadix*, and may be coloured, as in *Anthurium*, or white, as in arum lily (*Richardia aethiopica*). When the spadix is compound or branching, as in palms, there are smaller spathes, surrounding separate parts of the inflorescence. The spathe protects the flowers in their young state, and often falls off after they are developed, or hangs down in a withered form, as in some palms, *Typha* and *Pothos*. In grasses the outer scales or glumes of the spikelets are sterile bracts (fig. 5, *gl*); and in Cyperaceae bracts enclose the organs of reproduction. Bracts are frequently changed into complete leaves. This change is called *phyllody* of bracts, and is seen in species of *Plantago*, especially in the variety of *Plantago media*, called the rose-plantain in gardens, where the bracts become leafy and form a rosette round the flowering axis. Similar changes occur in *Plantago major*, *P. lanceolata*, *Ajuga reptans*, dandelion, daisy, dahlia and in umbelliferous plants. The conversion of bracts into stamens (*staminody* of bracts) has been observed in the case of *Abies excelsa*. A lengthening of the axis of the female strobilus of Coniferae is not of infrequent occurrence in *Cryptomeria japonica*, larch (*Larix europaea*), &c., and this is usually associated with a leaf-like condition of the bracts, and sometimes even with the development of leaf-bearing shoots in place of the scales.

The arrangement of the flowers on the axis, or the ramification of the floral axis, is called the *inflorescence*. The primary axis of the inflorescence is sometimes called the *rachis*; its branches, whether terminal or lateral, which form the stalks supporting flowers or clusters of flowers, are *peduncles*, and if small branches are given off by it, they are called *pedicels*. A flower having a stalk is called *pedunculate* or *pedicellate*; one having no stalk is *sessile*. In describing a branching inflorescence, it is common to speak of the rachis as the *primary* floral axis, its branches as the *secondary* floral axes, their divisions as the *tertiary* floral axes, and so on; thus avoiding any confusion that might arise from the use of the terms *rachis*, *peduncle* and *pedicel*.

The *peduncle* is simple, bearing a single flower, as in primrose; or branched, as in London-pride. It is sometimes succulent, as in the cashew, in which it forms the large coloured expansion supporting the nut; spiral, as in *Cyclamen* and *Vallisneria*; or spiny, as in *Alyssum spinosum*. When the peduncle proceeds from radical leaves, that is, from an axis which is so shortened as to bring the leaves close together in the form of a cluster, as in the primrose, auricula or hyacinth, it is termed a *scape*. The floral axis may be shortened, assuming a flattened, convex or concave form, and bearing numerous flowers, as in the artichoke, daisy and fig (fig. 6). The floral axis sometimes appears as if formed by several peduncles united together, constituting a fasciated axis, as in the cockscomb, in which the flowers form a peculiar crest at the apex of the flattened peduncles. Adhesions occasionally take place between the peduncle and the bracts or leaves of the plant, as in the lime-tree (fig. 7). The adhesion of the peduncles to the stem accounts for the extra-axillary position of flowers, as in many Solanaceae. When this union extends for a considerable length along the stem, several leaves may be interposed between the part where the peduncle becomes free and the leaf whence it originated, and it may be difficult to trace the connexion. The peduncle occasionally becomes abortive, and in place of bearing a flower, is transformed into a tendril; at other times it is hollowed at the apex, so as apparently to form the lower part of the outer whorl of floral leaves as in *Eschscholtzia*. The termination of the peduncle, or the part on which the whorls of the flower are arranged, is called the *thalamus*, *torus* or *receptacle*.

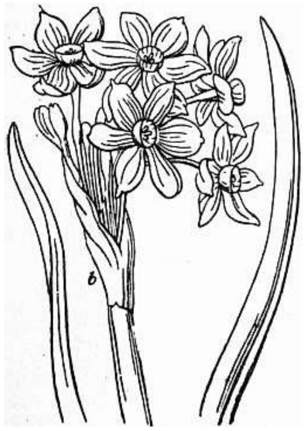


Fig. 4.—Flowers of Narcissus (*Narcissus Tazetta*) bursting from a sheathing bract *b*.

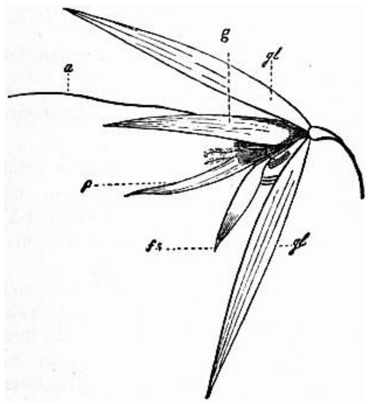


Fig. 5.—Spikelet of Oat (*Avena sativa*) laid open, showing the sterile bracts *gl, gl*, or empty glumes; *g*, the fertile or floral glume, with a dorsal awn *a*; *p*, the pale; *fs*, an abortive flower.

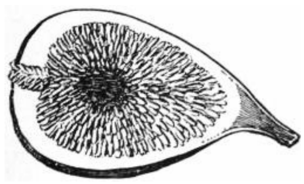
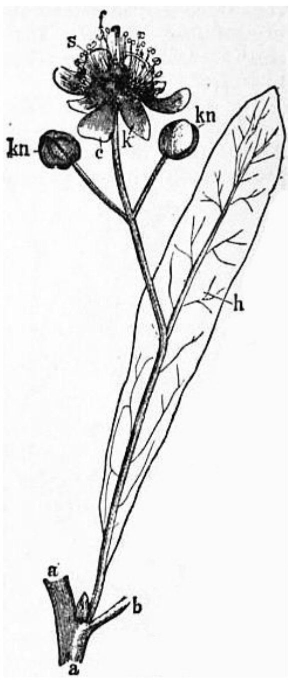


Fig. 6.—Peduncle of Fig (*Ficus Carica*), ending in a hollow receptacle, enclosing numerous male and female flowers.



(From Vines' *Students' Text-Book of Botany*, by permission of Swan Sonnenschein & Co.)

Fig. 7.—Inflorescence of the Lime (*Tilia platyphyllos*) (nat. size).

a, Branch.

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

Fig. 8.—Raceme of *Linaria striata*. *d*, bract.

b, Petiole with axillary bud. Attached to the peduncle is the bract (*h*).
k, Calyx.
c, Corolla.
s, Stamens.
f, Ovary.
kn, Flower-bud.

Fig. 9.—Head of flowers (capitulum) of *Scabiosa atropurpurea*. The inflorescence is simple and indeterminate, and the expansion of the flowers centripetal, those at the circumference opening first.

556

Inflorescence.

There are two distinct types of inflorescence—one in which the flowers arise as lateral shoots from a primary axis, which goes on elongating, and the lateral shoots never exceed in their development the length of the primary axis beyond their point of origin. The flowers are thus always *axillary*. Exceptions, such as in cruciferous plants, are due to the non-appearance of the bracts. In the other type the primary axis terminates in a single flower, but lateral axes are given off from the axils of the bracts, which again repeat the primary axis; the development of each lateral axis is stronger than that of the primary axis beyond its point of origin. The flowers produced in this inflorescence are thus *terminal*. The first kind of inflorescence is *indeterminate*, *indefinite* or *axillary*. Here the axis is either elongated, producing flower-buds as it grows, the lower expanding first (fig. 8), or it is shortened and depressed, and the outer flowers expand first (fig. 9). The expansion of the flowers is thus *centripetal*, that is, from base to apex, or from circumference to centre.

Fig. 10.—Plant of *Ranunculus bulbosus*, showing determinate inflorescence.

The second kind of inflorescence is *determinate*, *definite* or *terminal*. In this the axis is either elongated and ends in a solitary flower, which thus terminates the axis, and if other flowers are produced, they belong to secondary axes farther from the centre; or the axis is shortened and flattened, producing a number of separate floral axes, the central one expanding first, while the others are developed in succession farther from the centre. The expansion of the flowers is in this case *centrifugal*, that is, from apex to base, or from centre to circumference. It is illustrated in fig. 10, *Ranunculus bulbosus*; a' is the primary axis swollen at the base in a bulb-like manner *b*, and with roots proceeding from it. From the leaves which are radical proceeds the axis ending in a solitary terminal flower *f*. About the middle of this axis there is a leaf or bract, from which a secondary floral axis a'' is produced, ending in a single flower f', less advanced than the flower *f*. This secondary axis bears a leaf also, from which a tertiary floral axis a''' is produced, bearing an unexpanded solitary flower f''. From this tertiary axis a fourth is in progress of formation. Here *f* is the termination of the primary axis, and this flower expands first, while the other flowers are developed centrifugally on separate axes.

A third series of inflorescences, termed *mixed*, may be recognized. In them the primary axis has an arrangement belonging to the opposite type from that of the branches, or vice versa. According to the mode and degree of development of the lateral shoots and also of the bracts, various forms of both inflorescences result.

Amongst indefinite forms the simplest occurs when a lateral shoot produced in the axil of a large single foliage leaf of the plant ends in a single flower, the axis of the plant elongating beyond, as in *Veronica hederifolia*, *Vinca minor* and *Lysimachia nemorum*. The flower in this case is *solitary*, and the ordinary leaves become bracts by producing flower-buds in place of leaf-buds; their number, like that of the leaves of this main axis, is indefinite, varying with the vigour of the plant. Usually, however, the floral axis, arising from a more or less altered leaf or bract, instead of ending in a solitary flower, is prolonged, and bears numerous bracteoles, from which smaller peduncles are produced, and those again in their turn may be branched in a similar way. Thus the flowers are arranged in groups, and frequently very complicated forms of inflorescence result. When the primary peduncle or floral axis, as in fig. 8, is elongated, and gives off pedicels, ending in single flowers, a *raceme* is produced, as in currant, hyacinth and barberry. If the secondary floral axes give rise to tertiary ones, the raceme is branching, and forms a *panicle*, as in *Yucca gloriosa*. If in a raceme the lower flower-stalks are developed more strongly than the upper, and thus all the flowers are nearly on a level, a *corymb* is formed, which may be simple, as in fig. 11, where the primary axis a' gives off secondary axes a'', a'', which end in single flowers; or branching, where the secondary axes again subdivide. If the pedicels are very short or wanting, so that the flowers are sessile, a *spike* is produced, as in *Plantago* and vervain (*Verbena officinalis*) (fig. 12). If the spike bears unisexual flowers, as in willow or hazel (fig. 13), it is an *amentum* or *catkin*, hence such trees are called *amentiferous*; at other times it becomes succulent, bearing numerous flowers, surrounded by a sheathing bract or spathe, and then it constitutes a *spadix*, which may be simple, as in *Arum maculatum* (fig. 14), or branching as in palms. A spike bearing female flowers only, and covered with scales, is a *strobilus*, as in the hop. In grasses there are usually numerous sessile flowers arranged in small spikes, called *locustae* or *spikelets*, which are either set closely along a central axis, or produced on secondary axes formed by the branching of the central one; to the latter form the term panicle is applied.

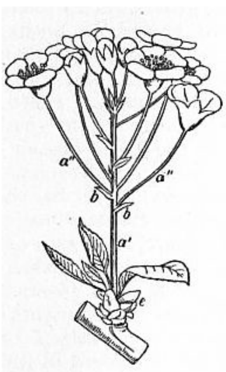


Fig. 11.

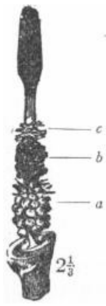
Fig. 12.

Fig. 13.

Fig. 11.—Corymb of *Cerasus Mahaleb*, terminating an abortive branch, at the base of which are modified leaves in the form of scales, *e*. a', Primary axis; a'', secondary axes bearing flowers; *b*, bract in the axils of which the secondary axes arise.

Fig. 12.—Spike of Vervain (*Verbena officinalis*), showing sessile flowers on a common rachis. The flowers at the lower part of the spike have passed into fruit, those towards the middle are in full bloom, and those at the top are only in bud.

Fig. 13.—Amentum or catkin of Hazel (*Corylus Avellana*), consisting of an axis or rachis covered with bracts in the form of scales, each of which covers a male flower, the stamens of which are seen projecting beyond the scale. The catkin falls off in a mass, separating from the branch by an articulation.



(From Strasburger’s *Lehrbuch der Botanik*, by permission of Gustav Fischer.)

Fig. 14.—Spadix of *Arum maculatum*. (After Wossidlo.) *a*, Female flowers; *b*, male flowers; *c*, hairs representing sterile flowers.

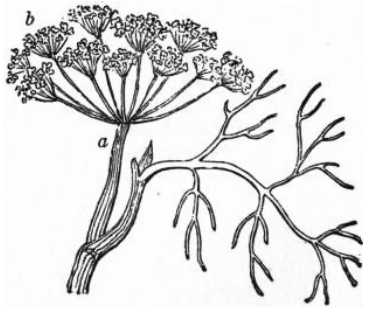


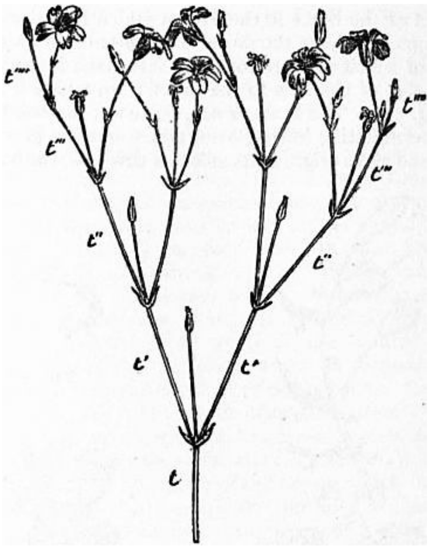
Fig. 15.—Compound umbel of Common Dill (*Anethum graveolens*), having a primary umbel *a*, and secondary umbels *b*, without either involucre or involucel.

If the primary axis, in place of being elongated, is contracted, it gives rise to other forms of indefinite inflorescence. When the axis is so shortened that the secondary axes arise from a common point, and spread out as *radii* of nearly equal length, each ending in a single flower or dividing again in a similar radiating manner, an *umbel* is produced, as in fig. 15. From the primary floral axis a the secondary axes come off in a radiating or umbrella-like manner, and end in small umbels *b*, which are called *partial umbels* or *umbellules*. This inflorescence is seen in hemlock and other allied plants, which are hence called umbelliferous. If there are numerous flowers on a flattened, convex or slightly concave receptacle, having either very short pedicels or none, a *capitulum* (head) is formed, as in dandelion, daisy and other composite plants 557
(fig. 2), also in scabious (fig. 9) and teazel. In the American button-bush the heads are globular, in some species of teazel elliptical, while in scabious and in composite plants, as sunflower, dandelion, thistle, centaury and marigold, they are somewhat hemispherical, with a flattened, slightly hollowed, or convex disk. If the margins of such a receptacle be developed upwards, the centre not developing, a concave receptacle is formed, which may partially or completely enclose a number of flowers that are generally unisexual. This gives rise to the peculiar inflorescence of *Dorstenia*, or to that of the fig (fig. 6), where the flowers are placed on the inner surface of the hollow receptacle, and are provided with bracteoles. This inflorescence has been called a *hypanthodium*.

Lastly, we have what are called *compound indefinite* inflorescences. In these forms the lateral shoots, developed centripetally upon the primary axis, bear numerous bracteoles, from which floral shoots arise which may have a centripetal arrangement similar to that on the mother shoot, or it may be different. Thus we may have a group of racemes, arranged in a racemose manner on a common axis, forming a raceme of racemes or compound raceme, as in *Astilbe*. In the same way we may have compound umbels, as in hemlock and most Umbelliferae (fig. 15), a compound spike, as in rye-grass, a compound spadix, as in some palms, and a compound capitulum, as in the hen-and-chickens daisy. Again, there may be a raceme of capitula, that is, a group of capitula disposed in a racemose manner, as in *Petasites*, a raceme of umbels, as in ivy, and so on, all the forms of inflorescence being indefinite in disposition. In *Eryngium* the shortening of the pedicels changes an umbel into a capitulum.

The simplest form of the definite type of the inflorescence is seen in *Anemone nemorosa* and in gentianella (*Gentiana acaulis*), where the axis terminates in a single flower, no other flowers being produced upon the plant. This is a *solitary terminal* inflorescence. If other flowers were produced, they would arise as lateral shoots from the bracts below the first-formed flower. The general name of *cyme* is applied to the arrangement of a group of flowers in a definite inflorescence. A *cymose* inflorescence is an inflorescence where the primary floral axis before terminating in a flower gives off one or more lateral unifloral axes which repeat the process—the development being only limited by the vigour of the plant. The floral axes are thus centrifugally developed. The cyme, according to its development, has been characterized as *biparous* or *uniparous*. In fig. 16 the biparous cyme is represented in the flowering branch of *Cerastium*. Here the primary axis *t* ends in a flower, which has passed into the state of fruit. At its base two leaves are produced, in each of which arise secondary axes *t′ t′*, ending in single flowers, and at the base of these axes a pair of opposite leaves is produced, giving rise to tertiary axes *t″ t″*, ending in single flowers, and so on. The term *dichasium* has also been applied to this form of cyme.

In the natural order Carophyllaceae (pink family) the dichasial form of inflorescence is very general. In some members of the order, as *Dianthus barbatus*, *D. carthusianorum*, &c., in which the peduncles are short, and the flowers closely approximated, with a centrifugal expansion, the inflorescence has the form of a contracted dichasium, and receives the name of *fascicle*. When the axes become very much shortened, the arrangement is more complicated in appearance, and the nature of the inflorescence can only be recognized by the order of opening of the flowers. In Labiate plants, as the dead-nettle (*Lamium*), the flowers are produced in the axil of each of the foliage leaves of the plant, and they appear as if arranged in a simple whorl of flowers. But on examination it is found that there is a central flower expanding first, and from its axis two secondary axes spring bearing solitary flowers; the expansion is thus centrifugal. The inflorescence is therefore a contracted dichasium, the flowers being sessile, or nearly so, and the clusters are called *verticillasters* (fig. 17). Sometimes, especially towards the summit of a dichasium, owing to the exhaustion of the growing power of the plant, only one of the bracts gives origin to a new axis, the other remaining empty; thus the inflorescence becomes unilateral, and further development is arrested. In addition to the dichasial form there are others where more than two lateral axes are produced from the primary floral axis, each of which in turn produces numerous axes. To this form the terms *trichasial* and *polychasial cyme* have been applied; but these are now usually designated *cymose umbels*. They are well seen in some species of *Euphorbia*. Another term, *anthela*, has been used to distinguish such forms as occur in several species of *Luzula* and *Juncus*, where numerous lateral axes arising from the primary axis grow very strongly and develop in an irregular manner.



(From Strasburger’s *Lehrbuch der Botanik*, by permission of Gustav Fischer.)
Fig. 16.—Cymose inflorescence (dichasium) of *Cerastium collinum*; *t-t″‴*, successive axes. (After Duchartre.)

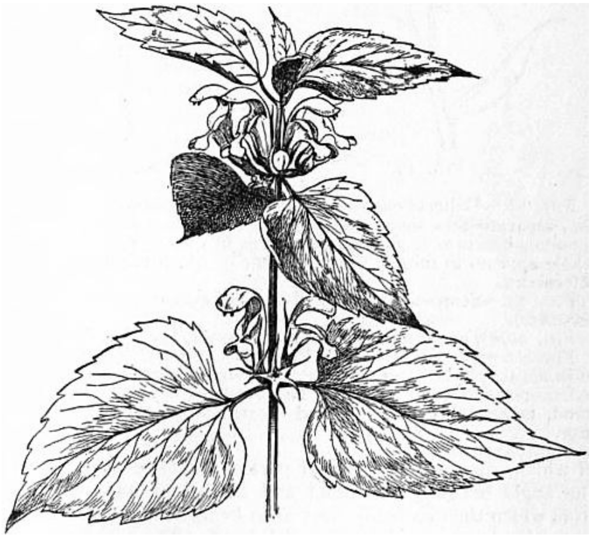


Fig. 17.—Flowering stalk of the White Dead-nettle (*Lamium album*). The bracts are like the ordinary leaves of the plant, and produce clusters of flowers in their axil. The clusters are called verticillasters, and consist of flowers which are produced in a centrifugal manner.

In the uniparous cyme a number of floral axes are successively developed one from the other, but the axis of each successive generation, instead of producing a pair of bracts, produces only one. The basal portion of the consecutive axes may become much thickened and arranged more or less in a straight line, and thus collectively form an apparent or false 558
axis or *sympodium*, and the inflorescence thus simulates a raceme. In the true raceme, however, we find only a single axis, producing in succession a series of bracts, from which the floral peduncles arise as lateral shoots, and thus each flower is on the same side of the floral axis as the bract in the axil of which it is developed; but in the uniparous cyme the flower of each of these axes, the basal portions of which unite to form the false axis, is situated on the opposite side of the axis to the bract from which it apparently arises (fig. 18). The bract is not, however, the one from which the axis terminating in the flower arises, but is a bract produced upon it, and gives origin in its axil to a new axis, the basal portion of which, constituting the next part of the false axis, occupies the angle between this bract and its parent axis—the bract from which the axis really does arise being situated lower down upon the same side of the axis with itself. The uniparous cyme presents two forms, the *scorpioid* or *cicinal* and the *helicoid* or *bostrychoid*.

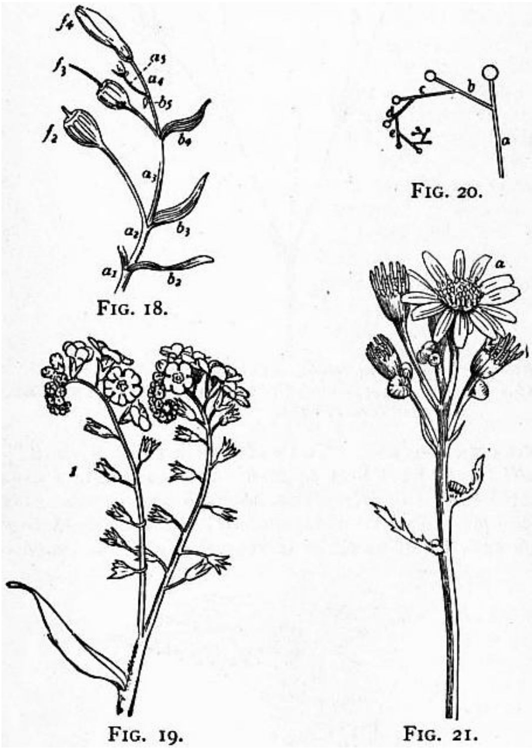


FIG. 18.—Helicoid cyme of a species of *Alstroemeria*. a_1, a_2, a_3, a_4, &c., separate axes successively developed in the axils of the corresponding bracts b_2, b_3, b_4, &c., and ending in a flower f_2, f_3, f_4, &c. The whole appears to form a simple raceme of which the axes form the internodes.

FIG. 19.—Scorpioidal or cicinal cyme of Forget-me-not (*Myosotis palustris*).

FIG. 20.—Diagram of definite floral axes *a*, *b*, *c*, *d*, *e*, &c.

FIG. 21.—Flowering stalk of Ragwort (*Senecio*). The flowers are in heads (capitula), and open from the circumference inwards in an indefinite centripetal manner. The heads of flowers, on the other hand, taken collectively, expand centrifugally—the central one a first.

In the scorpioid cyme the flowers are arranged alternately in a double row along one side of the false axis (fig. 19), the bracts when developed forming a second double row on the opposite side; the whole inflorescence usually curves on itself like a scorpion’s tail, hence its name. In fig. 20 is shown a diagrammatic sketch of this arrangement. The false axis, *a b c d*, is formed by successive generations of unifloral axes, the flowers being arranged along one side alternately and in a double row; had the bracts been developed they would have formed a similar double row on the opposite side of the false axis; the whole inflorescence is represented as curved on itself. The inflorescence in the family Boraginaceae are usually regarded as true scorpioid cymes.

In the helicoid cyme there is also a false axis formed by the basal portion of the separate axes, but the flowers are not placed in a double row, but in a single row, and form a spiral or helix round the false axis. In *Alstroemeria*, as represented in fig. 18, the axis a_1 ends in a flower (cut off in the figure) and bears a leaf. From the axil of this leaf, that is, between it and the primary axis a_1 arises a secondary axis a_2, ending in a flower f_2, and producing a leaf about the middle. From the axil of this leaf a tertiary floral axis a_3, ending in a flower f_3, takes origin. In this case the axes are not arranged in two rows along one side of the false axis, but are placed at regular intervals, so as to form an elongated spiral round it.

Compound definite inflorescences are by no means common, but in *Streptocarpus polyanthus* and in several calceolarias we probably have examples. Here there are *scorpioid cymes of pairs of flowers*, each pair consisting of an older and a younger flower.

Mixed inflorescence.

Forms of inflorescence occur, in which both the definite and indefinite types are represented—*mixed* inflorescences. Thus in Composite plants, such as hawk weeds (*Hieracia*) and ragworts (*Senecio*, fig. 21), the *heads* of flowers, taken as a whole, are developed centrifugally, the terminal head first, while the *florets*, or small flowers on the receptacle, open centripetally, those at the circumference first. So also in Labiatae, such as dead-nettle (*Lamium*), the different whorls of inflorescence are developed centripetally, while the florets of the verticillaster are centrifugal. This mixed character presents difficulties in such cases as Labiatae, where the leaves, in place of retaining their ordinary form, become bracts, and thus might lead to the supposition of the whole series of flowers being one inflorescence. In such cases the cymes are described as spiked, racemose, or panicled, according to circumstances. In *Saxifraga umbrosa* (London-pride) and in the horse-chestnut we meet with a raceme of scorpioid cymes; in sea-pink, a capitulum of contracted scorpioid cymes (often called a glomerulus); in laurustinus, a compound umbel of dichasial cymes; a scorpioid cyme of capitula in *Vernonia scorpioides*. The so-called catkins of the birch are, in reality, spikes of contracted dichasial cymes. In the bell-flower (*Campanula*) there is a racemose uniparous cyme. In the privet (*Ligustrum vulgare*) there are numerous racemes of dichasia arranged in a racemose manner along an axis; the whole inflorescence thus has an appearance not unlike a bunch of grapes, and has been called a *thyrsus*.

TABULAR VIEW OF INFLORESCENCES

A. Indefinite Centripetal Inflorescence.

I. Flowers solitary, axillary. *Vinca*, *Veronica hederifolia*.

II. Flowers in groups, pedicellate.

1. Elongated form (Raceme), *Hyacinth*, *Laburnum*, *Currant*. (Corymb), *Ornithogalum*.

2. Contracted or shortened form (Umbel), *Cowslip*, *Astrantia*.

III. Flowers in groups, sessile.

1. Elongated form (Spike), *Plantago*.
(Spikelet), *Grasses*.
(Amentum, Catkin), *Willow*, *Hazel*.
(Spadix) *Arum*, some *Palms*.

(Strobilus), *Hop*.

2. Contracted or shortened form (Capitulum), *Daisy*, *Dandelion*, *Scabious*.

IV. Compound Indefinite Inflorescence.

a. Compound Spike, *Rye-grass*.

b. Compound Spadix, *Palms*.

c. Compound Raceme, *Astilbe*.

d. Compound Umbel, *Hemlock* and most *Umbelliferae*.

e. Raceme of Capitula, *Petasites*.

f. Raceme of Umbels, *Ivy*.

B. Definite Centrifugal Inflorescence.

I. Flowers solitary, terminal. *Gentianella*, *Tulip*.

II. Flowers in Cymes.

1. Uniparous Cyme.

a. Helicoid Cyme (axes forming a spiral).
Elongated form, *Alstromeria*.
Contracted form, *Witsenia corymbosa*. 559

b. Scorpioid Cyme (axes unilateral, two rows).
Elongated form, *Forget-me-not*, *Symphytum*, *Henbane*.
Contracted form, *Erodium*, *Alchemilla arvensis*.

2. Biparous Cyme (Dichotomous), including 3-5 chotomous Cymes (Dichasium, Cymose Umbel, Anthela).

a. Elongated form, *Cerastium*, *Stellaria*.

b. Contracted form (Verticillaster), *Dead-nettle*, *Pelargonium*.

3. Compound Definite Inflorescence. *Streptocarpus polyanthus*, many *Calceolarias*.

C. Mixed Inflorescence.

Raceme of Scorpioid Cymes, *Horse-chestnut*.

Scorpioid Cyme of Capitula, *Vernonia scorpioides*.

Compound Umbel of Dichotomous Cymes, *Laurustinus*.

Capitulum of contracted Scorpioid Cymes (Glomerulus), *Sea-pink*.

The flower.

The flower consists of the floral axis bearing the sporophylls (stamens and carpels), usually with certain protective envelopes. The axis is usually very much contracted, no internodes being developed, and the portion bearing the floral leaves, termed the *thalamus* or *torus*, frequently expands into a conical, flattened or hollowed expansion; at other times, though rarely, the internodes are developed and it is elongated. Upon this torus the parts of the flower are arranged in a crowded manner, usually forming a series of verticils, the parts of which alternate; but they are sometimes arranged spirally especially if the floral axis be elongated. In a typical flower, as in fig. 22, we recognize four distinct whorls of leaves: an outer whorl, the *calyx* of *sepals*; within it, another whorl, the parts alternating with those of the outer whorl, the *corolla* of *petals*; next a whorl of parts alternating with the parts of the corolla, the *androecium* of *stamens*; and in the centre the *gynoecium* of *carpels*. Fig. 23 is a diagrammatic representation of the arrangement of the parts of such a flower; it is known as a *floral diagram*. The flower is supposed to be cut transversely, and the parts of each whorl are distinguished by a different symbol. Of these whorls the two internal, forming the sporophylls, constitute the *essential* organs of reproduction; the two outer whorls are the protective coverings or floral *envelopes*. The sepals are generally of a greenish colour; their function is mainly protective, shielding the more delicate internal organs before the flower opens. The petals are usually showy, and normally alternate with the sepals. Sometimes, as usually in monocotyledons, the calyx and corolla are similar; in such cases the term *perianth*, or *perigone*, is applied. Thus, in the tulip, crocus, lily, hyacinth, we speak of the parts of the perianth, in place of calyx and corolla, although in these plants there is an outer whorl (calyx), of three parts, and an inner (corolla), of a similar number, alternating with them. When the parts of the calyx are in appearance like petals they are said to be *petaloid*, as in Liliaceae. In some cases the petals have the appearance of sepals, then they are *sepaloid*, as in Juncaceae. In plants, as *Nymphaea alba*, where a spiral arrangement of the floral leaves occurs, it is not easy to say where the calyx ends and the corolla begins, as these two whorls pass insensibly into each other. When both calyx and corolla are present, the plants are *dichlamydeous*; when one only is present, the flower is termed *monochlamydeous* or *apetalous*, having no petals (fig. 24). Sometimes both are absent, when the flower is *achlamydeous*, or naked, as in willow. The outermost series of the essential organs, collectively termed the *androecium*, is composed of the microsporophylls known as the staminal leaves or *stamens*. In their most differentiated form each consists of a stalk, the *filament* (fig. 25, *f*), supporting at its summit the anther (*a*), consisting of the pollen-sacs which contain the powdery *pollen* (*p*), the microspores, which is ultimately discharged therefrom. The *gynoecium* or *pistil* is the central portion of the flower, terminating the floral axis. It consists of one or more *carpels* (megasporophylls), either separate (fig. 22, *c*) or combined (fig. 24). The parts distinguished in the pistil are the *ovary* (fig. 26, *o*), which is the lower portion enclosing the *ovules* destined to become seeds, and the *stigma* (*g*), a portion of loose cellular tissue, the receptive surface on which the pollen is deposited, which is either sessile on the apex of the ovary, as in the poppy, or is separated from it by a prolonged portion called the *style* (*s*). The

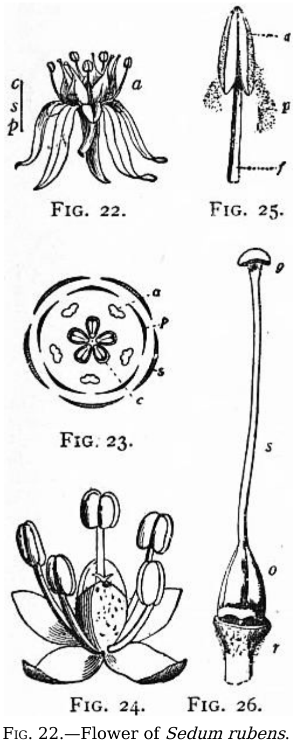


FIG. 22.—Flower of *Sedum rubens*. *s*, Sepals; *p*, petals; *a*, stamens; *c*, carpels.

FIG. 23.—Diagram of a completely symmetrical flower, consisting of four whorls, each of five parts, *s*, Sepals; *p*, petals; *a*, stamens; *c*, carpels.

FIG. 24.—Monochlamydeous (apetalous) flower of Goosefoot (*Chenopodium*), consisting of a single perianth (calyx) of five parts, enclosing five stamens, which are opposite the divisions of the perianth, owing to the absence of the petals.

FIG. 25.—Stamen, consisting of a filament (stalk) *f* and an anther *a*, containing the pollen *p*, which is discharged through

slits in the two lobes of the anther.

FIG. 26.—The pistil of Tobacco (*Nicotiana Tabacum*), consisting of the ovary *o*, containing ovules, the style *s*, and the capitate stigma *g*. The pistil is placed on the receptacle *r*, at the extremity of the peduncle.

androecium and gynoecium are not present in all flowers. When both are present the flower is *hermaphrodite*; and in descriptive botany such a flower is indicated by the symbol ☿. When only one of those organs is present the flower is *unisexual* or *diclinous*, and is either male (*staminate*), ♂; or female (*pistillate*), ♀. A flower then normally consists of the four series of leaves—calyx, corolla, androecium and gynoecium—and when these are all present the flower is *complete*. These are usually densely crowded upon the thalamus, but in some instances, after apical growth has ceased in the axis, an elongation of portions of the receptacle by intercalary growth occurs, by which changes in the position of the parts may be brought about. Thus in *Lychnis* an elongation of the axis betwixt the calyx and the corolla takes place, and in this way they are separated by an interval. Again, in the passion-flower (*Passiflora*) the stamens are separated from the corolla by an elongated portion of the axis, which has consequently been termed the *androphore*, and in *Passiflora* also, fraxinella (fig. 27), Capparidaceae, and some other plants, the ovary is raised upon a distinct stalk termed the *gynophore*; it is thus separated from the stamens, and is said to be *stipitate*. Usually the successive whorls of the flower, disposed from below upwards or from without inwards upon the floral axis, are of the same number of parts, or are a multiple of the same number of parts, those of one whorl alternating with those of the whorls next it.

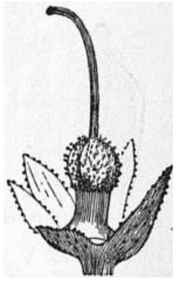


FIG. 27.—Calyx and pistil of Fraxinella (*Dictamnus Fraxinella*). The pistil consists of several carpels, which are elevated on a stalk or *gynophore* prolonged from the receptacle.

In the more primitive types of flowers the torus is more or less convex, and the series of organs follow in regular succession, culminating in the carpels, in the formation of which the growth of the axis is closed (fig. 28). This arrangement is known as hypogynous, the other series (calyx, corolla and stamens) being beneath (*hypo-*) the gynoecium. In other cases, the apex of the growing point ceases to develop, and the parts below form a cup around it, from the rim of which the outer members of the flower are developed around (*peri-*) the carpels, which are formed from the apex of the growing-point at the bottom of the cup. This arrangement is known as *perigynous* (fig. 29). In many cases this is carried farther and a cavity is formed which is roofed over by the carpels, so that the outer members of the flower spring from the edge of the receptacle which is immediately above the ovary (epigynous), hence the term epigyny (fig. 30). 560

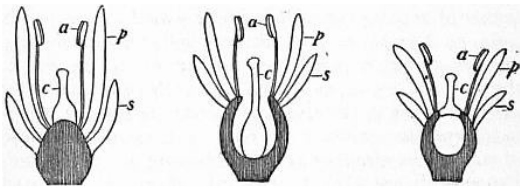


FIG. 28. FIG. 29. FIG. 30.

FIGS. 28, 29 and 30.—Diagrams illustrating hypogyny, perigyny and epigyny of the flower. *a*, Stamens; *c*, carpels; *p*, petals; *s*, sepals.

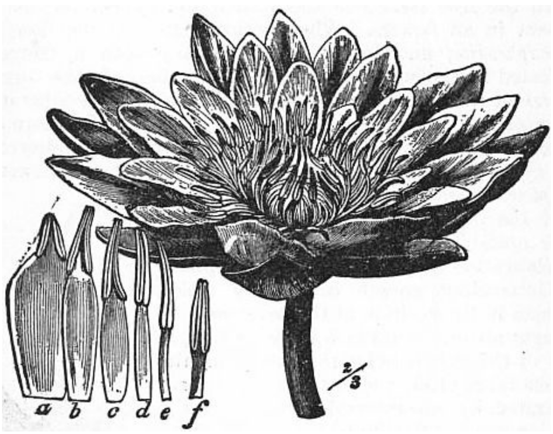


FIG. 31. FIG. 32.

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FIGS. 31 and 32.—White Water Lily. Fig. 31, flower; fig. 32, successive stages, *a-f*, in the transition from petals to stamens. (After Wossidlo.)

Symmetry of the flower.

When a flower consists of parts arranged in whorls it is said to be *cyclic*, and if all the whorls have an equal number of parts and are alternate it is *eucyclic* (figs. 22, 23). In contrast to the cyclic flowers are those, as in Magnoliaceae, where the parts are in spirals (*acyclic*). Flowers which are cyclic at one portion and spiral at another, as in many Ranunculaceae, are termed *hemicyclic*. In spiral flowers the distinction into series is by no means easy, and usually there is a gradual passage from sepaloid through petaloid to staminal parts, as in the water-lily family, Nymphaeaceae (figs. 31, 32), although in some plants there is no such distinction, the parts being all petaloid, as in *Trollius*. Normally, the parts of successive whorls alternate; but in some cases we find the parts of one whorl opposite or *superposed* to those of the next whorl. In some cases, as in the vine-family Ampelidaceae, this seems to be the ordinary mode of development, but the superposition of the stamens on the sepals in many plants, as in the pink family, Caryophyllaceae, is due to the suppression or abortion of the whorl of petals, and this idea is borne out by the development, in some plants of the order, of the suppressed whorl. As a rule, whenever we find the parts of one whorl superposed on those of another we may suspect some abnormality.

A flower is said to be *symmetrical* when each of its whorls consists of an equal number of parts, or when the parts of any one whorl are multiples of that preceding it. Thus, a symmetrical flower may have five sepals, five petals, five stamens and five carpels, or the number of any of these parts may be ten, twenty or some multiple of five. Fig. 23 is a diagram of a symmetrical flower, with five parts in each whorl, alternating with each other. Fig. 33 is a diagram of a symmetrical flower of stone-crop, with five sepals, five alternating petals, ten stamens and five carpels. Here the number of parts in the staminal whorl is double that in the others, and in such a case the additional five parts form a second row alternating with the others. In the staminal whorl especially it is common to find additional rows. Fig. 34 shows a symmetrical flower, with five parts in the three outer rows, and ten divisions in the inner. In this case it is the gynoecium which has an additional number of parts. Fig. 35 shows a flower of heath, with four divisions of the calyx and corolla, eight stamens in two rows, and four divisions of the pistil. In fig. 36 there are three parts in each whorl; and in fig. 37 there are three divisions of the calyx, corolla and pistil, and six stamens in two rows. In all these cases the flower is symmetrical. In Monocotyledons it is usual for the staminal whorl to be double, it rarely having more than two rows, whilst amongst dicotyledons there are often very numerous rows of stamens. The floral envelopes are rarely multiplied. Flowers in which the number of parts in each whorl is the same, are *isomerous* (of equal number); when the number in some of the whorls is different, the flower is *anisomerous* (of unequal number). The pistillate whorl is very liable to changes. It frequently happens that when it is fully formed, the number of its parts is not in conformity with that of the other whorls. In such circumstances, however, a flower has been called symmetrical, provided the parts of the other whorls are normal,—the permanent state of the pistil not being taken into account in determining symmetry. Thus fig. 38 shows a pentamerous symmetrical flower, with dimerous pistil. Symmetry, then, in botanical language, has reference to a certain definite numerical relation of parts. A flower in which the parts are arranged in twos is called *dimerous*; when the parts of the whorls are three, four or five, the flower is *trimerous*, *tetramerous* or *pentamerous*, respectively. The symmetry which is most commonly met with is trimerous and pentamerous—the former occurring generally among monocotyledons, the latter among dicotyledons. Dimerous and tetramerous symmetry occur also among dicotyledons.

The various parts of the flower have a certain definite relation to the axis. Thus, in axillary tetramerous flowers (fig. 35), one sepal is next the axis, and is called *superior* or *posterior*; another is next the bract, and is *inferior* or *anterior*, and the other two are *lateral*; and certain terms are used to indicate that position. A plane passing through the anterior and posterior sepal and through the floral axis is termed the *median plane* of the flower; a plane cutting it at right angles, and passing through the lateral sepals, is the *lateral plane*; whilst the planes which bisect the angles formed by the lateral and median planes are the *diagonal planes*, and in these flowers the petals which alternate with the sepals are cut by the diagonal planes.

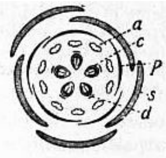


Fig. 33.

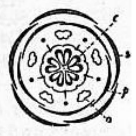


Fig. 34.

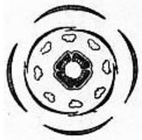


Fig. 35.

Fig. 36.

Fig. 37.

Fig. 38.

Fig. 33.—Diagrammatic section of a symmetrical pentamerous flower of Stone-crop (*Sedum*), consisting of five sepals (*s*), five petals (*p*) alternating with the sepals, ten stamens (*a*) in two rows, and five carpels (*c*) containing ovules. The dark lines (*d*) on the outside of the carpels are glands.

Fig. 34.—Diagram of the flower of Flax (*Linum*), consisting of five sepals (*s*), five petals (*p*), five stamens (*a*), and five carpels (*c*), each of which is partially divided into two. The dots represent a whorl of stamens which has disappeared. It is pentamerous, complete, symmetrical and regular.

Fig. 35.—Diagram of the flower of Heath (*Erica*), a regular tetramerous flower.

Fig. 36.—Diagram of the trimerous symmetrical flower of Iris.

Fig. 37.—Diagram of the symmetrical trimerous flower of Fritillary (*Fritillaria*).

Fig. 38.—Diagram of the flower of Saxifrage (*Saxifraga tridactylites*). The calyx and corolla consist of five parts, the stamens are ten in two rows, while the pistil has only two parts developed.

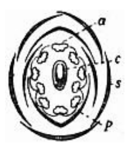


Fig. 39.—Diagram of flower of Sweet-pea (*Lathyrus*), showing five sepals (*s*), two superior, one inferior, and two lateral; five petals (*p*), one superior, two inferior, and two lateral; ten stamens in two rows (*a*); and one carpel (*c*).

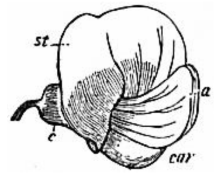


Fig. 40.—Flower of Pea (*Pisum sativum*), showing a papilionaceous corolla, with one petal superior (st) called the standard (vexillum), two inferior (car) called the keel (carina), and two lateral (*a*) called wings (alae). The calyx is marked c.

In a pentamerous flower one sepal may be superior, as in the calyx of Rosaceae and Labiatae; or it may be inferior, as in the calyx of Leguminosae (fig. 39)—the reverse, by the law of alternation, being the case with the petals. Thus, in the blossom of the pea (figs. 39, 40), the odd petal (vexillum) *st* is superior, while the odd sepal is inferior. In the order Scrophulariaceae one of the two carpels is posterior and the other anterior, whilst in Convolvulaceae the carpels are arranged laterally. Sometimes the twisting of a part makes a change in the position of other parts, as in Orchids, where the twisting of the ovary changes the position of the labellum.

When the different members of each whorl are like in size and shape, the flower is said to be *regular*; while differences in the size and shape of the parts of a whorl make the flower *irregular*, as in the papilionaceous flower, represented in fig. 39. When a flower can be divided by a single plane into two exactly similar parts; then it is said to be *zygomorphic*. Such flowers as Papilionaceae, Labiatae, are examples. In contrast with this are *polysymmetrical* or actinomorphic flowers, which have a radial symmetry and can be divided by several planes into several exactly similar portions; such are all regular, symmetrical flowers. When the parts of any whorl are not equal to or some multiple of the others, then the flower is *asymmetrical*. This want of symmetry may be brought about in various ways. Alteration in the symmetrical arrangement as well as in the completeness and regularity of flowers has been traced to *suppression* or the *non-development* of parts, *degeneration* or imperfect formation, *cohesion* or union of parts of the same whorl, *adhesion* or union of the parts of different whorls, *multiplication* of parts, and *deduplication* (sometimes called *chorisis*) or splitting of parts.

By *suppression* or non-appearance of a part at the place where it ought to appear if the structure was normal, the symmetry or completeness of the flower is disturbed. This suppression when confined to the parts of certain verticils makes the flower asymmetrical. Thus, in many Caryophyllaceae, as *Polycarpon* and *Holosteum*, while the calyx and corolla are pentamerous, there are only three or four stamens and three carpels; in *Impatiens Noli-me-tangere* the calyx is composed of three parts, while the other verticils have five; in labiate flowers there are five parts of the calyx and corolla, and only four stamens; and in *Tropaeolum pentaphyllum* there are five sepals, two petals, eight stamens and three carpels. In all these cases the want of symmetry is traced to the suppression of certain parts. In the last-mentioned plant the normal number is five, hence it is said that there are three petals suppressed, as shown by the position of the two remaining ones; there are two rows of stamens, in each of which one is wanting; and there are two carpels suppressed. In many instances the parts which are afterwards suppressed can be seen in the early stages of growth, and occasionally some vestiges of them remain in the fully developed flower. By the suppression of the verticil of the stamens, or of the carpels, flowers become *unisexual* or *diclinous*, and by the suppression of one or both of the floral envelopes, monochlamydeous and achlamydeous flowers are produced. The suppression of parts of the flower may be carried so far that at last a flower consists of only one part of one whorl. In the Euphorbiaceae we have an excellent example of the gradual suppression of parts, where from an apetalous, trimerous, staminal flower we pass to one where one of the stamens is suppressed, and then to forms where two of them are wanting. We next have flowers in which the calyx is suppressed, and its place occupied by one, two or three bracts (so that the flower is, properly speaking, achlamydeous), and only one or two stamens are produced. And finally, we find flowers consisting of a single stamen with a bract. There is thus traced a *degradation*, as it is called, from a flower with three stamens and three divisions of the calyx, to one with a single bract and a single stamen.

Degeneration, or the transformation of parts, often gives rise either to an apparent want of symmetry or to irregularity in form. In unisexual flowers it is not uncommon to find vestiges of the undeveloped stamens in the form of filiform bodies or scales. In double flowers transformations of the stamens and pistils take place, so that they appear as petals. In *Canna*, what are called petals are in reality metamorphosed stamens. In the capitula of Compositae we sometimes find the florets converted into green leaves. The limb of the calyx may appear as a rim, as in some Umbelliferae; or as pappus, in Compositae and *Valeriana*. In *Scrophularia* the fifth stamen appears as a scale-like body; in other Scrophulariaceae, as in *Pentstemon*, it assumes the form of a filament, with hairs at its apex in place of an anther.

Cohesion, or the union of parts of the same whorl, and *adhesion*, or the growing together of parts of different whorls, are causes of change both as regards form and symmetry. Thus in *Cucurbita* the stamens are originally five in number, but subsequently some cohere, so that three stamens only are seen in the mature flower. Adhesion is well seen in the *gynostemium* of orchids, where the stamens and stigmas adhere. In Capparidaceae the calyx and petals occupy their usual position, but the axis is prolonged in the form of a gynophore, to which the stamens are united.

Multiplication, or an increase of the number of parts, gives rise to changes. We have already alluded to the interposition of new members in a whorl. This takes place chiefly in the staminal whorl, but usually the additional parts produced form a symmetrical whorl with the others. In some instances, however, this is not the case. Thus in the horse-chestnut there is an interposition of two stamens, and thus seven stamens are formed in the flower, which is asymmetrical.

Parts of the flower are often increased by a process of *deduplication*, or *chorisis*, *i.e.* the splitting of a part so that two or more parts are formed out of what was originally one. Thus in Cruciferous plants the staminal whorl consists of four long stamens and two short ones (*tetradynamous*). The symmetry in the flower is evidently dimerous, and the abnormality in the androecium, where the four long stamens are opposite the posterior sepals, takes place by a splitting, at a very early stage of development, of a single outgrowth into two. Many cases of what was considered chorisis are in reality due to the development of stipules from the staminal leaf. Thus in *Dicentra* and *Corydalis* there are six stamens in two bundles; the central one of each bundle alone is perfect, the lateral ones have each only half an anther, and are really stipules formed from the staminal leaf. Branching of stamens also produces apparent want of symmetry; thus, in the so-called polyadelphous stamens of Hypericaceae there are really only five stamens which give off numerous branches, but the basal portion remaining short, the branches have the appearance of separate stamens, and the flower thus seems asymmetrical.

Cultivation has a great effect in causing changes in the various parts of plants. Many alterations in form, size, number and adhesion of parts are due to the art of the horticulturist. The changes in the colour and forms of flowers thus produced are endless. In the dahlia the florets are rendered quilled, and are made to assume many glowing colours. In pelargonium the flowers have been rendered larger and more showy; and such is also the case with the *Ranunculus*, the 562
auricula and the carnation. Some flowers, with spurred petals in their usual state, as columbine, are changed so that the spurs disappear; and others, as *Linaria*, in which one petal only is usually spurred, are altered so as to have all the petals spurred, and to present what are called *pelorian* varieties.

FIG. 41. FIG. 42. FIG. 43.

FIG. 41.—Tetramerous monochlamydeous male flower of the Nettle (*Urtica*).
FIG. 42.—Diagram to illustrate valvular or valvate aestivation, in which the parts are placed in a circle, without overlapping or folding.
FIG. 43.—Diagram to illustrate induplicative or induplicate aestivation, in which the parts of the verticil are slightly turned inwards at the edges.

As a convenient method of expressing the arrangement of the parts of the flower, *floral formulae* have been devised. Several modes of expression are employed. The following is a very simple mode which has been proposed:—The several whorls are represented by the letters S (sepals), P (petals), St (stamens), C (carpels), and a figure marked after each indicates the number of parts in that whorl. Thus the formula $S_5P_5St_5C_5$ means that the flower is perfect, and has pentamerous symmetry, the whorls being isomerous. Such a flower as that of Sedum (fig. 33) would be represented by the formula $S_5P_5St_{5+5}C_5$, where St_{5+5} indicates that the staminal whorl consists of two rows of five parts each. A flower such as the male flower of the nettle (fig. 41) would be expressed $S_4P_0St_4C_0$. When no other mark is appended the whorls are supposed to be alternate; but if it is desired to mark the position of the whorls special symbols are employed. Thus, to express the superposition of one whorl upon another, a line is drawn between them, *e.g.* the symbol $S_5P_5 \mid St_5C_5$ is the formula of the flower of Primulaceae.

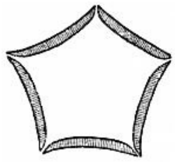


Fig. 44.

Fig. 45.

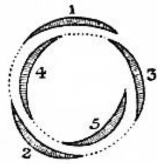


Fig. 46.

Fig. 44.—Diagram to illustrate reduplicative or reduplicate aestivation, in which the parts of the whorl are slightly turned outwards at the edges.

Fig. 45.—Diagram to illustrate contorted or twisted aestivation, in which the parts of the whorl are overlapped by each other in turn, and are twisted on their axis.

Fig. 46.—Diagram to illustrate the quincuncial aestivation, in which the parts of the flower are arranged in a spiral cycle, so that 1 and 2 are wholly external, 4 and 5 are internal, and 3 is partly external and partly overlapped by 1.

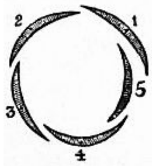


Fig. 47.

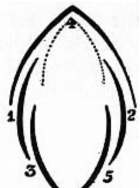


Fig. 48.

Fig. 47.—Diagram to illustrate imbricated aestivation, in which the parts are arranged in a spiral cycle, following the order indicated by the figures 1, 2, 3, 4, 5.

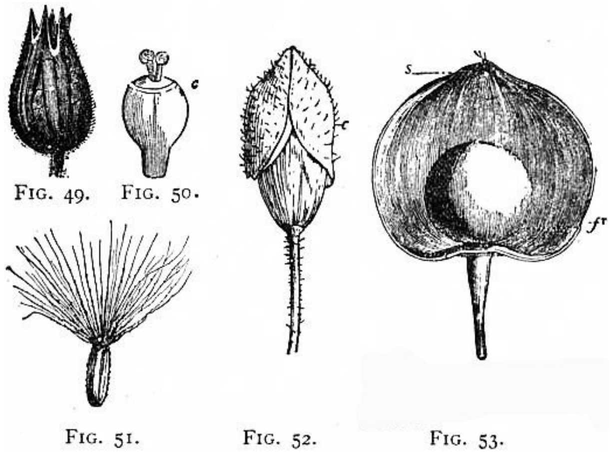
Fig. 48.—Diagram of a papilionaceous flower, showing vexillary aestivation.

1 and 2, The alae or wings.
3, A part of the carina or keel.
4, The vexillum or standard, which, in place of being internal, as marked by the dotted line, becomes external.
5, The remaining part of the keel.
The order of the cycle is indicated by the figures.

The manner in which the parts are arranged in the flower-bud with respect to each other before opening is the *aestivation* or *praefloration*. The latter terms are applied to the flower-bud in the same way as vernation is to the leaf-bud, and distinctive names have been given to the different arrangements exhibited, both by the leaves individually and in their relations to each other. As regards each leaf of the flower, it is either spread out, as the sepals in the bud of the lime-tree, or folded upon itself (conduplicate), as in the petals of some species of *Lysimachia*, or slightly folded inwards or outwards at the edges, as in the calyx of some species of clematis and of some herbaceous plants, or rolled up at the edges (involute or revolute), or folded transversely, becoming *crumpled* or *corrugated*, as in the poppy. When the parts of a whorl are placed in an exact circle, and are applied to each other by their edges only, without overlapping or being folded, thus resembling the valves of a seed-vessel, the aestivation is *valvate* (fig. 42). The edges of each of the parts may be turned either inwards or outwards; in the former case the aestivation is *induplicate* (fig. 43), in the latter case *reduplicate* (fig. 44). When the parts of a single whorl are placed in a circle, each of them exhibiting a torsion of its axis, so that by one of its sides it overlaps its neighbour, whilst its side is overlapped in like manner by that standing next to it, the aestivation is *twisted* or *contorted* (fig. 45). This arrangement is characteristic of the flower-buds of Malvaceae and Apocynaceae, and it is also seen in Convolvulaceae and Caryophyllaceae. When the flower expands, the traces of twisting often disappear, but sometimes, as in Apocynaceae, they remain. Those forms of aestivation are such as occur in cyclic flowers, and they are included under *circular* aestivation. But in spiral flowers we have a different arrangement; thus the leaves of the calyx of *Camellia japonica* cover each other partially like tiles on a house. This aestivation is *imbricate*. At other times, as in the petals of *Camellia*, the parts envelop each other completely, so as to become *convolute*. This is also seen in a transverse section of the calyx of *Magnolia grandiflora*, where each of the three leaves embraces that within it. When the parts of a whorl are five, as occurs in many dicotyledons, and the imbrication is such that there are two parts external, two internal, and a fifth which partially covers one of the internal parts by its margin, and is in its turn partially covered by one of the external parts, the aestivation is *quincuncial* (fig. 46). This quincunx is common in the corolla of Rosaceae. In fig. 47 a section is given of the bud of *Antirrhinum majus*, showing the imbricate spiral arrangement. In this case it will be seen that the part marked 5 has, by a slight change in position, become overlapped by 1. This variety of imbricate aestivation has been termed *cochlear*. In flowers such as those of the pea (fig. 40), one of the parts, the vexillum, is often large and folded over the others, giving rise to *vexillary* aestivation (fig. 48), or the carina may perform a similar office, and then the aestivation is *carinal*, as in the Judas-tree (*Cercis Siliquastrum*). The parts of the several verticils often differ in their mode of aestivation. Thus, in Malvaceae the corolla is contorted and the calyx valvate, or reduplicate; in St John’s-wort the calyx is imbricate, and the corolla contorted. In Convolvulaceae, while the corolla is twisted, and has its parts arranged in a circle, the calyx is imbricate, and exhibits a spiral arrangement. In *Guazuma* the calyx is valvate, and the corolla induplicate. The circular aestivation is generally associated with a regular calyx and corolla, while the spiral aestivations are connected with irregular as well as with regular forms.

Calyx.

The *sepals* are sometimes *free* or separate from each other, at other times they are united to a greater or less extent; in the former case, the calyx is *polysepalous*, in the latter *gamosepalous* or *monosepalous*. The divisions of the calyx present usually the characters of leaves, and in some cases of monstrosity they are converted into leaf-like organs, as not infrequently happens in primulas. They are usually entire, but occasionally they are cut in various ways, as in the rose; they are rarely stalked. Sepals are generally of a more or less oval, elliptical or oblong form, with their apices either blunt or acute. In their direction they are erect or reflexed (with their apices 563 downwards), spreading outwards (*divergent* or *patulous*), or arched inwards (*connivent*). They are usually of a greenish colour (*herbaceous*); but sometimes they are coloured or *petaloid*, as in the fuchsia, tropāeolum, globe-flower and pomegranate. Whatever be its colour, the external envelope of the flower is considered as the calyx. The vascular bundles sometimes form a prominent rib, which indicates the middle of the sepal; at other times they form several ribs. The venation is useful as pointing out the number of leaves which constitute a gamosepalous calyx. In a polysepalous calyx the number of the parts is indicated by Greek numerals prefixed; thus, a calyx which has three sepals is *trisepalous*; one with five sepals is *pentasepalous*. The sepals occasionally are of different forms and sizes. In Aconite one of them is shaped like a helmet (*galeate*). In a gamosepalous calyx the sepals are united in various ways, sometimes very slightly, and their number is marked by the divisions at the apex. These divisions either are simple projections in the form of acute or obtuse teeth (fig. 49); or they extend down the calyx as fissures about half-way, the calyx being *trifid* (three-cleft), *quinquefid* (five-cleft), &c., according to their number; or they reach to near the base in the form of partitions, the calyx being *tripartite*, *quadripartite*, *quinquepartite*, &c. The union of the parts may be complete, and the calyx may be quite entire or *truncate*, as in some Correas, the venation being the chief indication of the different parts. The cohesion is sometimes irregular, some parts uniting to a greater extent than others; thus a two-lipped or *labiate* calyx is formed. The upper lip is often composed of three parts, which are thus posterior or next the axis, while the lower has two, which are anterior. The part formed by the union of the sepals is called the *tube* of the calyx; the portion where the sepals are free is the *limb*.



From Strasburger's *Lehrbuch der Botanik*, by permission of Gustav Fischer.
FIG. 49.—Gamosepalous five-toothed calyx of Campion (*Lychnis*).
Fig. 50.—Obsolete calyx (*c*) of Madder (*Rubia*) adherent to the pistil, in the form of a rim.
Fig. 51.—Feathery pappus attached to the fruit of Groundsel (*Senecio vulgaris*).
FIG. 52.—Caducous calyx (*c*) of Poppy. There are two sepals which fall off before the petals expand.
FIG. 53.—Fruit of Physalis Alkekengi, consisting of the persistent calyx (*s*), surrounding the berry (*fr*), derived from the ovary. (After Duchartre.)

Occasionally, certain parts of the sepals undergo marked enlargement. In the violet the calycine segments are prolonged downwards beyond their insertions, and in the Indian cress (*Tropaeolum*) this prolongation is in the form of a spur (*calcar*), formed by three sepals; in Delphinium it is formed by one. In Pelargonium the spur from one of the sepals is adherent to the flower-stalk. In *Potentilla* and allied genera an *epicalyx* is formed by the development of stipules from the sepals, which form an apparent outer calyx, the parts of which alternate with the true sepals. In Malvaceae an epicalyx is formed by the bracteoles. Degenerations take place in the calyx, so that it becomes dry, scaly and glumaceous (like the glumes of grasses), as in the rushes (Juncaceae); hairy, as in Compositae; or a mere rim, as in some Umbelliferae and Acanthaceae, and in Madder (*Rubia tinctorum*, fig. 50), when it is called *obsolete* or *marginate*. In Compositae, Dipsacaceae and Valerianaceae the calyx is attached to the pistil, and its limb is developed in the form of hairs called *pappus* (fig. 51). This pappus is either simple (*pilose*) or feathery (*plumose*). In *Valeriana* the superior calyx is at first an obsolete rim, but as the fruit ripens it is shown to consist of hairs rolled inwards, which expand so as to waft the fruit. The calyx sometimes falls off before the flower expands, as in poppies, and is *caducous* (fig. 52); or along with the corolla, as in *Ranunculus*, and is *deciduous*; or it remains after flowering (*persistent*) as in Labiatae, Scrophulariaceae, and Boraginaceae; or its base only is persistent, as in *Datura Stramonium*. In *Eschscholtzia* and *Eucalyptus* the sepals remain united at the upper part, and become disarticulated at the base or middle, so as to come off in the form of a lid or funnel. Such a calyx is *operculate* or *calyptrate*. The existence or non-existence of an articulation determines the deciduous or persistent nature of the calyx.

The receptacle bearing the calyx is sometimes united to the pistil, and enlarges so as to form a part of the fruit, as in the apple, pear, &c. In these fruits the withered calyx is seen at the apex. Sometimes a persistent calyx increases much after flowering, and encloses the fruit without being incorporated with it, becoming *accrescent*, as in various species of *Physalis* (fig. 53); at other times it remains in a withered or *marcescent* form, as in *Erica*; sometimes it becomes *inflated* or *vesicular*, as in sea campion (*Silene maritima*).

Corolla.

The corolla is the more or less coloured attractive inner floral envelope; generally the most conspicuous whorl. It is present in the greater number of Dicotyledons. Petals differ more from ordinary leaves than sepals do, and are much more nearly allied to the staminal whorl. In some cases, however, they are transformed into leaves, like the calyx, and occasionally leaf-buds are developed in their axil They are seldom green, although occasionally that colour is met with, as in some species of *Cobaea*, *Hoya viridiflora*, *Gonolobus viridiflorus* and *Pentatropis spiralis*. As a rule they are highly coloured, the colouring matter being contained in the cell-sap, as in blue or red flowers, or in plastids (chromoplasts), as generally in yellow flowers, or in both forms, as in many orange-coloured or reddish flowers. The attractiveness of the petal is often due wholly or in part to surface markings; thus the cuticle of the petal of a pelargonium, when viewed with a ½ or ¼-in. object-glass, shows beautiful hexagons, the boundaries of which are ornamented with several inflected loops in the sides of the cells.

Petals are generally glabrous or smooth; but, in some instances, hairs are produced on their surface. Petaline hairs, though sparse and scattered, present occasionally the same arrangement as those which occur on the leaves; thus, in Bombaceae they are stellate. Coloured hairs are seen on the petals of *Menyanthes*, and on the segments of the perianth of *Iris*. They serve various purposes in the economy of the flower, often closing the way to the honey-secreting part of the flower to small insects, whose visits would be useless for purposes of pollination. Although petals are usually very thin and delicate in their texture, they occasionally become thick and fleshy, as in *Stapelia* and *Rafflesia*; or dry, as in heaths; or hard and stiff, as in *Xylopia*. A petal often consists of two portions—the lower narrow, resembling the petiole of a leaf, and called the *unguis* or *claw*; the upper broader, like the blade of a leaf, and called the *lamina* or *limb*. These parts are seen in the petals of the wallflower (fig. 54). The claw is often wanting, as in the crowfoot (fig. 55) and the poppy, and the petals are then *sessile*. According to the development of veins and the growth of cellular tissue, petals present varieties similar to those of leaves. Thus the margin is either entire or divided into lobes or teeth. These teeth sometimes form a regular fringe round the margin, and the petal becomes *fimbriated*, as in the pink; or *laciniated*, as in *Lychnis Flos-cuculi*; 564
or *crested*, as in *Polygala*. Sometimes the petal becomes pinnatifid, as in *Schizopetalum*. The median vein is occasionally prolonged beyond the summit of the petals in the form of a long process, as in *Strophanthus hispidus*, where it extends for 7 in.; or the prolonged extremity is folded downwards or inflexed, as in Umbelliferae, so that the apex approaches the base. The limb of the petal may be flat or concave, or hollowed like a boat. In Hellebore the petals become folded in a tubular form, resembling a horn (fig. 56); in aconite (fig. 58) some of the petals resemble a hollow-curved horn, supported on a grooved stalk; while in columbine, violet (fig. 57), snapdragon and *Centranthus*, one or all of them are prolonged in the form of a spur, and are *calcarate*. In *Valeriana*, *Antirrhinum* and *Corydalis*, the spur is very short, and the corolla or petal is said to be *gibbous*, or *saccate*, at the base. These spurs, tubes and sacs serve as receptacles for the secretion or containing of nectar.

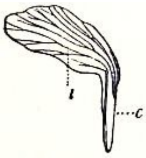


FIG. 54.

FIG. 55.

FIG. 56.

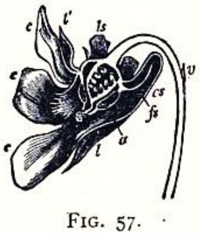


FIG. 57.

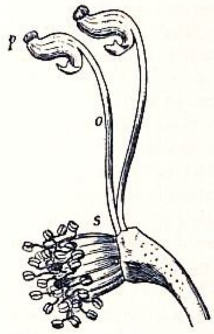


FIG. 58.

FIG. 54.—Unguiculate or clawed petal of Wallflower (*Cheiranthus Cheiri*). *c*, The claw or unguis; *l*, the blade or lamina.

FIG. 55.—Petal of Crowfoot (*Ranunculus*), without a claw, and thus resembling a sessile leaf. At the base of the petal a nectariferous scale is seen.

FIG. 56.—Tubular petal of Hellebore (*Helleborus*).

FIG. 57.—Pansy (*Viola tricolor*). Longitudinal section of flower; *v*, bracteole on the peduncle; *l*, sepals; *ls*, appendage of sepal; *c*, petals; *cs*, spur of the lower petals; *fs*, glandular appendage of the lower stamens; *a*, anthers. (After Sachs.)

(From Vines' Students' *Text-Book of Botany*, by permission of Swan Sonnenschein & Co.)

FIG. 58.—Part of the flower of Aconite (*Aconitum Napellus*), showing two irregular horn-like petals (*p*) supported on grooved stalks (*o*). These serve as nectaries, *s*, the whorl of stamens inserted on the thalamus and surrounding the pistil.

A corolla is *dipetalous*, *tripetalous*, *tetrapetalous* or *pentapetalous* according as it has two, three, four or five separate petals. The general name of *polypetalous* is given to corollas having separate petals, while *monopetalous*, *gamopetalous* or *sympetalous* is applied to those in which the petals are united. This union generally takes place at the base, and extends more or less towards the apex; in *Phyteuma* the petals are united at their apices also. In some polypetalous corollas, as that of the vine, the petals are separate at the base and adhere by the apices. When the petals are equal as regards their development and size, the corolla is *regular*; when unequal, it is *irregular*. When a corolla is gamopetalous it usually happens that the lower portion forms a tube, while the upper parts are either free or partially united, so as to form a common limb, the point of union of the two portions being the *throat*, which often exhibits a distinct constriction or dilatation. The number of parts forming such a corolla can be determined by the divisions, whether existing as teeth, crenations, fissures or partitions, or if, as rarely happens, the corolla is entire, by the venation. The union may be equal among the parts, or some may unite more than others.

Amongst regular polypetalous corollas may be noticed the *rosaceous* corolla (fig. 59), in which there are five spreading petals, having no claws, and arranged as in the rose, strawberry and *Potentilla*; the *caryophyllaceous* corolla, in which there are five petals with long, narrow, tapering claws, as in many of the pink tribe; the *cruciform*, having four petals, often unguiculate, placed opposite in the form of a cross, as seen in wallflower, and in other plants called *cruciferous*. Of irregular polypetalous corollas the most marked is the *papilionaceous* (fig. 40), in which there are five petals:—one superior (posterior), st, placed next to the axis, usually larger than the rest, called the *vexillum* or *standard*; two lateral, a, the *alae* or wings; two inferior (anterior), partially or completely covered by the alae, and often united slightly by their lower margins, so as to form a single keel-like piece, *car*, called *carina*, or keel, which embraces the essential organs. This form of corolla is characteristic of British leguminous plants.

FIG. 59.—Rosaceous corolla (*c*) of the Strawberry (*Fragaria vesca*), composed of five petals without claws.

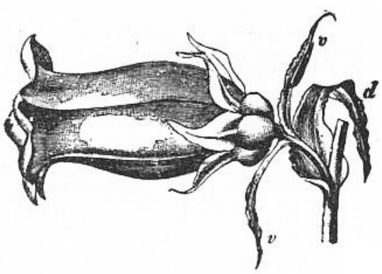


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FIG. 60.—Flower of *Campanula medium*; *d*, bract; *v*, bracteoles.

Regular gamopetalous corollas are sometimes *campanulate* or *bell-shaped*, as in (*Campanula*) (fig. 60); *infundibuliform* or *funnel-shaped*, when the tube is like an inverted cone, and the limb becomes more expanded at the apex, as in tobacco; *hypocrateriform* or *salver-shaped*, when there is a straight tube surmounted by a flat spreading limb, as in primula (fig. 61); *tubular*, having a long cylindrical tube, appearing continuous with the limb, as in *Spigelia* and comfrey; *rotate* or *wheel-shaped*, when the tube is very short, and the limb flat and spreading, as in forget-me-not, *Myosotis* (when the divisions of the rotate corolla are very acute, as in *Galium*, it is sometimes called *stellate* or *star-like*); *urceolate* or *urn-shaped*, when there is scarcely any limb, and the tube is narrow at both ends, and expanded in the middle, as in bell-heath (*Erica cinerea*). Some of these forms may become irregular in consequence of certain parts being more developed than others. Thus, in *Veronica*, the rotate corolla has one division much smaller than the rest, and in foxglove (*Digitalis*) there is a slightly irregular companulate corolla. Of irregular gamopetalous corollas there may be mentioned the *labiate* or *lipped* (fig. 62), having two divisions of the limb in the form of lips (the upper one, *u*, composed usually of two united petals, and the lower, *l*, of three), separated by a gap. In such cases the tube varies in length, and the parts in their union follow the reverse order of what occurs in the calyx, where two sepals are united in the lower lip and three in the upper. When the upper lip of a labiate corolla is much arched, and the lips separated by a distinct gap, it is called *ringent* (fig. 62). The labiate corolla characterizes the natural order Labiatae. When the lower lip is pressed against the upper, so as to leave only a chink between them, the corolla is said to be *personate*, as in snapdragon, and some other Scrophulariaceae. In some corollas the two lips become hollowed out in a remarkable manner, as in calceolaria, assuming a slipper-like appearance, similar to what occurs in the labellum of some orchids, as *Cypripedium*. When a tubular corolla is split in such a way as to form a strap-like process on one side with several tooth-like projections at its apex, it becomes *ligulate* or *strap-shaped* (fig. 63). This corolla occurs in many composite plants, as in the florets of dandelion, daisy and chicory. The number of divisions at the apex indicates the number of united petals, some of which, however, may be abortive. Occasionally some of the petals become more united than others, and then the corolla assumes a *bilabiate* or *two-lipped* form, as seen in the division of Compositae called Labiatiflorae.

Petals are sometimes suppressed, and sometimes the whole corolla is absent. In *Amorpha* and *Afzelia* the corolla is reduced to a single petal, and in some other Leguminous plants it is entirely wanting. In the natural order Ranunculaceae, some genera, such as *Ranunculus*, globe-flower and paeony, have both calyx and corolla, while others, such as clematis, anemone and *Caltha*, have only a coloured calyx. Flowers become double by the multiplication of the parts of the corolline whorl; this arises in general from a metamorphosis of the stamens.

Certain structures occur on the petals of some flowers, which received in former days the name of *nectaries*. The term nectary was very vaguely applied by Linnaeus to any part of the flower which presented an unusual aspect, as the crown (*corona*) of narcissus, the fringes of the Passion-flower, &c. If the name is retained it ought properly to include only those parts which secrete a honey-like substance, as the glandular depression at the base of the perianth of the fritillary, or on the petal of *Ranunculus* (fig. 55), or on the stamens of Rutaceae. The honey secreted by flowers attracts insects, which, by conveying the pollen to the stigma, effect fertilization. The horn-like nectaries under the galeate sepal of aconite (fig. 58) are modified petals, so also are the tubular nectaries of hellebore (fig. 56). Other modifications of some part of the flower, especially of the corolla and stamens, are produced either by degeneration or outgrowth, or by *chorisis*, or *deduplication*. Of this nature are the scales on the petals in *Lychnis*, *Silene* and *Cynoglossum*, which are formed in the same way as the ligules of grasses. In other cases, as in Samolus, the scales are alternate with the petals, and may represent altered stamens. In *Narcissus* the appendages are united to form a crown, consisting of a membrane similar to that which unites the stamens in *Pancratium*. It is sometimes difficult to say whether these structures are to be referred to the corolline or to the staminal row.

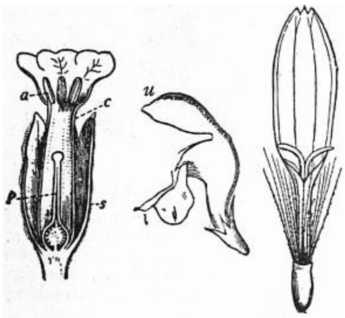

FIG. 61. FIG. 62. FIG. 63.

FIG. 61.—Flower of cowslip (*Primula veris*) cut vertically. *s*, Sepals joined to form a gamosepalous calyx; *c*, corolla consisting of tube and spreading limb; *a*, stamens springing from the mouth of the tube; *p*, pistil.

FIG. 62.—Irregular gamopetalous labiate corolla of the Dead-nettle (*Lamium album*). The upper lip *u* is composed of two petals united, the lower lip (*l*) of three. Between the two lips there is a gap. The throat is the part where the tube and the labiate limb join. From the arching of the upper lip this corolla is called ringent.

FIG. 63.—Irregular gamopetalous ligulate flower of Ragwort (*Senecio*). It is a tubular floret, split down on one side, with the united petals forming a straplike projection. The lines on the flat portion indicate the divisions of the five petals. From the tubular portion below, the bifid style projects slightly.

Petals are attached to the axis usually by a narrow base. When this attachment takes place by an articulation, the petals fall off either immediately after expansion (*caducous*) or after fertilization (*deciduous*). A corolla which is continuous with the axis and not articulated to it, as in campanula and heaths, may be persistent, and remain in a withered or marcescent state while the fruit is ripening. A gamopetalous corolla falls off in one piece; but sometimes the base of the corolla remains persistent, as in *Rhinanthus* and *Orobanche*.

The *stamens* and the *pistil* are sometimes spoken of as the essential organs of the flower, as the presence of both is required in order that perfect seed may be produced. As with few exceptions the stamen represents a leaf which has been specially developed to bear the pollen or microspores, it is spoken of in comparative morphology as a microsporophyll; similarly the carpels which make up the pistil are the megasporophylls (see ANGIOSPERMS). *Hermaphrodite* or *bisexual* flowers are those in which both these organs are found; *unisexual* or *diclinous* are those in which only one of these organs appears,—those bearing stamens only, being *staminiferous* or “male”; those having the pistil only, *pistilliferous* or “female.” But even in plants with hermaphrodite flowers self-fertilization is often provided against by the structure of the parts or by the period of ripening of the organs. For instance, in *Primula* and *Linum* some flowers have long stamens and a pistil with a short style, the others having short stamens and a pistil with a long style. The former occur in the so-called thrum-eyed primroses (fig. 61), the latter in the “pin-eyed.” Such plants are called *dimorphic*. Other plants are *trimorphic*, as species of *Lythrum*, and proper fertilization is only effected by combination of parts of equal length. In some plants the stamens are perfected before the pistil; these are called *proterandrous*, as in *Ranunculus repens*, *Silene maritima*, *Zea Mays*. In other plants, but more rarely, the pistil is perfected before the stamens, as in *Potentilla argentea*, *Plantago major*, *Coix Lachryma*, and they are termed *proterogynous*. Plants in which proterandry or proterogyny occurs are called *dichogamous*. When in the same plant there are unisexual flowers, both male and female, the plant is said to be *monoecious*, as in the hazel and castor-oil plant. When the male and female flowers of a species are found on separate plants, the term *dioecious* is applied, as in *Mercurialis* and hemp; and when a species has male, female and hermaphrodite flowers on the same or different plants, as in *Parietaria*, it is *polygamous*.

Stamens.

The stamens arise from the thalamus or torus within the petals, with which they generally alternate, forming one or more whorls, which collectively constitute the *androecium*. Their normal position is below the pistil, and when they are so placed (fig. 64, *a*) upon the thalamus they are *hypogynous*. Sometimes they become adherent to the petals, or are *epipetalous*, and the insertion of both is looked upon as similar, so that they are still hypogynous, provided they are independent of the calyx and the pistil. In other cases they are perigynous or epigynous (fig. 65). Numerous intermediate forms occur, especially amongst Saxifragaceae, where the parts are *half superior* or *half inferior*. Where the stamens become adherent to the pistil so as to form a column, the flowers are said to be *gynandrous*, as in *Aristolochia* (fig. 66). These arrangements of parts are of great importance in classification. The stamens vary in number from one to many hundreds. In acyclic flowers there is often a gradual transition from petals to stamens, as in the white water-lily (fig. 31). When flowers become double by cultivation, the stamens are converted into petals, as in the paeony, camellia, rose, &c. When there is only one whorl the stamens are usually equal in number to the sepals or petals, and are arranged opposite to the former, and alternate with the latter. The flower is then *isostemonous*. When the stamens are not equal in number to the sepals or petals, the flower is *anisostemonous*. When there is more than one whorl of stamens, then the parts of each successive whorl alternate with those of the whorl preceding it. The staminal row is more liable to multiplication of parts than the outer whorls. A flower with a single row of stamens is *haplostemonous*. If the stamens are double the sepals or petals as regards number, the flower is *diplostemonous*; if more than double, *polystemonous*. The additional rows of stamens may be developed in the usual centripetal (acropetal) order, as in Rhamnaceae; or they may be interposed between the pre-existing ones or be placed outside them, *i.e.* develop centrifugally (basipetally), as in geranium and oxalis, when the flower is said to be *obdiplostemonous*. When the stamens are fewer than twenty they are said to be *definite*; when above twenty they are *indefinite*, and are represented by the symbol ∞. The number of stamens is indicated by the Greek numerals prefixed to the term *androus*; thus a flower with one stamen is *monandrous*, with two, three, four, five, six or many stamens, di-, tri-, tetr-, pent-, hex- or polyandrous, respectively. 566

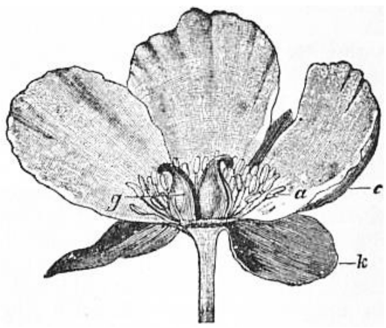

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FIG. 64.—Flower of *Paeonia peregrina*, in longitudinal section. *k*, Sepal; *c*, petal; *a*, stamens; *g*, pistil. (½ nat. size.)

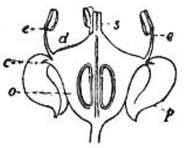

Fig. 65.—Flower of Aralia in vertical section. *c*, Calyx; *p*, petal; *e*, stamen; *s*, stigmas. The calyx, petals and stamens spring from above the ovary (*o*) in which two chambers are shown each with a pendulous ovule; *d*, disc between the stamens and stigmas.

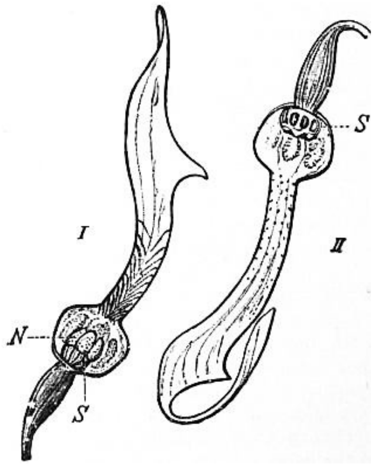

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Fig. 66.—Flowers of *Aristolochia Clematitis* cut through longitudinally. I. Young flower in which the stigma (*N*) is receptive and the stamens (*S*) have not yet opened; II. Older flower with the stamens (*S*) opened, the stigma withered, and the hairs on the corolla dried up.

The function of the stamen is the development and distribution of the pollen. The stamen usually consists of two parts, a contracted portion, often thread-like, termed the *filament* (fig. 25 *f*), and a broader portion, usually of two lobes, termed the *anther* (*a*), containing the powdery *pollen* (*p*), and supported upon the end of the filament. That portion of the filament in contact with the anther-lobes is termed the *connective*. If the anther is absent the stamen is abortive, and cannot perform its functions. The anther is developed before the filament, and when the latter is not produced, the anther is sessile, as in the mistletoe.

The filament is usually, as its name imports, filiform or thread-like, and cylindrical, or slightly tapering towards its summit. It is often, however, thickened, compressed and flattened in various ways, becoming *petaloid* in *Canna*, *Marania*, water-lily (fig. 32); *subulate* or slightly broadened at the base and drawn out into a point like an awl, as in *Butomus umbellatus*; or clavate, that is, narrow below and broad above, as in *Thalictrum*. In some instances, as in *Tamarix gallica*, *Peganum Harmala*, and *Campanula*, the base of the filament is much dilated, and ends suddenly in a narrow thread-like portion. In these cases the base may give off lateral stipulary processes, as in *Allium* and *Alyssum calycinum*. The filament varies much in length and in firmness. The length sometimes bears a relation to that of the pistil, and to the position of the flower, whether erect or drooping. The filament is usually of sufficient solidity to support the anther in an erect position; but sometimes, as in grasses, and other wind-pollinated flowers, it is very delicate and hair-like, so that the anther is pendulous (fig. 105). The filament is generally continuous from one end to the other, but in some cases it is bent or jointed, becoming *geniculate*; at other times, as in the pellitory, it is spiral. It is colourless, or of different colours. Thus in fuchsia and *Poinciana*, it is red; in *Adamia* and *Tradescantia virginica*, blue; in *Oenothera* and *Ranunculus acris*, yellow.

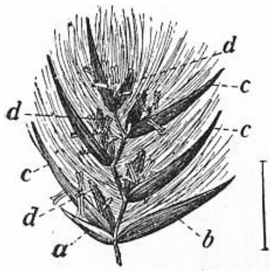

Fig. 67.—Spikelet of Reed (*Phragmites communis*) opened out. *a, b*, Barren glumes; *c*, fertile glumes, each enclosing one flower with its pale, *d*; the zigzag axis (*rhachilla*) bears long silky hairs.

Hairs, scales, teeth or processes of different kinds are sometimes times developed on the filament. In spiderwort (*Tradescantia virginica*) the hairs are beautifully coloured, moniliform or necklace-like, and afford good objects for studying rotation of the protoplasm. Filaments are usually articulated to the thalamus or torus, and the stamens fall off after fertilization; but in *Campanula* and some other plants they are continuous with the torus, and the stamens remain persistent, although in a withered state. Changes are produced in the whorl of stamens by cohesion of the filaments to a greater or less extent, while the anthers remain free; thus, all the filaments of the androecium may unite, forming a tube round the pistil, or a central bundle when the pistil is abortive, the stamens becoming *monadelphous*, as occurs in plants of the Mallow tribe; or they may be arranged in two bundles, the stamens being *diadelphous*, as in *Polygala*, *Fumaria* and Pea; in this case the bundles may be equal or unequal. It frequently happens, especially in Papilionaceous flowers, that out of ten stamens nine are united by their filaments, while one (the posterior one) is free (fig. 68). When there are three or more bundles the stamens are *triadelphous*, as in *Hypericum aegyptiacum*, or *polyadelphous*, as in *Ricinus communis* (castor-oil). In some cases, as in papilionaceous flowers, the stamens cohere, having been originally separate, but in most cases each bundle is produced by the branching of a single stamen. When there are three stamens in a bundle we may conceive the lateral ones as of a stipulary nature. In Lauraceae there are perfect stamens, each having at the base of the filament two abortive stamens or staminodes, which may be analogous to stipules. Filaments sometimes are adherent to the pistil, forming a column (*gynostemium*), as in *Stylidium*, Asclepiadaceae, *Rafflesia*, and Aristolochiaceae (fig. 66); the flowers are then termed *gynandrous*.

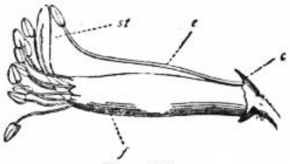

Fig. 68.

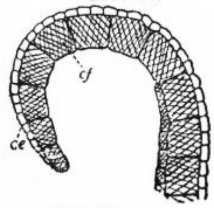

Fig. 69.

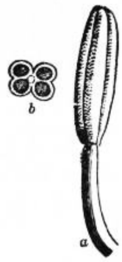

Fig. 70.

Fig. 68.—Stamens and pistil of Sweet Pea (*Lathyrus*). The stamens are diadelphous, nine of them being united by their filaments (*f*), while one of them (*e*) is free; *st*, stigma; *c*, calyx.

Fig. 69.—Portion of wall of anther of Wallflower (*Cheiranthus*). *ce*, Exothecium; *cf*, endothecium; highly magnified.

Fig. 70.—Quadrilocular or tetrathecal anther of the flowering Rush (*Butomus umbellatus*). The anther entire (*a*) with its filament; section of anther (*b*) showing the four loculi.

The anther.

The *anther* consists of lobes containing the minute powdery pollen grains, which, when mature, are discharged by a fissure or opening of some sort. There is a double covering of the anther—the outer, or *exothecium*, resembles the epidermis, and often presents stomata and projections of different kinds (fig. 69); the inner, or *endothecium*, is formed by a layer or layers of cellular tissue (fig. 69, *cf*), the cells of which have a spiral, annular, or reticulated thickening of the wall. 567 The endothecium varies in thickness, generally becoming thinner towards the part where the anther opens, and there disappears entirely. The walls of the cells are frequently absorbed, so that when the anther attains maturity the fibres are alone left, and these by their elasticity assist in discharging the pollen. The anther is developed before the filament, and is always sessile in the first instance, and sometimes continues so. It appears at first as a simple cellular papilla of meristem, upon which an indication of two lobes soon appears. Upon these projections the rudiments of the pollen-sacs are then seen, usually four in number, two on each lobe. In each a differentiation takes place in the layers beneath the epidermis, by which an outer layer of small-celled tissue surrounds an inner portion of large cells. Those central cells are the mother-cells of the pollen, whilst the small-celled layer of tissue external to them becomes the endothecium, the exothecium being formed from the epidermal layer.

In the young state there are usually four pollen-sacs, two for each anther-lobe, and when these remain permanently complete it is a *quadrilocular* or *tetrathecal* anther (fig. 70). Sometimes, however, only two cavities remain in the anther, by union of the sacs in each lobe, in which case the anther is said to be *bilocular* or *dithecal*. Sometimes the anther has a single cavity, and becomes *unilocular*, or *monothecal*, or *dimidiate*, either by the disappearance of the partition between the two lobes, or by the abortion of one of its lobes, as in *Styphelia laeta* and *Althaea officinalis* (hollyhock). Occasionally there are numerous cavities in the anther, as in *Viscum* and *Rafflesia*. The form of the anther-lobes varies. They are generally of a more or less oval or elliptical form, or they may be globular, as in *Mercurialis annua*; at other times linear or clavate: curved, flexuose, or sinuose, as in bryony and gourd. According to the amount of union of the lobes and the unequal development of different parts of their surface an infinite variety of forms is produced. That part of the anther to which the filament is attached is the *back*, the opposite being the *face*. The division between the lobes is marked on the face of the anther by a groove or *furrow*, and there is usually on the face a *suture*, indicating the line of dehiscence. The suture is often towards one side in consequence of the valves being unequal. The stamens may cohere by their anthers, and become *syngenesious*, as in composite flowers, and in lobelia, jasione, &c.

The connective.

The anther-lobes are united to the *connective*, which is either continuous with the filament or articulated with it. When the filament is continuous with the connective, and is prolonged so that the anther-lobes appear to be united to it throughout their whole length, and lie in apposition to it and on both sides of it, the anther is said to be *adnate* or *adherent*; when the filament ends at the base of the anther, then the latter is *innate* or *erect*. In these cases the anther is to a greater or less degree fixed. When, however, the attachment is very narrow, and an articulation exists, the anthers are movable (*versatile*) and are easily turned by the wind, as in *Tritonia*, grasses (fig. 105), &c., where the filament is attached only to the middle of the connective. The connective may unite the anther-lobes completely or only partially. It is sometimes very short and is reduced to a mere point, so that the lobes are separate or free. At other times it is prolonged upwards beyond the lobes, assuming various forms, as in *Acalypha* and oleander; or it is extended backwards and downwards, as in violet (fig. 71), forming a nectar-secreting spur. In *Salvia officinalis* the connective is attached to the filament in a horizontal manner, so as to separate the two anther-lobes (fig. 72), one only of which contains pollen, the other being imperfectly developed and sterile. The connective is joined to the filament by a movable joint forming a lever which plays an important part in the pollination-mechanism. In *Stachys* the connective is expanded laterally, so as to unite the bases of the anther-lobes and bring them into a horizontal line.

Anther dehiscence.

The opening or *dehiscence* of the anthers to discharge their contents takes place either by clefts, by valves, or by pores. When the anther-lobes are erect, the cleft is lengthwise along the line of the suture—*longitudinal dehiscence* (fig. 25). At other times the slit is horizontal, from the connective to the side, as in *Alchemilla arvensis* (fig. 73) and in *Lemna*; the dehiscence is then *transverse*. When the anther-lobes are rendered horizontal by the enlargement of the connective, then what is really longitudinal dehiscence may appear to be transverse. The cleft does not always proceed the whole length of the anther-lobe at once, but often for a time it extends only partially. In other instances the opening is confined to the base or apex, each loculament opening by a single pore, as in *Pyrola*, *Tetratheca juncea*, Rhododendron, *Vaccinium* and *Solanum* (fig. 74), where there are two, and *Poranthera*, where there are four; whilst in the mistletoe the anther has numerous pores for the discharge of the pollen. Another mode of dehiscence is the valvular, as in the barberry (fig. 75), where each lobe opens by a valve on the outer side of the suture, separately rolling up from base to apex; in some of the laurel tribe there are two such valves for each lobe, or four in all. In some Guttiferae, as *Hebradendron cambogioides* (the Ceylon gamboge plant), the anther opens by a lid separating from the apex (*circumscissile* dehiscence).

The anthers dehisce at different periods during the process of flowering;

sometimes in the bud, but more commonly when the pistil is fully developed and the flower is expanded. They either dehisce simultaneously or in succession. In the latter case individual stamens may move in succession towards the pistil and discharge their contents, as in *Parnassia palustris*, or the outer or the inner stamens may first dehisce, following thus a centripetal or centrifugal order. These variations are intimately connected with the arrangements for transference of pollen. The anthers are called *introrse* when they dehisce by the surface next to the centre of the flower; they are *extrorse* when they dehisce by the outer surface; when they dehisce by the sides, as in *Iris* and some grasses, they are *laterally* dehiscent. Sometimes, from their versatile nature, anthers originally introrse become extrorse, as in the Passion-flower and *Oxalis*.

The usual colour of anthers is yellow, but they present a great variety in this respect. They are red in the peach, dark purple in the poppy and tulip, orange in *Eschscholtzia*, &c. The colour and appearance of the anthers often change after they have discharged their functions.

Stamens occasionally become sterile by the degeneration or non-development of the anthers, when they are known as *staminodia*, or rudimentary stamens. In *Scrophularia* the fifth stamen appears in the form of a scale; and in many Pentstemons it is reduced to a filament with hairs or a shrivelled membrane at the apex. In other cases, as in double flowers, the stamens are converted into petals; this is also probably the case with such plants as *Mesembryanthemum*, where there is a multiplication of petals in several rows. Sometimes, as in *Canna*, one of the anther-lobes becomes abortive, and a petaloid appendage is produced. Stamens vary in length as regards the corolla. Some are enclosed within the tube of the flower, as in *Cinchona* (*included*); others are *exserted*, or extend beyond the flower, as in *Littorella* or *Plantago*. Sometimes the stamens in the early state of the flower project beyond the petals, and in the progress of growth become included, as in *Geranium striatum*. Stamens also vary in their relative lengths. When there is more than one row or whorl in a flower, those on the outside are sometimes longest, as in many Rosaceae; at other times those in the interior are longest, as in *Luhea*. When the stamens are in two rows, those opposite the petals are usually shorter than those which alternate with the petals. It sometimes happens that a single stamen is longer than all the rest. A definite relation, as regards number, sometimes exists between the long and the short stamens. Thus, in some flowers the stamens are *didynamous*, having only four out of five stamens developed, and the two corresponding to the upper part of the flower longer than the two lateral ones. This occurs in Labiatae and Scrophulariaceae (fig. 76). Again, in other cases there are six stamens, whereof four long ones are arranged in pairs opposite to each other, and alternate with two isolated short ones (fig. 77), giving rise to *tetradynamous* flowers, as in Cruciferae. Stamens, as regards their direction, may be erect, turned inwards, outwards, or to one side. In the last-mentioned case they are called *declinate*, as in amaryllis, horse-chestnut and fraxinella.

FIG. 71.

FIG. 73.

FIG. 74.

FIG. 72.

FIG. 75.

568

Fig. 71.—Two stamens of Pansy (*Viola tricolor*), with their two anther-lobes and the connectives (*p*) extending beyond them. One of the stamens has been deprived of its spur, the other shows its spur *c*.

Fig. 72.—Anther of *Salvia officinalis*. *lf*, fertile lobe full of pollen; *ls*, barren lobe without pollen; *e*, connective; *f*, filament.

Fig. 73.—Stamen of Lady’s Mantle (*Alchemilla*), with the anther opening transversely.

Fig. 74.—Stamen of a species of Nightshade (*Solanum*), showing the divergence of the anther-lobes at the base, and the dehiscence by pores at the apex.

Fig. 75.—The stamen of the Barberry (*Berberis vulgaris*), showing one of the valves of the anther (*v*) curved upwards, bearing the pollen on its inner surface.

Fig. 76.—Corolla of foxglove (*Digitalis purpurea*), cut in order to show the didynamous stamens (two long and two short) which are attached to it.

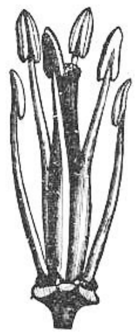

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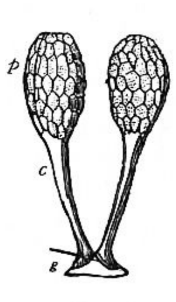
Fig. 77.—Tetradynamous stamens (four long and two short) of wallflower (*Cheiranthus Cheiri*).

The pollen-grains or microspores contained in the anther consist of small cells, which are developed in the large thick-walled mother-cells formed in the interior of the pollen-sacs (microsporangia) of the young anther. These mother-cells are either separated from one another and float in the granular fluid which fills up the cavity of the pollen-sac, or are not so isolated. A division takes place, by which four cells are formed in each, the exact mode of division differing in dicotyledons and monocotyledons. These cells are the pollen-grains. They increase in size and acquire a cell-wall, which becomes differentiated into an outer cuticular layer, or *extine*, and an inner layer, or *intine*. Then the walls of the mother-cells are absorbed, and the pollen-grains float freely in the fluid of the pollen-sacs, which gradually disappears, and the mature grains form a powdery mass within the anther. They then either remain united in fours, or multiples of four, as in some acacias, *Periploca graeca* and *Inga anomala*, or separate into individual grains, which by degrees become mature pollen. Occasionally the membrane of the mother-cell is not completely absorbed, and traces of it are detected in a viscid matter surrounding the pollen-grains, as in Onagraceae. In orchidaceous plants the pollen-grains are united into masses, or *pollinia* (fig. 78), by means of viscid matter. In orchids each of the pollen-masses has a prolongation or stalk (*caudicle*) which adheres to a prolongation at the base of the anther (*rostellum*) by means of a viscid gland (*retinaculum*) which is either naked or covered. The term *clinandrium* is sometimes applied to the part of the column in orchids where the stamens are situated. In some orchids, as *Cypripedium*, the pollen has its ordinary character of separate grains. The number of pollinia varies; thus, in *Orchis* there are usually two, in *Cattleya* four, and in *Laelia* eight. The two pollinia in *Orchis Morio* contain each about 200 secondary smaller masses. These small masses, when bruised, divide into grains which are united in fours. In Asclepiadaceae the pollinia are usually united in pairs (fig. 79), belonging to two contiguous anther-lobes—each pollen-mass having a caudicular appendage, ending in a common gland, by means of which they are attached to a process of the stigma. The pollinia are also provided with an appendicular staminal covering (fig. 80). The exine is a firm membrane, which defines the figure of the pollen-grain, and gives colour to it. It is either smooth, or covered with numerous projections (fig. 81), granules, points or crested reticulations. The colour is generally yellow, and the surface is often covered with a viscid or oily matter. The intine is uniform in different kinds of pollen, thin and transparent, and possesses great power of extension. In some aquatics, as *Zostera*, *Zannichellia*, *Naias*, &c., only one covering exists.



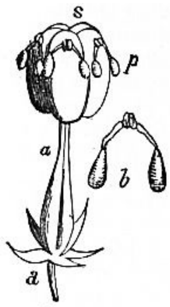


Fig. 78. Fig. 79. Fig. 80.

Fig. 78.—Pollinia, or pollen-masses, with their retinacula (*g*) or viscid matter attaching them at the base. The pollen masses (*p*) are supported on stalks or caudicles (*c*). These masses are easily detached by the agency of insects. Much enlarged.

Fig. 79.—Pistil of *Asclepias* (*a*) with pollen-masses (*p*) adhering to the stigma (*s*). *b*, pollen-masses, removed from the stigma, united by a gland-like body. Enlarged.

Fig. 80.—Stamen of *Asclepias*, showing filament f, anther a, and appendages p. Enlarged.

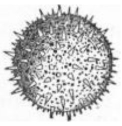


Fig. 81.—Pollen of Hollyhock (*Althaea rosea*), highly magnified.

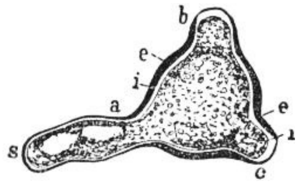


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Fig. 82.—Germinating pollen-grain of Epilobium (highly mag.) bearing a pollen-tube *s*; *e*, exine; *i*, intine; *abc*, the three spots where the exine is thicker in anticipation of the formation of the pollen-tube developed in this case at *a*.

Fig. 83.—Male flower of Pellitory (*Parietaria officinalis*), having four stamens with in-curved elastic filaments, and an abortive pistil in the centre. When the perianth (*p*) expands, the filaments are thrown out with force as at *a*, so as to scatter the pollen.

Pollen-grains vary from $\frac{1}{300}$ to $\frac{1}{700}$ of an inch or less in diameter. Their forms are various. The most common form of grain is ellipsoidal, more or less narrow at the extremities, which are called its *poles*, in contradistinction to a line equidistant from the extremities, which is its equator. Pollen-grains are also spherical; cylindrical and curved, as in *Tradescantia virginica*; polyhedral in Dipsacaceae and Compositae; nearly triangular in section in Proteaceae and Onagraceae (fig. 82). The surface of the pollen-grain is either uniform and homogeneous, or it is marked by folds formed by thinnings of the membrane. There are also rounded portions of the membrane or pores visible in the pollen-grain; these vary in number from one to fifty, and through one or more of them the pollen-tube is extended in germination of the 569
spore. In Monocotyledons, as in grasses, there is often only one, while in Dicotyledons they number from three upwards; when numerous, the pores are either scattered irregularly, or in a regular order, frequently forming a circle round the equatorial surface. Sometimes at the place where they exist, the outer membrane, in place of being thin and transparent, is separated in the form of a lid, thus becoming *operculate*, as in the passion-flower and gourd. Within the pollen-grain is the granular protoplasm with some oily particles, and occasionally starch. Before leaving the pollen-sac a division takes place in the pollen-grain into a vegetative cell or cells, from which the tube is developed, and a generative cell, which ultimately divides to form the male cells (see Angiosperms and Gymnosperms).

Pollination.

When the pollen-grains are ripe, the anther dehisces and the pollen is shed. In order that fertilization may be effected the pollen must be conveyed to the stigma of the pistil. This process, termed *pollination* (see Pollination), is promoted in various ways,—the whole form and structure of the flower having relation to the process. In some plants, as *Kalmia* and Pellitory (fig. 83), the mere elasticity of the filaments is sufficient to effect this; in other plants pollination is effected by the wind, as in most of our forest trees, grasses, &c., and in such cases enormous quantities of pollen are produced. These plants are *anemophilous*. But the common agents for pollination are insects. To allure and attract them to visit the flower the odoriferous secretions and gay colours are developed, and the position and complicated structure of the parts of the flower are adapted to the perfect performance of the process. It is comparatively rare in hermaphrodite flowers for self-fertilization to occur, and the various forms of dichogamy, dimorphism and trimorphism are fitted to prevent this.

Disk.

Under the term *disk* is included every structure intervening between the stamens and the pistil. It was to such structures that the name of *nectary* was applied by old authors. It presents great varieties of form, such as a ring, scales, glands, hairs, petaloid appendages, &c., and in the progress of growth it often contains saccharine matter, thus becoming truly nectariferous. The disk is frequently formed by degeneration or transformation of the staminal row. It may consist of processes rising from the torus, alternating with the stamens, and thus representing an abortive whorl; or its parts may be opposite to the stamens. In some flowers, as *Jatropha Curcas*, in which the stamens are not developed, their place is occupied by glandular bodies forming the disk. In Gesneraceae and Cruciferae the disk consists of tooth-like scales at the base of the stamens. The parts composing the disk sometimes unite and form a glandular ring, as in the orange; or they form a dark-red lamina covering the pistil, as in *Paeonia Moutan* (fig. 84); or a waxy lining of the hollow receptacle, as in the rose; or a swelling at the top of the ovary, as in Umbelliferae, in which the disk is said to be epigynous. The enlarged torus covering the ovary in *Nymphaea* (*Castalia*) and *Nelumbium*

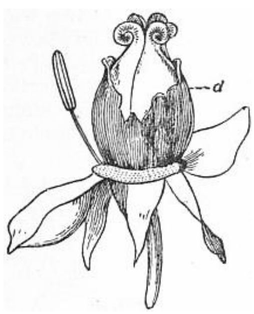

Fig. 84.—Flower of Tree Paeony (*Paeonia Moutan*), deprived of its corolla,

may be regarded as a form of disk.

and showing the disk in the form of a fleshy expansion (*d*) covering the ovary.

The pistil or *gynoecium* occupies the centre or apex of the flower, and is surrounded by the stamens and floral envelopes when these are present. It constitutes the innermost whorl, which after flowering is changed into the fruit and contains the seeds. It consists essentially of two parts, a basal portion forming a chamber, the *ovary*, containing the ovules attached to a part called the *placenta*, and an upper receptive portion, the *stigma*, which is either seated on the ovary (*sessile*), as in the tulip and poppy, or is elevated on a stalk called the *style*, interposed between the ovary and stigma. The pistil consists of one or more modified leaves, the *carpels* (or *megasporophylls*). When a pistil consists of a single carpel it is *simple* or monocarpellary (fig. 85). When it is composed of several carpels, more or less united, it is *compound* or *polycarpellary* (fig. 86). In the first-mentioned case the terms carpel and pistil are synonymous. Each carpel has its own ovary, style (when present), and stigma, and may be regarded as formed by a folded leaf, the upper surface of which is turned inwards towards the axis, and the lower outwards, while from its margins are developed one or more *ovules*. This comparison is borne out by an examination of the flower of the double-flowering cherry. In it no fruit is produced, and the pistil consists merely of sessile leaves, the limb of each being green and folded, with a narrow prolongation upwards, as if from the midrib, and ending in a thickened portion. In *Cycas* the carpels are ordinary leaves, with ovules upon their margin.

The pistil.

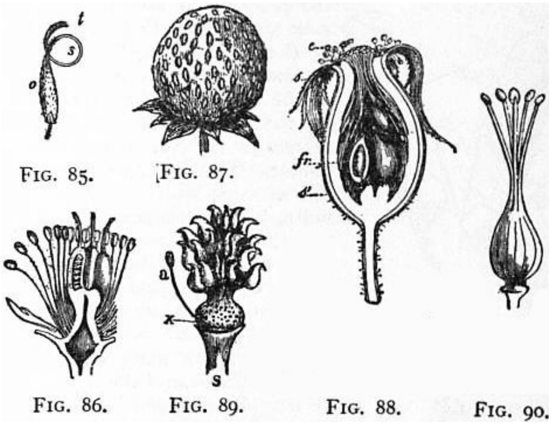

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Fig. 85.—Pistil of Broom (*Cytisus*) consisting of ovary *o*, style *s*, and stigma *t*. It is formed by a single carpel.
Fig. 86.—Vertical section of the flower of Black Hellebore (*Helleborus niger*). The pistil is apocarpous, consisting of several distinct carpels, each with ovary, style and stigma. The stamens are indefinite, and are inserted below the pistil (hypogynous).
Fig. 87.—Fruit of the Strawberry (*Fragaria vesca*), consisting of an enlarged succulent receptacle, bearing on its surface the small dry seed-like fruits (achenes).
Fig. 88.—Fruit of *Rosa alba*, consisting of the fleshy hollowed axis s´, the persistent sepals s, and the carpels *fr*. The stamens (*c*) have withered. (After Duchartre.)
Fig. 89.—Pistil of *Ranunculus*. *x*, Receptacle with the points of insertion of the stamens *a*, most of which have been removed.
Fig. 90.—Syncarpous Pistil of Flax (*Linum*), consisting of five carpels, united by their ovaries, while their styles and stigmas are separate.

A pistil is usually formed by more than one carpel. The carpels may be arranged either at the same or nearly the same height in a verticil, or at different heights in a spiral cycle. When they remain separate and distinct, thus showing at once the composition of the pistil, as in *Caltha, Ranunculus*, hellebore (fig. 86), and *Spiraea*, the term *apocarpous* is applied. Thus, in Sedum (fig. 22) the pistil consists of five verticillate carpels *o*, alternating with the stamens *e*. In magnolia and *Ranunculus* (fig. 89) the separate carpels are numerous and are arranged in a spiral cycle upon an elongated axis or receptacle. In the raspberry the carpels are on a conical receptacle; in the strawberry, on a swollen succulent one (fig. 87); and in the rose (fig. 88), on a hollow one. When the carpels are united, as in the pear, arbutus and chickweed, the pistil becomes *syncarpous*. The number of carpels in a pistil is indicated by the Greek numeral. A flower with a simple pistil is monogynous; with two carpels, digynous; with three carpels, trigynous, &c.

The union in a syncarpous pistil is not always complete; it may take place by the ovaries alone, while the styles and stigmas remain free (fig. 90), and in this case, when the ovaries form apparently a single body, the organ receives the name of *compound* ovary; or the union may take place by the ovaries and styles while the stigmas are disunited; or by the stigmas and the summit of the style only. Various intermediate states exist, such as partial union of the ovaries, as in the rue, where they coalesce at their base; and partial union of the styles, as in Malvaceae. The union is usually most complete at the base; but in Labiatae the styles are united throughout their length, and in Apocynaceae and Asclepiadaceae the stigmas only. When the union is incomplete, the number of the parts of a compound pistil may be determined by the number of styles and stigmas; when complete, the external venation, the grooves on the surface, and the internal divisions of the ovary indicate the number. 570

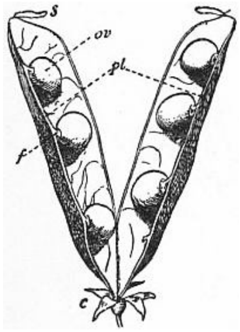
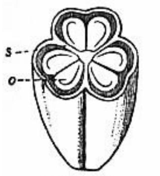
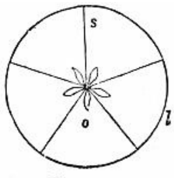


Fig. 91.—Pistil of Pea after fertilization of the ovules, developing to form the fruit. *f*, Funicle or stalk of ovule (*ov*); *pl*, placenta; *s*, withered style and stigma; *c*, persistent calyx.





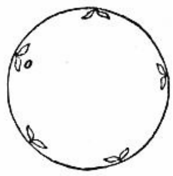


FIG. 92. FIG. 93. FIG. 94.

FIG. 92.—Trilocular ovary of the Lily (*Lilium*), cut transversely. *s*, Septum; *o*, ovules, which form a double row in the inner angle of each chamber. Enlarged.

FIG. 93.—Diagrammatic section of a quinquelocular ovary, composed of five carpels, the edges of which are folded inwards, and meet in the centre forming the septa, *s*. The ovules (*o*) are attached to a central placenta, formed by the union of the five ventral sutures. Dorsal suture, *l*.

FIG. 94.—Diagrammatic section of a five-carpellary ovary, in which the edges of the carpels, bearing the placentas and ovules *o*, are not folded inwards. The placentas are parietal, and the ovules appear sessile on the walls of the ovary. The ovary is unilocular.

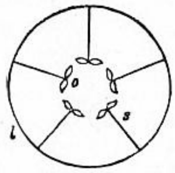


FIG. 95.

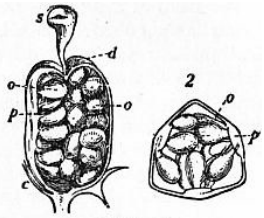


FIG. 96.

FIG. 97.

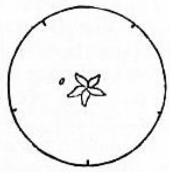


FIG. 98.

FIG. 95.—Diagrammatic section of a five-carpellary ovary, in which the septa (*s*) proceed inwards for a certain length, bearing the placentas and ovules (*o*). In this case the ovary is unilocular, and the placentas are parietal. Dorsal suture, *l*.

FIG. 96.—Pistil of Pansy (*Viola tricolor*), enlarged. 1, Vertical; 2, horizontal section; *c*, calyx; *d*, wall of ovary; *o*, ovules; *p*, placenta; *s*, stigma.

FIG. 97.—Transverse section of the fruit of the Melon (*Cucumis Melo*), showing the placentas with the seeds attached to them. The three carpels forming the pepo are separated by partitions. From the centre, processes go to circumference, ending in curved placentas bearing the ovules.

FIG. 98.—Diagrammatic section of a compound unilocular ovary, in which there are no indications of partitions. The ovules (*o*) are attached to a free central placenta, which has no connexion with the walls of the ovary.

The placenta.

The ovules are attached to the *placenta*, which consists of a mass of cellular tissue, through which the nourishing vessels pass to the ovule. The placenta is usually formed on the edges of the carpellary leaf (fig. 91)—*marginal*. In many cases, however, the placentas are formations from the axis (axile), and are not connected with the carpellary leaves. In marginal placentation the part of the carpel bearing the placenta is the *inner* or *ventral suture*, corresponding to the margin of the folded carpellary leaf, while the *outer* or *dorsal suture* corresponds to the midrib of the carpellary leaf. As the placenta is formed on each margin of the carpel it is essentially double. This is seen in cases where the margins of the carpel do not unite, but remain separate, and consequently two placentas are formed in place of one. When the pistil is formed by one carpel the inner margins unite and form usually a common marginal placenta, which may extend along the whole margin of the ovary as far as the base of the style (fig. 91), or may be confined to the base or apex only. When the pistil consists of several separate carpels, or is apocarpous, there are generally separate placentas at each of their margins. In a syncarpous pistil, on the other hand, the carpels are so united that the edges of each of the contiguous ones, by their union, form a *septum* or *dissepiment*, and the number of these septa consequently indicates the number of carpels in the compound pistil (fig. 92). When the dissepiments extend to the centre or axis, the ovary is divided into cavities or *cells*, and it may be *bilocular*, *triloculur* (fig. 92), *quadrilocular*, *quinquelocular*, or *multilocular*, according as it is formed by two, three, four, five or many carpels, each carpel corresponding to a single cell. In these cases the marginal placentas meet in the axis, and unite so as to form a single *central* one (figs. 92, 93), and the ovules appear in the central angle of the loculi. When the carpels in a syncarpous pistil do not fold inwards so that the placentas appear as projections on the walls of the ovary, then the ovary is *unilocular* (fig. 95) and the placentas are *parietal*, as in *Viola* (fig. 96). In these instances the placentas may be formed at the margin of the united contiguous leaves, so as to appear single, or the margins may not be united, each developing a placenta. Frequently the margins of the carpels, which fold in to the centre, split there into two lamellae, each of which is curved outwards and projects into the loculament, dilating at the end into a placenta. This is well seen in Cucurbitaceae (fig. 97), *Pyrola*, &c. The carpellary leaves may fold inwards very slightly, or they may be applied in a valvate manner, merely touching at their margins, the placentas then being parietal (fig. 94), and appearing as lines or thickenings along the walls. Cases occur, however, in which the placentas are not connected with the walls of the ovary, and form what is called a *free central placenta* (fig. 98). This is seen in many of the Caryophyllaceae and Primulaceae (figs. 99, 100). In Caryophyllaceae, however, while the placenta is free in the centre, there are often traces found at the base of the ovary of the remains of septa, as if rupture had taken place, and, in rare instances, ovules are found on the margins of the carpels. But in Primulaceae no vestiges of septa or marginal ovules can be perceived at any period of growth; the placenta is always free, and rises in the centre of the ovary. Free central placentation, therefore, has been accounted for in two ways: either by supposing that the placentas in the early state were formed on the margins of carpellary leaves, and that in the 571 progress of development these leaves separated from them, leaving the placentas and ovules free in the centre; or by supposing that the placentas are not *marginal* but *axile* formations, produced by an elongation of the axis, and the carpels verticillate leaves, united together around the axis. The first of these views applies to Caryophyllaceae, the second to Primulaceae.

Occasionally, divisions take place in ovaries which are not formed by the edges of contiguous carpels. These are called *spurious dissepiments*. They are often horizontal, as in *Cathartocarpus Fistula*, where they consist of transverse cellular prolongations from the walls of the ovary, only developed after fertilization, and therefore more properly noticed under fruit. At other times they are vertical, as in *Datura*, where the ovary, in place of being two-celled, becomes four-celled; in Cruciferae, where the prolongation of the placentas forms a vertical partition; in *Astragalus* and *Thespesia*, where the dorsal suture is folded inwards; and in *Oxytropis*, where the ventral suture is folded inwards.

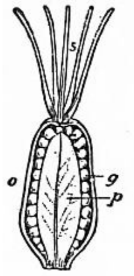


FIG. 99. FIG. 100.

FIG. 99.—Pistil of *Cerastium hirsutum* cut vertically. *o*, Ovary; *p*, free central placenta; *g*, ovules; *s*, styles.

FIG. 100.—The same cut horizontally, and the halves separated so as to show the interior of the cavity of the ovary *o*, with the free central placenta *p*, covered with ovules *g*.

The ovary is usually of a more or less spherical or curved form, sometimes smooth and uniform on its surface, at other times hairy and grooved. The grooves usually indicate the divisions between the carpels and correspond to the dissepiments. The dorsal suture may be marked by a slight projection or by a superficial groove. When the ovary is situated on the centre of the receptacle, free from the other whorls, so that its base is above the insertion of the stamens, it is termed *superior*, as in *Lychnis*, *Primula* (fig. 61) and Peony (fig. 64) (see also fig. 28). When the margin of the receptacle is prolonged upwards, carrying with it the floral envelopes and staminal leaves, the basal portion of the ovary being formed by the receptacle, and the carpellary leaves alone closing in the apex, the ovary is *inferior*, as in pomegranate, aralia (fig. 65), gooseberry and fuchsia (see fig. 30). In some plants, as many Saxifragaceae, there are intermediate forms, in which the term *half-inferior* is applied to the ovary, whilst the floral whorls are *half-superior*.

FIG. 101. FIG. 102.

FIG. 104.

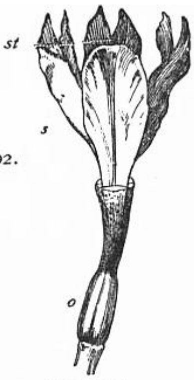


FIG. 103.

FIG. 101.—Carpel of Lady’s-mantle (*Alchemilla*) with lateral style *s*; *o*, ovary, *st*, stigma. Enlarged.

FIG. 102.—Pistil of Primrose (*Primula*) composed of five carpels which are completely united; *o*, ovary; *s*, style; *st*, stigma. Enlarged.

FIG. 103.—Gynoecium of the Flower-de-Luce (*Iris*), consisting of an inferior ovary (*o*) and a style which divides into three petaloid segments (*s*), each bearing a stigma (*st*).

FIG. 104.—Capsule of Poppy, opening by pores (*p*), under the radiating peltate stigma (*s*).

The style.

The *style* proceeds from the summit of the carpel (fig. 102), and is traversed by a narrow canal, in which there are some loose projecting cells, a continuation of the placenta, constituting what is called conducting tissue, which ends in the stigma. This is particularly abundant when the pistil is ready for fertilization. In some cases, owing to more rapid growth of the dorsal side of the ovary, the style becomes *lateral* (fig. 101); this may so increase that the style appears to arise from near the base, as in the strawberry, or from the base, as in *Chrysobalanus Icaco*, when it is called *basilar*. In all these cases the style still indicates the organic apex of the ovary, although it may not be the apparent apex. When in a compound pistil the style of each carpel is thus displaced, it appears as if the ovary were depressed in the centre, and the style rising from the depression in the midst of the carpels seems to come from the torus. Such a style is *gynobasic*, and is well seen in Boraginaceae. The form of the style is usually cylindrical, more or less filiform and simple; sometimes it is grooved on one side, at other times it is flat, thick, angular, compressed and even petaloid, as in *Iris* (fig. 103) and *Canna*. In Goodeniaceae it ends in a cuplike expansion, enclosing the stigma. It sometimes bears hairs, which aid in the application of the pollen to the stigma, and are called *collecting hairs*, as in *Campanula*, and also in *Aster* and other Compositae. These hairs, during the upward growth of the style, come into contact with the already ripened pollen, and carry it up along with them, ready to be applied by insects to the mature stigma of other flowers. In *Vicia* and *Lobelia* the hairs frequently form a tuft below the stigma. The styles of a syncarpous pistil are either separate or united; when separate, they alternate with the septa; when united completely, the style is said to be *simple* (fig. 102). The style of a single carpel, or of each carpel of a compound pistil, may also be divided. Each division of the tricarpellary ovary of *Jatropha Curcas* has a *bifurcate* or forked style, and the ovary of *Emblica officinalis* has three styles, each of which is twice forked. The length of the style is determined by the relation which should subsist between the position of the stigma and that of the anthers, so as to allow the proper application of the pollen. The style is deciduous or persists after fertilization.

The stigma.

The *stigma* is the termination of the conducting tissue of the style, and is usually in direct communication with the placenta. It consists of loose cellular tissue, and secretes a viscid matter which detains the pollen, and causes it to germinate. This secreting portion is, strictly speaking, the true stigma, but the name is generally applied to all the divisions of the style on which the stigmatic apparatus is situated. The stigma alternates with the dissepiments of a syncarpous pistil, or, in other words, corresponds with the back of the loculaments; but in some cases it would appear that half the stigma of one carpel unites with half that of the contiguous carpel, and thus the stigma is opposite the dissepiments, that is, alternates with the loculaments, as in the poppy.

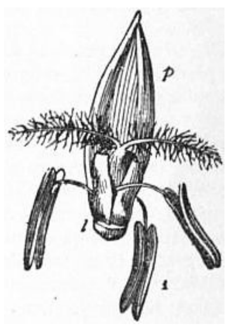


FIG. 105.—Flower of a grass with glumes removed, showing three stamens and two feathery styles. *p*, Pale; *l*, lodicules. Enlarged.

The divisions of the stigma mark the number of carpels which compose the pistil. Thus in *Campanula* a five-cleft stigma indicates five carpels; in Bignoniaceae, Scrophulariaceae and Acanthaceae, the two-lobed or bilamellar stigma indicates a bilocular ovary. Sometimes, however, as in Gramineae, the stigma of a single carpel divides. Its position may be terminal or lateral. In *Iris* it is situated on a cleft on the back of the petaloid divisions of the style (fig. 103). Some stigmas, as those of *Mimulus*, present sensitive flattened laminae, which close when touched. The stigma presents various forms. It may be globular, as in *Mirabilis Jalapa*; orbicular, as in *Arbutus Andrachne*; umbrella-like, as in *Sarracenia*, where, however, the proper stigmatic surface is beneath the angles of the large expansion of the apex of the style; ovoid, as in fuchsia; hemispherical; polyhedral; radiating, as in the poppy (fig. 104), where the true stigmatic rays are attached to a sort of *peltate* or shield-like body, which may represent depressed or flattened styles; *cucullate*, *i.e.* covered by a hood, in calabar bean. The lobes of a stigma are flat and pointed as in *Mimulus* and *Bignonia*, fleshy and blunt, smooth or granular, or they are feathery, as in many grasses (fig. 105) and other wind-pollinated flowers. In Orchidaceae the stigma is situated on the anterior surface of the column beneath the anther. In Asclepiadaceae the stigmas are united to the face of the anthers, and along with them form a solid mass.

The ovule.

The ovule is attached to the placenta, and destined to become the seed. Ovules are most usually produced on the margins of the carpellary leaves, but are also formed over the whole surface of the leaf, as in *Butomus*. In other instances they rise from the floral axis itself, either terminal, as in Polygonaceae and Piperaceae, or lateral, as in Primulaceae and Compositae. The ovule is usually contained in an ovary, and all plants in which the ovule is so enclosed are termed *angiospermous*;

but in Coniferae and Cycadaceae it has no proper ovarian covering, and is called naked, these orders being denominated *gymnospermous*. In *Cycas* the altered leaf, upon the margin of which the ovule is produced, and the peltate scales, from which they are pendulous in *Zamia*, are regarded by all botanists as carpellary leaves. As for the Coniferae great discussion has arisen regarding the morphology of parts in many genera. The carpellary leaves are sometimes united in such a way as to leave an opening at the apex of the pistil, so that the ovules are exposed, as in mignonette. In *Leontice thalictroides* (Blue Cohosh), species of *Ophiopogon*, *Peliosanthes* and *Stateria*, the ovary ruptures immediately after flowering, and the ovules are exposed; and in species of *Cuphea* the placenta ultimately bursts through the ovary and corolla, and becomes erect, bearing the exposed ovules. The ovule is attached to the placenta either directly, when it is *sessile*, or by means of a prolongation *funicle* (fig. 110, *f*). This cord sometimes becomes much elongated after fertilization. The part by which the ovule is attached to the placenta or cord is its *base* or *hilum*, the opposite extremity being its *apex*. The latter is frequently turned round in such a way as to approach the base. The ovule is sometimes embedded in the placenta, as in *Hydnora*.

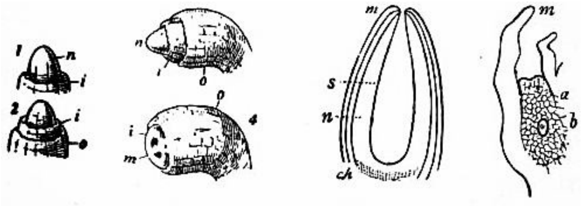


FIG. 106. FIG. 107. FIG. 108. FIG. 109.

FIGS. 106 and 107.—Successive stages in the development of an ovule. *n*, Nucellus; *i*, inner; *o*, outer integument in section; *m*, micropyle.

FIG. 108.—Orthotropous ovule of *Polygonum* in section, showing the embryo-sac *s*, in the nucellus *n*, the different ovular coverings, the base of the nucellus or chalaza *ch*, and the apex of the ovule with its micropyle *m*.

FIG. 109.—Vertical section of the ovule of the Austrian Pine (*Pinus austriaca*), showing the nucellus *a*, consisting of delicate cellular tissue containing deep in its substance an embryo-sac *b*. The micropyle *m* is very wide.

The ovule appears at first as a small cellular projection from the placenta. The cells multiply until they assume a more or less enlarged ovate form constituting what has been called the *nucellus* (fig. 106, *n*), or central cellular mass of the ovule. This nucellus may remain naked, and alone form the ovule, as in some orders of parasitic plants such as Balanophoraceae, Santalaceae, &c.; but in most plants it becomes surrounded by certain coverings or integuments during its development. These appear first in the form of cellular rings at the base of the nucellus, which gradually spread over its surface (figs. 106, 107). In some cases only one covering is formed, especially amongst gamopetalous dicotyledons, as in Compositae, Campanulaceae, also in walnut, &c. But usually besides the single covering another is developed subsequently (fig. 106, *o*), which gradually extends over that first formed, and ultimately covers it completely, except at the apex. There are thus two integuments to the nucellus, an outer and an inner. The integuments do not completely invest the apex of the nucellus, but an opening termed the *micropyle* is left. The micropyle indicates the organic apex of the ovule. A single cell of the nucellus enlarges greatly to form the *embryo-sac* or megaspore (fig. 108, *s*). This embryo-sac increases in size, gradually supplanting the cellular tissue of the nucellus until it is surrounded only by a thin layer of it; or it may actually extend at the apex beyond it, as in *Phaseolus* and *Alsine media*; or it may pass into the micropyle, as in *Santalum*. In Gymnosperms it usually remains deep in the nucellus and surrounded by a thick mass of cellular tissue (fig. 109). For an account of the further development of the megaspore, and the formation of the egg-cell, from which after fertilization is formed the embryo, see GYMNOSPERMS and ANGIOSPERMS.

The point where the integuments are united to the base of the nucellus is called the *chalaza* (figs. 111, 112). This is often coloured, is of a denser texture than the surrounding tissue, and is traversed by fibro-vascular bundles, which pass from the placenta to nourish the ovule.

When the ovule is so developed that the chalaza is at the hilum (next the placenta), and the micropyle is at the opposite extremity, there being a short funicle, the ovule is *orthotropous*. This form is well seen in Polygonaceae (fig. 112), Cistaceae, and most gymnosperms. In such an ovule a straight line drawn from the hilum to the micropyle passes along the axis of the ovule. Where, by more rapid growth on one side than on the other, the nucellus, together with the integuments, is curved upon itself, so that the micropyle approaches the hilum, and ultimately is placed close to it, while the chalaza is at the hilum, the ovule is *campylotropous* (fig. 110). Curved ovules are found in Cruciferae, and Caryophyllaceae. The inverted or *anatropous* ovule (fig. 111) is the commonest form amongst angiosperms. In this ovule the apex with the micropyle is turned towards the point of attachment of the funicle to the placenta, the chalaza being situated at the opposite extremity; and the funicle, which runs along the side usually next the placenta, coalesces with the ovule and constitutes the *raphe* (*r*), which often forms a ridge. The anatropous ovule arises from the placenta as a straight or only slightly curved cellular process, and as it grows, gradually becomes inverted, curving from the point of origin of the integuments (cf. figs. 106, 107). As the first integument grows round it, the amount of inversion increases, and the funicle becomes adherent to the side of the nucellus. Then if a second integument be formed it covers all the free part of the ovule, but does not form on the side to which the raphe is adherent. These may be taken as the three types of ovule; but there are various intermediate forms, such as *semi-anatropous* and others.

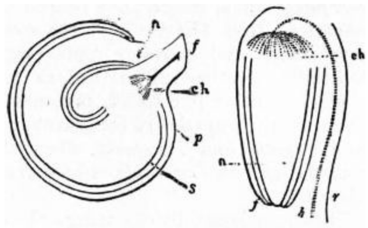


FIG. 110. FIG. 111.

FIG. 110.—Campylotropous ovule of wall-flower (*Cheiranthus*), showing the funicle *f*, which attaches the ovule to the placenta; *p*, the outer, *s*, the inner coat, *n*, the nucellus, *ch*, the chalaza. The ovule is curved upon itself, so that the micropyle is near the funicle.

FIG. 111.—Anatropous ovule of Dandelion (*Taraxacum*), *n*, nucellus, which is inverted, so that the chalaza *ch*, is removed from the base or hilum *h*, while the micropyle *f* is near the base. The connexion between the base of the ovule and the base of the nucellus is kept up by means of the raphe *r*.

The position of the ovule relative to the ovary varies. When there is a single ovule, with its axis vertical, it may be attached to the placenta at the base of the ovary (*basal placenta*), and is then *erect*, as in Polygonaceae and Compositae; or it may be inserted a little above the base, on a parietal placenta, with its apex upwards, and then is *ascending*, as in *Parietaria*. It may hang from an apicilar placenta at the summit of the ovary, its apex being directed downwards, and is *inverted* or *pendulous*, as in *Hippuris vulgaris*; or from a parietal placenta near the summit, and then is *suspended*, as in *Daphne Mezereum*, Polygalaceae and Euphorbiaceae. Sometimes a long funicle arises from a basal placenta, reaches the summit of the ovary, and there bending over suspends the ovule, as in *Armeria* (sea-pink); at other times the hilum appears to be in the middle, and the ovule becomes *horizontal*. When there are two ovules in the same cell, they may be either *collateral*, that is, placed side by side (fig. 92), or the one may be erect and the other inverted, as in some species of *Spiraea* and *Aesculus*; or they may be placed one above another, each directed similarly, as is the case in ovaries containing a moderate or definite number of ovules. Thus, in the ovary of Leguminous plants (fig. 91), the ovules, o, are attached to the extended marginal placenta, one above the other, forming usually two parallel rows corresponding to each margin of the carpel. When the ovules are *definite* (*i.e.* are uniform, and can be counted), it is usual to find their attachment so constant as to afford good characters for classification. When the ovules are very numerous (*indefinite*), while at the same time the placenta is not much developed, their position exhibits great variation, some being directed upwards, others downwards, others transversely; and their form is altered by pressure into various polyhedral shapes. In such cases it frequently happens that some of the ovules are arrested in their development and become abortive.

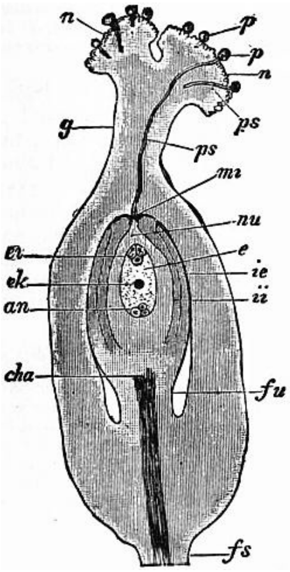


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Fig. 112.—Ovary of *Polygonum Convolvulus* in longitudinal section during fertilization. (× 48.)

fs, Stalk-like base of ovary.	*ek*, Nucleus of embryo-sac.
fu, Funicle.	*ei*, Egg-apparatus.
cha, Chalaza.	*an*, Antipodal cells.
nu, Nucellus.	*g*, Style.
mi, Micropyle.	*n*, Stigma.
ii, inner, ie, outer integument.	*p*, Pollen-grains.
e, Embryo-sac.	*ps*, Pollen-tubes.

Fertilization.

When the pistil has reached a certain stage in growth it becomes ready for fertilization. Pollination having been effected, and the pollen-grain having reached the stigma in angiosperms, or the summit of the nucellus in gymnosperms, it is detained there, and the viscid secretion from the glands of the stigma in the former case, or from the nucellus in the latter, induce the protrusion of the intine as a pollen-tube through the pores of the grain. The pollen-tube or tubes pass down the canal (fig. 112), through the conducting tissue of the style when present, and reach the interior of the ovary in angiosperms, and then pass to the micropyle of the ovule, one pollen-tube going to each ovule. Sometimes the micropyle lies close to the base of the style, and then the pollen-tube enters it at once, but frequently it has to pass some distance into the ovary, being guided in its direction by various contrivances, as hairs, grooves, &c. In gymnosperms the pollen-grain resting on the apex of the nucellus sends out its pollen-tubes, which at once penetrate the nucellus (fig. 113). In angiosperms when the pollen-tube reaches the micropyle it passes down into the canal, and this portion of it increases considerably in size. Ultimately the apex of the tube comes in contact with the tip of the embryo-sac and perforates it. The male cells in the end of the pollen-tube are then transmitted to the embryo-sac and fertilization is effected. Consequent upon this, after a longer or shorter period, those changes commence in the embryo-sac which result in the formation of the embryo plant, the ovule also undergoing changes which convert it into the seed, and fit it for a protective covering, and a store of nutriment for the embryo. Nor are the effects of fertilization confined to the ovule; they extend to other parts of the plant. The ovary enlarges, and, with the seeds enclosed, constitutes the fruit, frequently incorporated with which are other parts of the flower, as receptacle, calyx, &c. In gymnosperms the pollen-tubes, having penetrated a certain distance down the tissue of the nucellus, are usually arrested in growth for a longer or shorter period, sometimes nearly a year. Fruit and seed are discussed in a separate article—Fruit.

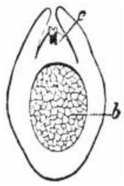


Fig. 113.—Vertical section of the ovule of the Scotch Fir (*Pinus sylvestris*) in May of the second year, showing the enlarged embryo-sac b, full of endosperm cells, and pollen-tubes c, penetrating the summit of the nucellus after the pollen has entered the large micropyle.

(A. B. R.)

FLOWERS, ARTIFICIAL. Imitations of natural flowers are sometimes made for scientific purposes (as the collection of glass flowers at Harvard University, which illustrates the flora of the United States), but more often as articles of decoration and ornament. A large variety of materials have been used in their manufacture by different peoples at different times—painted linen and shavings of stained horn by the Egyptians, gold and silver by the Romans, rice-paper by the Chinese, silkworm cocoons in Italy, the plumage of highly coloured birds in South America, wax, small tinted shells, &c. At the beginning of the 18th century the French, who originally learnt the art from the Italians, made great advances in the accuracy of their reproductions, and towards the end of that century the Paris manufacturers enjoyed a world-wide reputation. About the same time the art was introduced into England by French refugees, and soon afterwards it spread also to America. The industry is now a highly specialized one and comprises a large number of operations performed by separate hands. Four main processes may be distinguished. The first consists of cutting up the various fabrics and materials employed into shapes suitable for forming the leaves, petals, &c.; this may be done by scissors, but more often stamps are employed which will cut through a dozen or more thicknesses at one blow. The veins of the leaves are next impressed by means of a die, and the petals are given their natural rounded forms by goffering irons of various shapes. The next step is to assemble the petals and other parts of the flower, which is built up from the centre outwards; and the fourth is to mount the flower on a stalk formed of brass or iron wire wrapped round with suitably coloured material, and to fasten on the leaves required to complete the spray.

FLOYD, JOHN (1572-1649), English Jesuit, was born in Cambridgeshire in 1572. He entered the Society of Jesus when at Rome in 1592 and is also known as Daniel à Jesu, Hermannus Loemelius, and George White, the names under which he published a score of controversial treatises. He had considerable fame both as a preacher and teacher, and was frequently arrested in England. His last years were spent at Louvain and he died at St Omer on the 15th of September 1649. His brother Edward Floyd was impeached and sentenced by the Commons in 1621 for speaking disparagingly of the elector palatine.

FLOYD, JOHN BUCHANAN (1807-1863), American politician, was born at Blacksburg, Virginia, on the 1st of June 1807. He was the son of John Floyd (1770-1837), a representative in Congress from 1817 to 1829 and governor of Virginia from 1830 to 1834. After graduating at South Carolina College in 1826, the son practised law in his native state and at Helena, Arkansas, and in 1839 settled in Washington county, Virginia, which in 1847-1849 and again in 1853 he represented in the state legislature. Meanwhile, from 1849 to 1852, he was governor of Virginia, in which position he recommended to the legislature the enactment of a law laying an import tax on the products of such states as refused to surrender fugitive slaves owned by Virginia masters. In March 1857 he became secretary of war in President Buchanan's cabinet, where his lack of administrative ability was soon apparent. In December 1860, on ascertaining that Floyd had honoured heavy drafts made by government contractors in anticipation of their earnings, the president requested his resignation. Several days later Floyd was indicted for malversation in office, but the indictment was overruled on technical grounds. There is no proof that he profited by these irregular transactions; in fact he went out of the office financially embarrassed. Though he had openly opposed secession before the election of Lincoln, his conduct after that event, especially after his breach with Buchanan, fell under suspicion, and he was accused of having sent large stores of government arms to Southern arsenals in anticipation of the Civil War. In the last days of his term he apparently had such an intention, but during the year 1860 the Southern States actually received less than their full quota of arms. After the secession of Virginia he was commissioned a brigadier-general in the Confederate service. He was first employed in some unsuccessful operations in western Virginia, and in February 1862 became commander of the Confederate forces at Fort Donelson, from which he fled with his second in command, General Gideon J. Pillow, on the night of February 18, leaving General Simon B. Buckner to surrender to General Grant. A fortnight later President Davis relieved him of his command. He died at Abingdon, Virginia, on the 26th of August 1863. 574

FLOYER, SIR JOHN (1649-1734), English physician and author, was born at Hinters in Staffordshire, and was educated at Oxford. He practised in Lichfield, and it was by his advice that Dr Johnson, when a child, was taken by his mother to be touched by Queen Anne for the king's evil on the 30th of March 1714. He died on the 1st of February 1734. Floyer was an advocate of cold bathing, introduced the practice of counting the rate of the pulse-beats, and gave an early account of the pathological changes in the lungs associated with emphysema.

His writings include:—Φαρμακο-Βάσανος: *or the Touchstone of Medicines, discovering the virtues of Vegetables, Minerals and Animals, by their Tastes and Smells* (2 vols., 1687); *The praeternatural State of animal Humours described by their sensible Qualities* (1696); *An Enquiry into the right Use and Abuses of the hot, cold and temperate Baths in England* (1697); *A Treatise of the Asthma* (1st ed., 1698); *The ancient* Ψυχρολουσία *revived, or an Essay to prove cold Bathing both safe and useful* (London, 1702; several editions 8vo; abridged, Manchester, 1844, 12mo); *The Physician's Pulse-watch* (1707-1710); *The Sibylline Oracles, translated from the best Greek copies, and compared with the sacred Prophecies* (1st ed., 1713); *Two Essays: the first Essay concerning the Creation, Aetherial Bodies, and Offices of good and bad Angels; the second Essay concerning the Mosaic System of the World* (Nottingham, 1717); *An Exposition of the Revelations* (1719); *An Essay to restore the Dipping of Infants in their Baptism* (1722); *Medicina Gerocomica, or the Galenic Art of preserving old Men's Healths* (1st ed., 1724); *A Comment on forty-two Histories described by Hippocrates* (1726).

FLUDD, or Flud, **ROBERT** [Robertus de Fluctibus] (1574-1637), English physician and mystical philosopher, the son of Sir Thomas Fludd, treasurer of war to Queen Elizabeth in France and the Low Countries, was born at Milgate, Kent. After studying at St John's College, Oxford, he travelled in Europe for six years, and became acquainted with the writings of Paracelsus. He subsequently returned to Oxford, became a member of Christ Church, took his medical degrees, and ultimately became a fellow of the College of Physicians. He practised in London with success, though it is said that he combined with purely medical treatment a good deal of faith-healing. Following Paracelsus, he endeavoured to form a system of philosophy founded on the identity of physical and spiritual truth. The universe and all created things proceed from God, who is the beginning, the end and the sum of all things, and to him they will return. The act of creation is the separation of the active principle (light) from the passive (darkness) in the bosom of the divine unity (God). The universe consists of three worlds; the archetypal (God), the macrocosm (the world), the microcosm (man). Man is the world in miniature, all the parts of both sympathetically correspond and act upon each other. It is possible for man (and even for the mineral and the plant) to undergo transformation and to win immortality. Fludd's system may be described as a materialistic pantheism, which, allegorically interpreted, he put forward as containing the real meaning of Christianity, revealed to Adam by God himself, handed down by tradition to Moses and the patriarchs, and revealed a second time by Christ. The opinions of Fludd had the honour of being refuted by Kepler, Gassendi and Mersenne. Though rapt in mystical speculation, Fludd was a man of varied attainments. He did not disdain scientific experiments, and is thought by some to be the original inventor of the barometer. He was an ardent defender of the Rosicrucians, and De Quincey considers him to have been the immediate, as J.V. Andreä was the remote, father of freemasonry. Fludd died on the 8th of September 1637.

See J.B. Craven, *Robert Fludd, the English Rosicrucian* (1902), where a list of his works is given; A.E. Waite, *The Real History of the Rosicrucians* (1887); De Quincey, *The Rosicrucians and Freemasons*; J. Hunt, *Religious Thought in England* (1870), i. 240 seq. His works were published in 6 vols., Oppenheim and Gouda, 1638.

FLÜGEL, GUSTAV LEBERECHT (1802-1870), German orientalist, was born at Bautzen on the 18th of February 1802. He received his early education at the gymnasium of his native town, and studied theology and philology at Leipzig. Gradually he devoted his attention chiefly to Oriental languages, which he studied in Vienna and Paris. In 1832 he became professor at the *Fürstenschule* of St Afra in Meissen, but ill-health compelled him to resign that office in 1850, and in 1851 he went to Vienna, where he was employed in cataloguing the Arabic, Turkish and Persian manuscripts of the court library. He died at Dresden on the 5th of July 1870.

Flügel's chief work is an edition of the bibliographical and encyclopaedic lexicon of Haji Khalfa, with Latin translation (7 vols., London and Leipzig, 1835-1858). He also brought out an edition of the Koran (Leipzig, 1834 and again 1893); then followed *Concordantiae Corani arabicae* (Leipzig, 1842 and again 1898); *Mani, seine Lehren und seine Schriften* (Leipzig, 1862); *Die grammatischen Schulen der Araber* (Leipzig, 1862); and *Ibn Kutlûbugas Krone der Lebensbeschreibungen* (Leipzig, 1862). An edition of *Kitâb-al-Fihrist*, prepared by him, was published after his death.

FLÜGEL, JOHANN GOTTFRIED (1788-1855), German lexicographer, was born at Barby near Magdeburg, on the 22nd of November 1788. He was originally a merchant's clerk, but emigrating to the United States in 1810, he made a special study of the English language, and returning to Germany in 1819, was in 1824 appointed lector of the English language in the university of Leipzig. In 1838 he became American consul, and subsequently representative and correspondent of the Smithsonian Institution at Washington and several other leading American literary and scientific institutions. He died at Leipzig on the 24th of June 1855.

The fame of Flügel rests chiefly on the *Vollständige englisch-deutsche und deutsch-englische Wörterbuch*, first published in 2 vols. (Leipzig) in 1830, which has had an extensive circulation not only in Germany but in England and America. In this work he was assisted by J. Sporschil, and a new and enlarged edition, edited by his son Felix Flügel (1820-1904), was published at Brunswick (1890-1892). Another edition, in two volumes, edited by Prof. Immanuel Schmidt and S. Tanger appeared (Brunswick, London & New York) in 1906. Among his other works are—*Vollständige engl. Sprachlehre* (1824-1826); *Triglotte, oder kaufmännisches Wörterbuch in drei Sprachen, Deutsch, Englisch und Französisch* (1836-1840); *Kleines Kaufmännisches Handwörterbuch in drei Sprachen* (1840); and *Praktisches Handbuch der engl. Handelscorrespondenz* (1827, 9th ed. 1873). All these have passed through several editions. In addition, Flügel also published in the English language: *A series of Commercial Letters* (Leipzig, 1822), a 9th edition of which appeared in 1874 under the title *Practical Mercantile Correspondence* and a *Practical Dictionary of the English and German Languages* (2 vols., Hamburg and Leipzig, 1847-1852; 15th ed., Leipzig, 1891). The last was continued and re-edited by his son Felix.

FLUKE (probably connected with the Ger. *flach*, flat), a name given to several kinds of fish, flat in shape, especially to the common flounder; also the name of a trematoid worm, resembling a flounder in shape, which as a parasite infects the liver and neighbouring organs of certain animals, especially sheep, and causes liver-rot. The most common is the *Fasciola hepatica* (see Trematodes). It is also the name of a species of kidney potato. Probably from a resemblance to the shape of the fish, "fluke" is the name given to the holding-plates, triangular in shape, at the end of the arms of an anchor, and to the triangular extremities of the tail of a whale. The use of the word as a slang expression for a lucky accident appears to have been first applied in billiards to an unintentional scoring shot.

FLUME (through an O. Fr. word *flum*, from the Lat. *flumen*, a river), a word formerly used for a stream, and particularly for the tail of a mill-race. It is used in America for a very narrow gorge running between precipitous rocks, with a stream at the bottom, but more frequently is applied to an artificial channel of wood or other material for the diversion of a stream of water from a river for purposes of irrigation, for running a sawmill, or for various processes in the hydraulic method of gold-mining (see Aqueduct).

FLUMINI MAGGIORE, a town of the province of Cagliari, Sardinia, 10 m. by road N. of Iglesias, and 5 m. from the W. coast. Pop. (1901) town 3908; commune 9647. It is the centre of a considerable lead and zinc mining district. Three miles to the S. are the ruins of a temple erected probably in the time of Commodus (*Corpus inscr. Lat.* x., Berlin, 1883, No. 7539). They seem to mark the site of Metalla (mines), a station on the coast road from Sulci to Tharros, and the centre of the mining district in Roman times. At Flumini Maggiore itself were found two ingots of lead, one bearing a stamp with Hadrian’s name.

FLUORANTHENE, $C_{15}H_{10}$, also known as idryl, a hydrocarbon occurring with phenanthrene, pyrene, diphenyl, and other substances in “Stupp” fat (the fat obtained in working up the mercury ores in Idria), and also in the higher boiling fractions of the coal tar distillate. It was discovered by R. Fittig in 1878, who, with Gebhard and H. Liepmann, elucidated its constitution (see *Ann.*, 1879, 200, p. 1). The hydrocarbons are separated from the “Stupp” by means of alcohol, the soluble portion on distillation giving first phenanthrene and then a mixture of pyrene and fluoranthene. From the tar distillate, the chrysene can be fractionally precipitated, and the fluoranthene can be separated from most of the pyrene by fractional distillation in a partial vacuum. In either case the two hydrocarbons are finally separated by fractional crystallization of their picrates, which are then decomposed by ammonia. Fluoranthene crystallizes in large slender needles or monoclinic tables, melting at 109-110° C. and boiling at 250-251° C. (60 mm.). It is easily soluble in hot alcohol, ether and carbon bisulphide. On oxidation with chromic acid it forms a quinone, $C_{15}H_8O_2$, and an α-diphenylene ketocarboxylic acid $\begin{matrix} C_6H_4 > CO \\ C_6H_3 - CO_2H \end{matrix}$. The picrate melts at 182-183° C.

FLUORENE (α-diphenylene methane), $C_{13}H_{10}$ or $(C_6H_4)_2CH_2$, a hydrocarbon found in coal-tar. It is obtained from the higher boiling fractions, after separation of naphthalene and anthracene, by fractional distillation, the portion boiling between 290-340° C. being taken. The fluorene is separated from this by placing it in a freezing mixture, and is then redistilled or crystallized from glacial acetic acid, or purified by means of its picrate. It may be prepared by distilling diphenylene ketone over zinc dust, or by heating it with hydriodic acid and phosphorus to 150-160° C.; and also by passing the vapour of diphenyl methane through a red hot tube. It crystallizes in colourless plates, possessing a violet fluorescence, melting at 112-113° and boiling at 293-295° C. By oxidation with chromic acid in glacial acetic acid solution, it is converted into diphenylene ketone $(C_6H_4)_2 \cdot CO$; whilst on heating with hydriodic acid and phosphorus to 250-260° C. it gives a hydro derivative of composition $C_{18}H_{22}$.

FLUORESCEIN, or Resorcin-Phthalein, $C_{20}H_{12}O_5$, in chemistry, a compound discovered in 1876 by A. v. Baeyer by the condensation of phthalic anhydride with resorcin at 195-200° C. (*Ann.*, 1876, 183, p. 1). The two reacting substances are either heated alone or with zinc chloride for some hours, and the melt obtained is boiled out with water, washed by dilute alcohol, extracted by means of sodium hydrate, and the solution so obtained is precipitated by an acid. The precipitate is well washed with water and then dried. By repeating this process two or three times, the fluorescein may be obtained in a very pure condition. It forms a yellow amorphous powder, insoluble in water but soluble in alcohol, and crystallizing from the alcoholic solution in small dark red nodules. It is readily soluble in solutions of the caustic alkalis, the solution being of a dark red colour and showing (especially when largely diluted with water) a brilliant green fluorescence. It was so named on account of this last character. By brominating fluorescein in glacial acetic acid solution, *eosin* (tetrabromfluorescein) is obtained, the same compound being formed by heating 3.5-dibrom-2.4-dioxybenzoylbenzoic acid above its melting point (R. Meyer, *Ber.*, 1895, 28, p. 1576). It crystallizes from alcohol in yellowish red needles, and dyes silk, wool, and mordanted cotton a fine pink colour. When heated with caustic alkalis it yields dibromresorcin and dibrommonoresorcin-phthalein. The corresponding iodo compound is known as *erythrosin*. Fluorescein is readily nitrated, yielding a di- or tetra-nitro compound according to conditions. The entrance of the negative nitro group into the molecule weakens the central pyrone ring in the fluorescein nucleus and the di- and tetra-nitro compounds readily yield hydrates (see J.T. Hewitt and B.W. Perkins, *Jour. Chem. Soc.*, 1900, p. 1326). By the action of ammonia or amines the di-nitro fluoresceins are converted into yellow dyestuffs (F. Reverdin, *Ber.*, 1897, 30, p. 332). Other dyestuffs obtained from fluorescein are safrosine or eosin scarlet (dibromdinitrofluorescein) and rose Bengal (tetraiodotetrachlorfluorescein).

On fusion with caustic alkali, fluorescein yields resorcin, $C_6H_4(OH)_2$, and monoresorcin phthalein (dioxybenzoylbenzoic acid), $(HO)_2C_6H_3 \cdot CO \cdot C\ H_4 \cdot COOH$. With zinc dust and caustic soda it yields fluorescin. By warming fluorescein with excess of phosphorus pentachloride it yields fluorescein chloride, $C_{20}H_{10}O_3Cl_2$ (A. Baeyer), which crystallizes from alcohol in small prisms, melting at 252° C. When heated with aniline and aniline hydrochloride, fluorescein yields a colourless anilide (O. Fischer and E. Hepp, *Ber.*, 1893, 26, p. 2236), which is readily methylated by methyl iodide and potash to a fluoresceinanilidedimethyl ether, which when heated for six hours to 150° C. with acetic and hydrochloric acids, is hydrolysed and yields a colourless fluoresceindimethyl ether, which melts at 198° C. On the other hand, by heating fluorescein with caustic potash, methyl iodide and methyl alcohol, a coloured (yellow) dimethyl ether, melting at 208° C. is obtained (Fischer and Hepp). By heating the coloured dimethyl ether with caustic soda, the monomethyl ether is obtained (O. Fischer and E. Hepp, *Ber.*, 1895, 28, p. 397); this crystallizes in triclinic tables, and melts at 262° C. It is to be noted that the colourless monomethyl ether fluoresces strongly in alkaline solution, the dimethyl ether of melting point 208° fluoresces only in neutral solution (*e.g.*, in alcoholic solution), and the dimethyl ether of melting point 198° C. only in concentrated hydrochloric or sulphuric acid solution (Fischer and Hepp). Considerable discussion has taken place as to the position held by the hydroxyl groups in the fluorescein molecule, C. Graebe (*Ber.*, 1895, 28, p. 28) asserting that they were in the ortho position to the linking carbon atom of the phthalic anhydride residue. G. Heller (*Ber.*, 1895, 28, p. 312), however, showed that monoresorcin-phthalein when brominated in glacial acetic acid gives a dibrom derivative which, with fuming sulphuric acid, yields dibromxanthopurpurin (1.3-dioxy-2.4-dibromanthraquinone), a reaction which is only possible if the fluorescein (from which the monoresorcin-phthalein is derived) contains free hydroxyl groups in the para position to the linking carbon atom of the phthalic anhydride residue.

FLUORESCENCE. In a paper read before the Royal Society of Edinburgh in 1833, Sir David Brewster described a remarkable phenomenon he had discovered to which he gave the name of “internal dispersion.” On admitting a beam of sunlight, condensed by a lens, into a solution of chlorophyll, the green colouring matter of leaves (see fig. 1), he was surprised to find that the path of the rays within the fluid was marked by a bright light of a blood-red colour, strangely contrasting with the beautiful green of the fluid when seen in moderate thickness. Brewster afterwards observed the same phenomenon in various vegetable solutions and essential oils, and in some solids, amongst which was fluor-spar. He believed this effect to be due to coloured particles held in suspension. A few years later, Sir John Herschel independently discovered that if a solution of quinine sulphate, which, viewed by transmitted light, appears colourless and transparent like water, were illuminated by a beam of ordinary daylight, a peculiar blue colour was seen in a thin stratum of the fluid adjacent to the surface by which the light entered. The blue light was unpolarized and passed freely through many inches of the fluid. The incident beam, after having passed through the stratum from which the blue light came, was not sensibly enfeebled or coloured, but yet it had lost the power of producing the characteristic blue colour when admitted into a second solution of quinine sulphate. A beam of light modified in this mysterious manner was called by Herschel “epipolized.” Brewster showed that epipolic was merely a particular case of internal dispersion, peculiar only in this respect, that the rays capable of dispersion were dispersed with unusual rapidity.

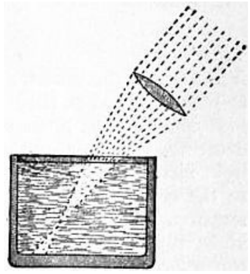


Fig. 1.

The investigation of this phenomenon was afterwards taken up by Sir G.G. Stokes, to whom the greater part of our present knowledge of the subject is due. Stokes’s first paper “On the Change of the Refrangibility of Light” appeared in 1852. He repeated the experiments of Brewster and Herschel, and considerably extended them. These experiments soon led him to the conclusion that the effect could not be due, as Brewster had imagined, to the scattering of light by suspended particles, but that the dispersed beam actually differed in refrangibility from the light which excited it. He therefore termed it “true internal dispersion” to distinguish it from the scattering of light, which he called “false internal dispersion.” As this name, however, is apt to suggest Brewster’s view of the phenomenon, he afterwards abandoned it as unsatisfactory, and substituted the word “fluorescence.” This term, derived from fluor-spar after the analogy of opalescence from opal, does not presuppose any theory. To examine the nature of the fluorescence produced by quinine, Stokes formed a pure spectrum of the sun’s rays in the usual manner. A test-tube, filled with a dilute solution of quinine sulphate, was placed just outside the red end of the spectrum and then gradually moved along the spectrum to the other extremity. No fluorescence was observed as long as the tube remained in the more luminous portion, but as soon as the violet was reached, a ghost-like gleam of blue light shot right across the tube. On continuing to move the tube, the blue light at first increased in intensity and afterwards died away, but not until the tube had been moved a considerable distance into the ultra-violet part of the spectrum. When the blue gleam first appeared it extended right across the tube, but just before disappearing it was confined to a very thin stratum on the side at which the exciting rays entered. Stokes varied this experiment by placing a vessel filled with the dilute solution in a spectrum formed by a train of prisms. The appearance is illustrated diagrammatically in fig. 2. The greater part of the light passed freely as if through water, but from about half-way between the Fraunhofer lines G and H to far beyond the extreme violet, the incident rays gave rise to light of a sky-blue colour, which emanated in all directions from the portion of the fluid (represented white in fig. 2) which was under the influence of the incident rays. The anterior surface of the blue space coincided, of course, with the inner surface of the glass vessel. The posterior surface marked the distance to which the incident rays were able to penetrate before they were absorbed. This distance was at first considerable, greater than the diameter of the vessel, but decreased with great rapidity as the refrangibility of the incident light increased, so that from a little beyond the extreme violet to the end, the blue space was reduced to an excessively thin stratum. This shows that the fluid is very opaque to the ultra-violet rays. The fixed lines in the violet and invisible part of the solar spectrum were represented by dark lines, or rather planes, intersecting the blue region. Stokes found that the fluorescent light is not homogeneous, for on reducing the incident rays to a narrow band of homogeneous light, and examining the dispersed beam through a prism, he found that the blue light consisted of rays extending over a wide range of refrangibility, but not into the ultra-violet.

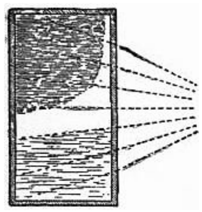


Fig. 2.

Another method, which Stokes found especially useful in examining different substances for fluorescence, was as follows. Two coloured media were prepared, one of which transmitted the upper portion of the spectrum and was opaque to the lower portion, while the second was opaque to the upper and transparent to the lower part of the spectrum. These were called by Stokes “complementary absorbents.” No pair could be found which were exactly complementary, of course, but the condition was approximately fulfilled by several sets of coloured glasses or solutions. One such combination consisted of a deep-blue solution of ammioniacal copper sulphate and a yellow glass coloured with silver. The two media together were almost opaque. The light of the sun being admitted through a hole in the window-shutter, a white porcelain tablet was laid on a shelf fastened in front of the hole. If the vessel containing the blue solution was placed so as to cover the hole, and the tablet was viewed through the yellow glass, scarcely any light entered the eye, but if a paper washed with some fluorescent liquid were laid on the tablet it appeared brilliantly luminous. Different pairs of complementary absorbents were required according to the colour of the fluorescent light. This experiment shows clearly that the light which passed through the first absorbent and which would have been stopped by the second gave rise in the fluorescent substance to rays of a different wave-length which were transmitted by the second absorbent. Scattered light, with which the true fluorescent light was often associated, was eliminated by this method, being stopped by the second absorbent.

Stokes also used a method, analogous to Newton’s method of crossed prisms, for the purpose of analysing the fluorescent light. A spectrum was produced by means of a slit and a prism, the slit being horizontal instead of vertical. The resulting very narrow spectrum was projected on a white paper moistened with a fluorescent solution, and viewed through a second prism with its refracting edge perpendicular to that of the first prism. In addition to the sloping spectrum seen under ordinary circumstances, another spectrum due to the fluorescent light alone, made its appearance, as seen in figs. 3 and 4. In this spectrum the colours do not run from left to right, but in horizontal lines. Thus the dark lines of the solar spectrum lie across the colours. The spectra in figs. 3 and 4 were obtained by V. Pierre with an improved arrangement of Stokes’s method. It will be seen that, in the case of chlorophyll, the whole spectrum, far into the ultra-violet, gives rise to a short range of red fluorescent light, while the effective part of the exciting light in the case of aesculin (a glucoside occurring in horse-chestnut bark) begins a little above the fixed line G and the fluorescent light covers a wide range extending from orange to blue.

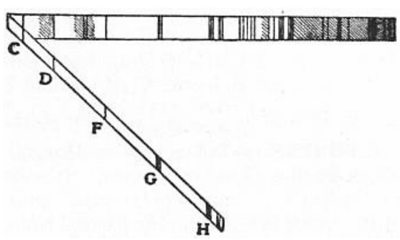


Fig. 3.—Spectrum of Chlorophyll.

Besides the substances already mentioned, a large number of vegetable extracts and some inorganic bodies are strongly fluorescent. Stokes found that most organic substances show signs of fluorescence. Green fluor-spar from Alston Moor exhibits a violet, uranium glass a yellowish-green fluorescence. Tincture of turmeric gives rise to a greenish light, and the extract of seeds of *Datura stramonium* a pale green light. Ordinary paraffin oil fluoresces blue. Barium platinocyanide, which is much used in the fluorescent screens employed in work with the Röntgen rays, shows a brilliant green fluorescence with ordinary light. Crystals of magnesium platinocyanide possess the remarkable property of emitting a polarized fluorescent light, the colour and plane of polarization depending on the position of the crystal with respect to the incident beam, and, if polarized light is used, on the plane of polarization of the latter.

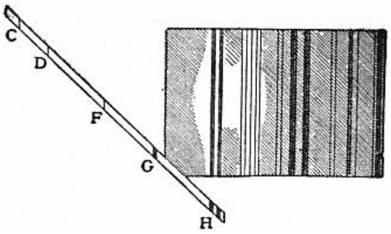


Fig. 4.—Spectrum of Aesculin.

Stokes's Law.—In all the substances examined by Stokes, the fluorescent light appeared to be of lower refrangibility than the light which excited it. Stokes considered it probable that this lowering of the refrangibility of the light was a general law which held for all substances. This is known as Stokes's law. It has been shown, however, by E. Lommel and others, that this law does not hold generally. Lommel distinguishes two kinds of fluorescence. The bodies which exhibit the first kind are those which possess strong absorption bands, of which only one remains appreciable after great dilution. These bodies are always strongly coloured and show anomalous dispersion and (in solids) surface colour. In such cases, the maximum of intensity in the fluorescent spectrum corresponds to the maximum of absorption. Stokes's law is not obeyed, for a fluorescent spectrum can be produced by means of homogeneous light of lower refrangibility than a great part of the fluorescent light. The second kind of fluorescence is the most common, and is exhibited by bodies which show absorption only in the upper part of the spectrum, *i.e.* they are usually yellow or brown or (if the absorption is in the ultra-violet) colourless. The absorption bands also are different from those of substances of the first kind, for they readily disappear on dilution. A third class of bodies is formed by those substances which exhibit both kinds of fluorescence.

Nature of Fluorescence.—No complete theory of fluorescence has yet been given, though various attempts have been made to explain the phenomenon. Fluorescence is closely allied to phosphorescence (*q.v.*), the difference consisting in the duration of the effect after the exciting cause is removed. Liquids which fluoresce only do so while the exciting light is falling on them, ceasing immediately the exciting light is cut off. In the case of solids, on the other hand, such as fluor-spar or uranium glass, the effect, though very brief, does not die away quite instantaneously, so that it is really a very brief phosphorescence. The property of phosphorescence has been generally attributed to some molecular change taking place in the bodies possessing it. That some such change takes place during fluorescence is rendered probable by the fact that the property depends upon the state of the sensitive substance; some bodies, such as barium platinocyanide, fluorescing in the solid state but not in solution, while others, such as fluorescein, only fluoresce in solution. Fluorescence is always associated with absorption, but many bodies are absorbent without showing fluorescence. A satisfactory theory would have to account for these facts as well as for the production of waves of one period by those of another, and the non-homogeneous character of the fluorescent light. Quite recently W. Voigt has sought to give a theory of fluorescence depending on the theory of electrons. Briefly, this theory assumes that the electrons which constitute the molecule of the sensitive body can exist in two or more different configurations simultaneously, and that these are in dynamical equilibrium, like the molecule in a partially dissociated gas. If the electrons have different periods of vibration in the different configurations, then it would happen that the electrons whose period nearly corresponded with that of the incident light would absorb the energy of the latter, and if they then underwent a transformation into a different configuration with a different period, this absorbed energy would be given out in waves of a period corresponding to that of the new configuration.

Applications of Fluorescence.—The phenomenon of fluorescence can be utilized for the purpose of illustrating the laws of reflection and refraction in lecture experiments since the path of a ray of light through a very dilute solution of a sensitive substance is rendered visible. The existence of the dark lines in the ultra-violet portion of the solar spectrum can also be demonstrated in a simple manner. In addition to the foregoing applications, Stokes made use of this property for studying the character of the ultra-violet spectrum of different sources of illumination and flames. He suggested also that the property would in some cases furnish a simple test for the presence of a small quantity of a sensitive substance in an organic mixture. Fluorescent screens are largely used in work with Röntgen rays. There appears to be some prospect of light being thrown on the question of molecular structure by experiments on the fluorescence of vapours. Some very interesting experiments in this direction have been performed by R.W. Wood on the fluorescence of sodium vapour.

References.—Sir G.G. Stokes, *Mathematical and Physical Papers*, vols. iii. and iv.; Müller-Pouillet, *Lehrbuch der Physik*, Bd. ii. (1897); A. Wullner, *Lehrbuch der Experimentalphysik*, Bd. iv. (1899); A.A. Winkelmann, *Handbuch der Physik*, Bd. vi. (1906); R.W. Wood, *Physical Optics* (1905).

(J. R. C.)

FLUORINE (symbol F, atomic weight 19), a chemical element of the halogen group. It is never found in the uncombined condition, but in combination with calcium as fluor-spar CaF_2 it is widely distributed; it is also found in cryolite Na_3AlF_6, in fluor-apatite, $CaF_2 \cdot 3Ca_3P_2O_8$, and in minute traces in sea-water, in some mineral springs, and as a constituent of the enamel of the teeth. It was first isolated by H. Moissan in 1886 by the electrolysis of pure anhydrous hydrofluoric acid containing dissolved potassium fluoride. The U-shaped electrolytic vessel and the electrodes are made of an alloy of platinum-iridium, the limbs of the tube being closed by stoppers made of fluor-spar, and fitted with two lateral exit tubes for carrying off the gases evolved. Whilst the electrolysis is proceeding, the apparatus is kept at a constant temperature of −23° C. by means of liquid methyl chloride. The fluorine, which is liberated as a gas at the anode, is passed through a well cooled platinum vessel, in order to free it from any acid fumes that may be carried over, and finally through two platinum tubes containing sodium fluoride to remove the last traces of hydrofluoric acid; it is then collected in a platinum tube closed with fluor-spar plates. B. Brauner (*Jour. Chem. Soc.*, 1894, 65, p. 393) obtained fluorine by heating potassium fluorplumbate $3KF \cdot HF \cdot PbF_4$. At 200° C. this salt decomposes, giving off hydrofluoric acid, and between 230-250° C. fluorine is liberated.

Fluorine is a pale greenish-yellow gas with a very sharp smell; its specific gravity is 1.265 (H. Moissan); it has been liquefied, the liquid also being of a yellow colour and boiling at -187° C. It is the most active of all the chemical elements; in contact with hydrogen combination takes place between the two gases with explosive violence, even in the dark, and at as low a temperature as −210° C; finely divided carbon burns in the gas, forming carbon tetrafluoride; water is decomposed even at ordinary temperatures, with the formation of hydrofluoric acid and "ozonised" oxygen; iodine, sulphur and phosphorus melt and then inflame in the gas; it liberates chlorine from chlorides, and combines with most metals instantaneously to form fluorides; it does not, however, combine with oxygen. Organic compounds are rapidly attacked by the gas.

Only one compound of hydrogen and fluorine is known, namely *hydrofluoric acid*, HF or H_2F_2, which was first obtained by C. Scheele in 1771 by decomposing fluor-spar with concentrated sulphuric acid, a method still used for the commercial preparation of the aqueous solution of the acid, the mixture being distilled from leaden retorts and the acid stored in leaden or gutta-percha bottles. The perfectly anhydrous acid is a very volatile colourless liquid and is best obtained, according to G. Gore (*Phil. Trans.*, 1869, p. 173) by decomposing the double fluoride of hydrogen and potassium, at a red heat in a platinum retort fitted with a platinum condenser surrounded by a freezing mixture, and having a platinum receiver luted on. It can also be prepared in the anhydrous condition by passing a current of hydrogen over dry silver fluoride. The pure acid thus obtained is a most dangerous substance to handle, its vapour even when highly diluted with air having an exceedingly injurious action on the respiratory organs, whilst inhalation of the pure vapour is followed by death. The anhydrous acid boils at 19°.5 C. (H. Moissan), and on cooling, sets to a solid mass at −102°.5 C, which melts at −92°.3 C. (K. Olszewski, *Monats. für Chemie*, 1886, 7, p. 371). Potassium and sodium readily dissolve in the anhydrous acid with evolution of hydrogen and formation of fluorides. The aqueous solution is strongly acid to litmus and dissolves 578
most metals directly. Its most important property is that it rapidly attacks glass, reacting with the silica of the glass to form gaseous silicon fluoride, and consequently it is used for etching. T.E. Thorpe (*Jour. Chem. Soc.*, 1889, 55, p. 163) determined the vapour density of hydrofluoric acid at different temperatures, and showed that there is no approach to a definite value below about 88° C. where it reaches the value 10.29 corresponding to the molecular formula HF; at temperatures below 88° C. the value increases rapidly, showing that the molecule is more complex in its structure. (For references see J.N. Friend, *The Theory of Valency* (1909), p. 111.) The aqueous solution behaves on concentration similarly to the other halogen acids; E. Deussen (*Zeit. anorg. Chem.*, 1905, 44, pp. 300, 408; 1906, 49, p. 297) found the solution of constant boiling point to contain 43.2% HF and to boil at 110° (750 mm.).

The salts of hydrofluoric acid are known as *fluorides* and are easily obtained by the action of the acid on metals or their oxides, hydroxides or carbonates. The fluorides of the alkali metals, of silver, and of most of the heavy metals are soluble in water; those of the alkaline earths are insoluble. A characteristic property of the alkaline fluorides is their power of combining with a molecule of hydrofluoric acid and with the fluorides of the more electro-negative elements to form double fluorides, a behaviour not shown by other metallic halides. Fluorides can be readily detected by their power of etching glass when warmed with sulphuric acid; or by warming them in a glass tube with concentrated sulphuric acid and holding a moistened glass rod in the mouth of the tube, the water apparently gelatinizes owing to the decomposition of the silicon fluoride formed. The atomic weight of fluorine has been determined by the conversion of calcium, sodium and potassium fluorides into the corresponding sulphates. J. Berzelius, by converting silver fluoride into silver chloride, obtained the value 19.44, and by analysing calcium fluoride the value 19.16; the more recent work of H. Moissan gives the value 19.05.

See H. Moissan, *Le Fluor et ses composes* (Paris, 1900).

FLUOR-SPAR, native calcium fluoride (CaF_2), known also as Fluorite or simply Fluor. In France it is called fluorine, whilst the term fluor is applied to the element (F). All these terms, from the Lat. *fluere*, “to flow,” recall the fact that the spar is useful as a flux in certain metallurgical operations. (Cf. its Ger. name *Flussspat* or *Fluss*.)

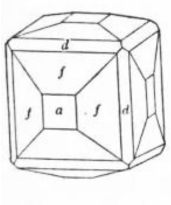


Fig. 1.

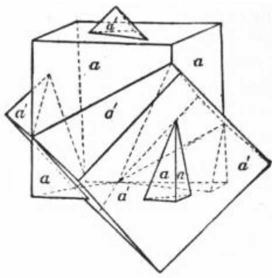


Fig. 2.

Fluor-spar crystallizes in the cubic system, commonly in cubes, either alone or combined with the octahedron, rhombic dodecahedron, four-faced cube, &c. The four-faced cube has been called the fluoroid. In fig. 1, *a* is the cube (100), *d* the rhombic dodecahedron (110), and *f* the four-faced cube (310). Fig. 2 shows a characteristic twin of interpenetrant cubes. The crystals are sometimes polysynthetic, a large octahedron, *e.g.*, being built up of small cubes. The faces are often etched or corroded. Cleavage is nearly always perfect, parallel to the octahedron.

Fluor-spar has a hardness of 4, so that it is scratched by a knife, though not so readily as calcite. Its specific gravity is about 3.2. The colour is very variable, and often beautiful, but the mineral is too soft for personal decoration, though it forms a handsome material for vases, &c. In some fluor-spar the colour is disposed in bands, regularly following the contour of the crystal. As the colour is usually expelled, or much altered, by heat, it is believed to be due to an organic pigment, and the presence of hydrocarbons has been detected in many specimens by G. Wyrouboff, and other observers. H.W. Morse (*Proc. Amer. Acad.*, 1906, p. 587) obtained carbon monoxide and dioxide, hydrogen and nitrogen and small quantities of oxygen from Weardale specimens by heating. He concluded that the gases are due to the decomposition of an organic colouring matter, which has, however, no connexion with the fluorescence or thermo-luminescence of the mineral. Certain crystals from Cumberland are beautifully fluorescent, appearing purple with a bluish internal haziness by reflected light, and greenish by transmitted light. Fluor-spar, though cubic, sometimes exhibits weak double refraction, probably due to internal tension. Many kinds of fluor-spar are thermo-luminescent, *i.e.* they glow on exposure to a moderate heat, and the name of chlorophane has been given to a variety which exhibits a green glow. The mineral also phosphoresces under the Röntgen rays. Cavities containing liquid occasionally occur in crystals of fluor-spar, notably in the greasy green cubes of Weardale in Durham. A dark violet fluor-spar from Wölsendorf in Bavaria, evolves an odour of ozone when struck, and has been called antozonite. Ozone is also emitted by a violet fluor-spar from Quincié, dep. Rhône, France. In both cases the spar evolves free fluorine, which ozonizes the air.

Fluor-spar is largely employed by the metallurgist, especially in lead-smelting, and in the production of ferro-silicon and ferro-manganese. It is also used in iron and brass foundries, and has been found useful as a flux for certain gold-ores and in the reduction of aluminium. It is used as a source of hydrofluoric acid, which it evolves when heated with sulphuric acid. The mineral is also used in the production of opal glass and enamel ware. In consequence of its low refractive and dispersive power, colourless pellucid fluor-spar is valuable in the construction of apochromatic lenses, but this variety is rare. The dark violet fluor-spar of Derbyshire, known locally as “Blue John,” is prized for ornamental purposes. It occurs almost exclusively at Tray Cliff, near Castleton. The dark purple spar, called by the workmen “bull beef,” may be changed, by heat, to a rich amethystine tint. Being very brittle, the spar is rather difficult to work on the lathe, and is often toughened by means of resin. F. Corsi, the eminent Italian antiquary, held that fluor-spar was the material of the famous murrhine vases.

Fluor-spar is a mineral of very wide distribution. Some of the finest crystals occur in the lead-veins of the Carboniferous Limestone series in the north of England, especially at Weardale, Allendale and Alston Moor. It is also found in the lead and copper-mines of Cornwall and S. Devon, notably near Liskeard, where fine crystals have been found, with faces of the six-faced octahedron replacing the corners of the cube. In Cornwall fluor-spar is known to the miners as “cann.” Fine yellow fluor-spar occurs in some of the Saxon mines, and beautiful rose-red octahedra are found in the Alps, near Göschenen. Many localities in the United States yield fluor-spar, and it is worked commercially in a few places, notably at Rosiclare in southern Illinois.

FLUSHING, formerly a township and a village of Queens county, New York, U.S.A., on Long Island, at the head of Flushing Bay, since the 1st of January 1898 a part of the borough of Queens, New York City. Flushing is served by the Long Island railroad and by electric lines. It was settled in 1644 by a company of English non-conformists who had probably been residents of Flushing in Holland, from which the new place took its name. Subsequently a large number of Quakers settled here, and in 1672 George Fox spent some time in the township. Before the War of Independence Flushing was the country-seat of many rich New Yorkers and colonial officials.

FLUSHING (Dutch *Vlissingen*), a fortified seaport in the province of Zeeland, Holland, on the south side of the island of Walcheren, at the mouth of the estuary of the western Scheldt, 4 m. by rail S. by W. of Middelburg, with which it is also connected by steam tramway and by a ship canal. There is a steam ferry to Breskens and Ter Neuzen on the coast of Zeeland-Flandres. Pop. (1900) 18,893. An important naval station and fortress up to 1867, Flushing has since aspired, under the care of the Dutch government, to become a great commercial port. In 1872 the railway was opened which, in conjunction with the regular day and night service of steamers to Queenborough in the county of Kent, forms one of the 579
main routes between England and the east of Europe. In 1873 the great harbour, docks and canal works were completed. Yet the navigation of the port remains far behind that of Rotterdam or Antwerp, the tonnage being in 1899 about 7.9% of that of the kingdom. As a summer resort, however, Flushing has acquired considerable popularity, sea-baths and a large modern hotel being situated on the fine beach about three-quarters of a mile north-west of the town. It possesses a town hall, containing a collection of local antiquities, a theatre, an exchange, an academy of sciences and a school of navigation. The Jakobskerk, or Jacob’s church, founded in 1328, contains monuments to Admiral de Ruyter (1607-1676) and the poet Jacob Bellamy (1757-1786), who were natives of Flushing. The chief industries of the town are connected with the considerable manufacture of machinery, the state railway-workshops, shipbuilding yards, Krupp iron and steel works’ depot, brewing, and oil and soap manufacture. The chief imports are colonial produce and wine, wood and coal. The exports include agricultural produce (wheat and beans), shrimps and meat.

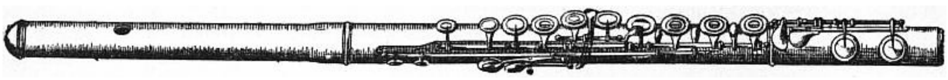
FLUTE, a word adapted from O. Fr. *fleüte*, modern *flûte*; from O. Fr. have come the Span. *flauta*, Ital. *flauto* and Ger. *Flöte*. The *New English Dictionary* dismisses the derivations suggested from Lat. *flatuare* or *flavitare*; ultimately the word must be referred to the root seen in “blow,” Lat. *flare*, Ger. *blasen*, &c.

1. In music “flute” is a general term applied to wood-wind instruments consisting of a pipe pierced with lateral holes and blown directly through the mouthpiece without the intervention of a reed. The flute family is classified according to the mouthpiece used to set in vibration the column of air within the tube: *i.e.* (1) the simple lateral mouth-hole or embouchure which necessitates holding the instrument in a transverse position; (2) the whistle or fipple mouthpiece which allows the performer to hold the instrument vertically in front of him. There is a third class of pipes included among the flutes, having no mouthpiece of any sort, in which the column of air is set in vibration by blowing obliquely across the open end of the pipe, as in the ancient Egyptian nay, and the pan-pipe or syrinx (*q.v.*). The transverse flute has entirely superseded the whistle flute, which has survived only in the so-called penny whistle, in the “flute-work” of the organ (*q.v.*), and in the French flageolet.

The Transverse Flute or *German Flute* (Fr. *flûte traversière*, *flûte allemande*: Ger. *Flöte*, *Querflöte*, *Zwerchpfeiff*, *Schweitzerpfeiff*; Ital. *flauto traverso*) includes the *concert flute* known both as flute in C and as flute in D, the piccolo (*q.v.*) or octave flute, and the fife (*q.v.*). The modern flute consists of a tube open at one end and nominally closed at the other by means of a plug or cork stopper: virtually, however, the tube is an open one giving the consecutive harmonic series of the open pipe or of a stretched string. The primitive flute was made in one piece, but the modern instrument is composed of three adjustable joints. (1) The head-joint, plugged at the upper end and containing at about one-third of the length the mouth-hole or embouchure. This embouchure, always open when the instrument is being played, converts the closed tube into an open one, in an acoustical sense. (2) The body, containing the holes and keys necessary to produce the scale which gave the flute its original designation of D flute, the head and body together, when the holes are closed, giving the fundamental note D. Before the invention of keys, this fundamental note and the notes obtained by the successive opening of the six holes produced the diatonic scale of D major. All other semitones were obtained by what is known as cross fingering (Fr. *doigté fourchu*; Ger. *Gabelgriffe*). It became usual to consider this the typical fingering nomenclature, whatever the fundamental note given out by the flute, and to indicate the tonality by the note given out when the six lateral holes are covered by the fingers. The result is that the tonality is always a tone lower than the name of the instrument indicates. Thus the D flute is really in C, the F flute is E♭, &c. (3) The foot-joint or tail-joint containing the two additional keys for C♯ and C which extend the compass downwards, completing the chromatic scale of C in the fundamental octave.

The compass of the modern flute is three octaves with chromatic semitones from  The sound is produced by holding the flute transversely with the embouchure turned slightly outwards, the lower lip resting on the nearer edge of the embouchure, and blowing obliquely across, not into, the orifice. The flat stream of air from the lips, known as the air-reed, breaks against the sharp outer edge of the embouchure. The current of air, thus set in a flutter, produces in the stationary column of air within the tube a series of pulsations or vibrations caused by the alternate compression and rarefaction of the air and generating sounds of a pitch proportional to the length of the stationary column, which is practically somewhat longer than the length of the tube.[1] The length of this column is varied by opening the lateral finger-holes. The current or air-reed thus acts upon the air column within the flute, without passing through the tube, as a plectrum upon a string, setting it in vibration. The air column of the flute is the sound-producer, whereas in instruments with reed mouthpieces the vibrating reed is more properly the sound-producer, while the air column, acting as a resonating medium, reinforces the note of the reed by vibrating synchronously with it. If the angle[2] at which the current of air is directed against the outer edge of the embouchure be made less acute and the pressure of the breath be at the same time increased, the frequency of the alternate pulses of compression and rarefaction within the tube will be increased two, three or fourfold, forming a corresponding number of nodes and loops which results in harmonics or upper partials, respectively the octave, the twelfth, the double octave. By this means sounds of higher pitch are produced without actually shortening the length of the column of air by means of lateral holes. The acoustic theory of sound-production in the flute is one on which there is great diversity of opinion. The subject is too vast to be treated here, but readers who wish to pursue it may consult the works of Rockstro,[3] Helmholtz,[4] and others.[5] The effect of boring lateral holes in pipes is to shorten the vibrating length of the air column, which may be regarded as being effective only between the hole in question and the mouthpiece. In order to obtain this result the diameter of the hole should be equal to that of the bore; as long as the holes were covered by the fingers, this was obviously impossible. The holes, therefore, being smaller than the laws of acoustics demand, have to be placed proportionally nearer the mouthpiece in order to avoid deepening the pitch and deadening the tone. This principle was understood by wind-instrument makers of classic Greece (see Aulos and Clarinet), and has been explained by Chladni[6] and Gottfried Weber.[7]

From Captain Day's *Catalogue, &c.*, by permission of Messrs. Eyre & Spottiswoode.
Fig. 1.—Eight-keyed Cone Flute by Richard Potter. 18th century.



Messrs. Rudall, Carte & Co.
Fig. 2.—Boehm Cylinder Flute. Rockstro Model.

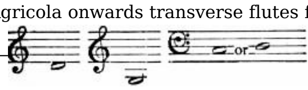
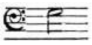
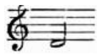
The bore of the early flute with six finger-holes was invariably cylindrical throughout, but towards the end of the 17th century a modification took place, the head joint alone remaining cylindrical while the rest of the bore assumed the form of a cone having its smallest diameter at the open end of the tube. 580 The conoidal bore greatly improved the quality of tone and the production of the higher harmonics of the third octave. Once the conical bore had been adopted, the term flute was exclusively applied to the new instruments, the smaller flutes, then cylindrical, used in the army being designated fife (*q.v.*). At the present day in England, France and America, the favourite mode of construction is that introduced by Theobald Boehm, and known as the "cylinder flute with the parabolic head," of which more will be said further on. The successive opening of the holes and keys on the flute produces the chromatic scale of the first or fundamental octave. By increasing the pressure of the breath and slightly altering the position of the lips over the mouth-hole, the same fingering produces the notes of the fundamental octave in the next octave higher. The third octave of the compass is obtained by the production of the higher harmonics (Fr. *sons harmoniques*; Ger. *Flageolettöne*), of the fundamental scale, facilitated by the opening of certain of the finger-holes as "vent holes." The quality of tone depends somewhat on the material of which the flute is made; silver and gold produce a liquid tone of exquisite delicacy suitable for solo music, cocus-wood and ebonite a rich mellow tone of considerable power suitable for orchestral music. The tone differs further in the three registers, the lowest being slightly rough, the medium sweet and elegiac, and the third bird-like and brilliant. The proportions, position and form of the stopper and of the air chamber situated between it and the embouchure are mainly influential in giving the flute its peculiar slightly hollow timbre, due to the paucity of the upper partials of which according to Helmholtz[8] only the octave and twelfth are heard. Mr Blaikley[9] states, however, that when the fundamental D is played, he can discern the seventh partial. The technical capabilities of the flute are practically unlimited to a good player who can obtain sustained notes diminuendo and crescendo, diatonic and chromatic scales and arpeggios both legato and staccato, leaps, turns, shakes, &c. By the articulation with the tongue of the syllables *te-ke* or *ti-ke* repeated quickly for groups of double notes, or of *te-ke-ti* for triplets, an easy effective staccato is produced, known respectively as *double* or *triple tonguing*, a device understood early in the 16th century and mentioned by Martin Agricola,[10] who gives the syllables as *de* for sustained notes, di-ri for shorter notes, and *tel-lel-lel* for staccato passages in quick tempo.[11]

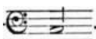
Musical instruments, such as flutes, in which a column of air is set in vibration by regular pulsations derived from a current of air directed by the lips of the executant against the side of the orifice serving as embouchure, appear to be of very ancient origin. The Hindus, Chinese and Japanese claim to have used these modes of blowing from time immemorial. The ancient Egyptians had a long pipe held obliquely and blown across the end of the pipe itself at its upper extremity; it was known as *Saïb-it*[12] and was frequently figured on the monuments. The same instrument, called "nay," is still used in Mahommedan countries. The oblique aulos of the Greeks, plagiaulos,[13] was of Egyptian origin and was perhaps at first blown from the end as described above,[14] since we know that the Greeks were familiar with that method of blowing in the syrinx or pan-pipe. The instruments preserved at the British Museum[15] having lateral embouchures show, however, that they were also acquainted—probably through the Hindus—with the transverse flute, although in the case of these specimens a reed must have been inserted into the mouth-hole or no sound would have been obtained.

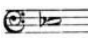
FIG. 3.—Transverse Flute. 1st or 2nd century A.D. From the Tope at Amarābati, British Museum.

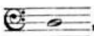
The high antiquity of a lateral embouchure in Europe is generally admitted; the flute evidently penetrated from the East at some period not yet determined. A transverse flute is seen on Indian sculptures of the Gandhara school showing Greek influence, and dating from the beginning of our era (fig. 3). But although the transverse flute was evidently known to the Greeks and Romans, it did not find the same favour as the reed instruments known as auloi. We have no evidence of the survival of the transverse flute after the fall of the Roman empire until it filtered through from Byzantine sources during the early middle ages. Instances of the flute occur on a group of caskets[16] of Italo-Byzantine work of the 9th or 10th century, while of purely Byzantine origin we find examples of flutes in Greek MSS.[17] preserved in Paris, at the British 581 Museum and elsewhere. There is moreover in the cathedral of St Sophia at Kiev[18] an orchestra depicted on frescoes said to date from the 11th century; among the musicians is a flautist.

The first essentially western European trace of the transverse flute occurs in a German MS. of the 12th century, the celebrated *Hortus deliciarum* of the abbess Herrad von Landsperg.[19] Fol. 221 shows a syren playing upon the transverse flute, which Herrad explains in a legend as *tibia*; in the vocabulary the latter is translated swegel. In the 13th century it occurs among the miniatures of the fifty-one musicians in the beautiful MS. *Las Cantigas de Santa Maria* in the Escorial, Madrid.[20] Eustache Deschamps, a French poet of the 14th century, in one of his ballads, makes mention of the "flute traversaine," and we are justified in supposing that he refers to the transverse flute. It had certainly acquired some vogue in the 15th century, being figured in an engraving in Sebastian Virdung's celebrated work,[21] where it is called "Zwerchpfeiff," and, with the drums, it already constituted the principal element of the military music. Agricola (*op. cit.*) alludes to it as the "Querchpfeiff" or "Schweizerpfeiff," the latter designation dating, it is said, from the battle of Marignan (1515), when the Swiss troops used it for the first time in war.

From Agricola onwards transverse flutes formed a complete family, said to comprise the discant, the alto and tenor, and the bass—  respectively. Praetorius[22] designates the transverse flute as "Flauta traversa' Querpfeiff" and "Querflöt," and gives the pitch of the bass in  the tenor and alto in  and the discant in  as varieties then in use. A flute concert at that time included two discants, four altos or tenors, and two basses. The same author distinguishes between the "Traversa" and the "Schweizerpfeiff" or fife (which he also calls "Feldpfeiff," *i.e.* military flute), although the construction was the same. There were two kinds of "Feldpfeiff," in  and  respectively; they were employed exclusively with the military drum.

Mersenne's[23] account of the transverse flute, then designated "flûte d'Allemagne" or "flûte allemande" in France, and an "Air de Cour" for four flutes in his work lead us to believe that there were then in use in France the soprano flute in  the tenor or alto flute in  and the bass flute descending to . The museum of the Conservatoire Royal of Brussels possesses specimens of all these varieties except the last. All of them are laterally pierced with six finger-holes; they have a cylindrical bore, and are fashioned out of a single piece of wood. Their compass consists of two octaves and a fifth. Mersenne's tablature for fingering the flute differs but little from those of Hotteterre-le-Romain[24] and Eisel[25] for the diatonic scale; he does not give the chromatic semitones and the flute had as yet no keys.

The largest bass flute in the Brussels museum is in  at the French normal pitch A 435 double vibrations per second. It measures 0.95 m. from the centre of the blow orifice to the lower extremity of the tube. The disposition of the lateral holes is such that it is impossible to cover them with the fingers if the flute is held in the ordinary way. The instrument must be placed against the mouth in an almost vertical direction, inclining the extremity of the tube either to the right or the left. This inconvenient position makes it necessary that the instrument should be divided into two parts, enabling the player to turn the head joint that the embouchure may be most commodiously approached by the lips, which is not at all easy. The first and fourth of the six lateral holes are double in order to accommodate both right- and left-handed players, the holes not in use being stopped up with wax. The bass flute shown in fig. 4 is the facsimile of an instrument in the Museo Civico of Verona. The original, unfortunately no longer fit for use, is nevertheless sufficiently well preserved to allow of all its proportionate measurements being given. The lowest note, E♭, is obtained with a remarkable amplitude of sound, thus upsetting a very prevalent opinion that it is impossible to produce by lateral insufflation sounds which go a little lower than the ordinary limit downwards of the modern orchestral flute.[26]

The bass flute cited by Mersenne should not differ much from that of the Museo Civico at Verona. We suppose it to have been in , and that it was furnished with an open key like that which was applied to the recorders (*flûtes douces*) of the same epoch, the function of the key being to augment by another note the compass of the instrument in the lower part. A bass flute in G similar to the one in fig. 5 is figured and described in Diderot and D'Alembert's encyclopaedia [27] (1751). According to Quantz,[28] it was in France and about the middle of the 17th century that the first modifications were introduced in the manufacture of the flute. The improvements at this period consisted of the abandonment of the cylindrical bore in favour of a conical one, with the base of the cone forming the head of the instrument. At the same time the flute was made of three separate pieces called head, body, and tail or foot, which were ultimately further subdivided. The body or middle joint was divided into two pieces, so that the instrument could be tuned to the different pitches then in use by a replacement with longer or shorter pieces. It was probably about 1677, when Lully introduced the German flute into the opera, that recourse was had for the first time to keys, and that the key of D# was applied to the lower part of the instrument.[29] The engraving of B. Picart, dated 1707, given in Hotteterre's book, represents the flute as having reached the stage of improvement of which we have just spoken. In 1726 Quantz,[30] finding himself in Paris, had a second key applied to the flute, placed nearly at the same height as the first, that of the , intended to differentiate the D# and the E♭.[31] This innovation was generally well received in Germany, but does not appear to have met with corresponding success in other countries. In France and England manufacturers adopted it but rarely; in Italy it was declared useless.[32] About the same time flutes were 582 constructed with the lower extremity lengthened sufficiently to produce the fundamental C, and furnished with a supplementary key to produce the C♯. This innovation, spoken of by Quantz,[33] did not meet with a very favourable reception, and was shortly afterwards abandoned. Passing mention may be made of the drawing of a flute with a C key in the *Music-Saal* of J.F.B. Majer (Nuremberg, 1741), p. 45.

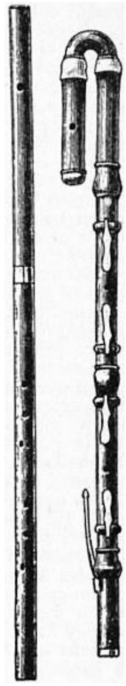


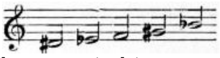
Fig. 4. Fig. 5.

Fig. 4.—Bass Flute. From Museo Civico, Verona (facsimile).

Fig. 5.—Bass Flute. Brussels Museum.

The tuning of the instrument to different pitches was effected by changes in the length, and notably by substituting a longer or shorter upper piece in the middle joint. So wide were the differences in the pitches then in use that seven such pieces for the upper portion of it were deemed necessary. The relative proportions between the different parts of the instrument being altered by these modifications in the length, it was conceived that the just relation could be re-established by dividing the foot into two pieces, below the key. These two pieces were adjusted by means of a tenon, and it was asserted that, in this way, the foot could be lengthened proportionately to the length of the middle joint. Flutes thus improved took the name of "flûtes à registre." The register system was, about 1752, applied by Quantz to the head joint[34] and, the embouchure section being thus capable of elongation, it was allowable to the performer, according to the opinion of this professor, to lower the pitch of the flute a semitone, without having recourse to other lengthening pieces, and without disturbing the accuracy of intonation.

The upper extremity of the flute, beyond the embouchure orifice, is closed by means of a cork stopper. On the position of this cork depends, in a great measure, the accurate tuning of the flute. It is in its right place when the accompanying octaves  are true. Quantz, in speaking of this accessory, mentions the use of a nut-screw to give the required position to the cork.[35] He does not name the inventor of this appliance, but, according to Tromlitz,[36] the improvement was due to Quantz himself. The invention goes back to 1726.

When the *Method* of Quantz appeared there were still in use, besides the orchestral flute in D, the little fourth flute in G, the low fourth flute in A, and the flûte d'amour a note higher; in France they had, moreover, the little octave flute in D (octave). A bass flute in D had also been attempted (see fig. 5). When Ribock published his *Bemerkungen über die Flöte*[37] the flute had already the five keys here shown.  This author states that the inventor of these new keys is not known to him, but that either Kusder, a musical instrument-maker in London, or Johann Georg Tromlitz of Leipzig was the originator, since he has not been able to trace those keys on the flutes of any other maker. Although Tromlitz does not claim for himself the invention of the keys for F, G♯ and B♭, he states that "he had occupied himself for several years in applying these keys so as not to augment the difficulty of playing, but on the contrary to render the handling of them as easy as possible."[38] In the later work published in 1800,[39] however, he seems to attribute the invention of these keys to Richard Potter of London; he says that he has never yet been fortunate enough to come across a good flute by that maker—"the flute has certainly gained by the addition of the keys for F, G♯ and B♭, but this is not everything, for on such a flute much must perforce be left unattempted.... Only a flute with eight keys according to my invention is capable of everything." It would seem, moreover, from circumstantial evidence stated clearly and on good authority by Rockstro[40] that the keys for F, G♯ and B♭ must have been used first in England and made by Richard Potter before 1774. The higher key of C adopted from 1786 by Tromlitz, we believe to have been first recommended by Ribock (1782).[41] Tromlitz in *Über Flöten* describes at length what may be termed the first systematic effort to overcome the difficulties created by the combination of open holes and closed keys. He attempted to solve the question by determining the positions of the holes according to the exigencies of fingering instead of subordinating them to the more arbitrary theories connected with the musical scale.

In 1785 Richard Potter improved Quantz's slide applied to the head joint as well as to the register of the foot by a double system of tubes forming double sliding air-tight joints. In the document[42] describing this improvement Potter patented the idea of lining the holes with silver tubes and of adapting metal conical valves to the keys. Potter's patent conical valves were an adaptation of the contrivance first invented by J.F. Boie or Boye of Göttingen,[43] who used pewter for the plugs, and silver for lining the holes. The keys mentioned in the patent were four—D♯, F, G♯, A♯. The idea of extending the compass of the flute downwards was taken up again about the same time by two players of the flute in London named Tacet and Florio. They devised a new disposition of the keys C and C#, and confided the execution of their invention to Potter. In Dr Arnold's *New Instructions for the German Flute* occurs a tablature, the engraving of which goes back to the end of the 18th century, and bears the following title, "A Complete Drawing and Concise Scale and Description of Tacet and Florio's new invented German Flute, with all the additional keys explained." It explains the use of six keys—C, C♯, D♯, F, G♯, A♯—that are not always figured, because the employment of so many keys was at once admitted. Tromlitz himself, who, however, made flutes with nine keys—adding E♭, another F, and C♮, declared that he was not in favour of so great a complication, and that he preferred the flute with only two keys, D♯ and E♭, with a register foot joint and a cork nut-screw at the head joint. This instrument met all requirements. He was always much opposed to the use of the old keys for C♮ and C♯, because they altered the recognised quality of tone of the instrument. When Tromlitz published his method, the family of flutes had become modified. It comprehended only the typical flute in D, the flûte d'amour a minor third lower, a "third" flute a minor third higher, and, finally, the little octave flute.

While Tromlitz was struggling in Germany with the idea of augmenting the compass of the flute downwards by employing open keys for C♮ and C♯, an Italian, Giovanni Batista Orazi,[44] increased the scale of the instrument downwards by the application of five new keys, viz. B, B♭, A, A♭, and G. At the same time that he produced this invention [45] he conceived the plugging of the lateral holes by the valve keys then recently invented by Potter. But it was hardly possible to obtain a perfect plugging of seven lateral holes with the aid of as many keys, for the control of which there were only the two little fingers, and therefore this invention of Orazi proved a failure.

In 1808 the Rev. Frederick Nolan,[46] of Stratford, near London, conceived an open key, the lever of which, terminating by a ring, permitted the closing of a lateral hole at the same time the key was being acted upon. The combination in this double action is the embryo of the mechanism that a little later was to transform the system of the flute. Two years later Macgregor,[47] a musical-instrument maker in London, constructed a bass flute an octave lower than the ordinary flute. The idea was not new, as is proved by the existence of the bass flute mentioned above. The difference between the two instruments lies in the mechanism of the keys. That employed by Macgregor consisted of a double lever, a contrivance dating from before the middle of the 18th century, of which the application is seen in an oboe of large dimensions preserved in the National Museum at Munich.[48]

In 1811 Johann Nepomuk Capeller invented the extra D[natural] hole and key, which is still in constant use on every flute of modern construction.[49]

About 1830 the celebrated French flautist Tulou added two more keys, those of F♯ and C♯, and a key, called "de cadence," to facilitate the accompanying shakes.

To increase the number of keys, to improve their system of plugging, and to extend the  scale of the instrument in the lower region,—these had hitherto been the principal problems dealt with in the improvement of the flute. No maker, no inventor to whose labours we have called attention, had as yet devoted his attention to the rational division of the column of air by means of the lateral holes. In 1831 Theobald Boehm, a Bavarian, happening to be in London, was struck with the power of tone the celebrated English performer Charles Nicholson drew from his instrument. Boehm learned, and not without astonishment, that his English colleague obtained this result by giving the lateral holes a much greater diameter than was then usually admitted. About the same time Boehm made the acquaintance of an amateur player named Gordon, who had effected certain improvements; he had bored the lateral hole for the lower E, and had covered it with a key, while he had replaced the key for F with a ring. These innovations set Boehm about attempting a complete reform of the instrument.[50] He went resolutely to work, and during the year 1832 he produced the new flute 583 which bears his name. This instrument is distinguished by a new mechanism of keys, as well as by larger holes disposed along the tube in geometrical progression.

Boehm's system had preserved the key of G♯ open; Coche,[51] a professor in the Paris Conservatoire, assisted by Auguste Buffet the younger, a musical-instrument maker in that city, modified Boehm's flute by closing the G♯ with a key, wishing thus to render the new fingering more conformable to the old. He thus added a key, facilitating the shake upon C♯ with D♯, and brought about some other changes in the instrument of less importance.

Boehm had not, however, altered the bore of the flute, which had been conical from the end of the 17th century. In 1846, however, he made further experiments, and the results obtained were put in practice by the construction of a new instrument, of which the body was given a cylindrical bore, while the diameter of the head was modified at the embouchure, the head-joint becoming parabolic (see fig. 2). The inventor thus obtained a remarkable equality in the tones of the lower octave, a greater sonorousness, and a perfect accuracy of intonation, by establishing the more exact proportions which a column of air of cylindrical form permitted.

The priority of Boehm's invention was long contested, his detractors maintaining that the honour of having reconstructed the flute was due to Gordon. But an impartial investigation vindicates the claim of the former to the invention of the large lateral holes.[52] His greatest title to fame is the invention of the mechanism which allows the production of the eleven chromatic semitones intermediate between the fundamental note and its first harmonic by means of eleven holes so disposed that in opening them successively they shorten the column of air in exact proportional quantities.[53] Boehm (*Essays*, &c.) published a diagram or scheme to be adopted in determining the position of the note-holes of wind instruments for every given pitch. This diagram gives the position of the intermediate holes which he had been enabled to establish by a rule of proportion based on the law of the lengths of strings.

The Boehm flute, notwithstanding the high degree of perfection it has reached, has not secured unanimous favour; even now there are players who prefer the ordinary flute. The change of fingering required for some notes, the great delicacy and liability to derangement of the mechanism, have something to do with this. In England especially, the ordinary flute retains many partisans, thanks to the improvements introduced by a clever player, Abel Siccama, in 1845 (Patent No. 10,553). He bored the lateral holes of E and A lower, and covered them with open keys. He added some keys, and made a better disposition of the other lateral holes, of which he increased the diameter, producing thus a sonorousness almost equal to that of the Boehm flute, while yet preserving the old fingering for the notes of the first two octaves. But in spite of these improvements the old flute will not bear an impartial comparison with that of Boehm.

A flute constructed on a radically new system by Signor Carlo Tommaso Georgi and introduced in 1896 places the technique of the instrument on an entirely new and simple basis. The principal features of this flute consist in an embouchure placed at the upper extremity of the tube instead of at the side, which allows the instrument to be held in a perpendicular position; no tuning cork is required. There are eleven holes mathematically placed in the tube which give the semitones of the scale; there are no keys. The eleven holes are fingered by the fingers and thumbs, the C♯ hole being closed by the side of the left fore-finger. All the notes are obtained by means of simple fingering as far as G♯ of the third octave, the remaining notes of which are produced by cross-fingering. For the convenience of players with short fingers keys can be added, and the head of the Georgi flute can be used with any cylinder flute. The compass of the Georgi flute is almost the same as that of the concert flute; viz. 

If the lower C and C♯ are required, extra holes and keys can be added. Everything that is possible on the Boehm flute is possible on the Georgi and more, owing to the simplicity of the fingering; each finger having but one duty to perform, all trills are equally easy. The tone is the true flute tone, brilliant and sympathetic.[54]

The old English *fipple flute*, or *flûte à bec*, is described under the headings Recorder and Flageolet.

(V. M.; K. S.)

2. In architecture the name "flute" is given to the vertical channels (segmental, semicircular or elliptical in horizontal section) employed on the shafts of columns in the classic styles. The flutes are separated one from the other by an "arris" in the Doric order and by a "fillet" in the Ionic and Corinthian orders. The earliest fluted columns are those in Egypt, at first with plain faces without any sinking, subsequently at Karnac (1400 B.C.) with a segmental sinking equal in depth to about one-seventh of the width of the flute. The columns flanking one of the "beehive" tombs at Mycenae have segmental flutes and are the earliest Greek examples. In two of the earliest Doric temples at Metapontum and Syracuse (temple of Apollo) the flutes are also segmental, but in later examples in order to emphasize the arris they were formed of three arcs and are known as "false ellipses," and this applies to nearly all the fluting in Greek examples whether belonging to the Doric, Ionic or Corinthian orders. The number of flutes varies, there being 52 in the archaic temple of Diana at Ephesus and from 30 to 52 flutes in the Persian columns according to the diameter of the column. In the Greek Doric column 20 is the usual number, but there are 16 only in the temples of Sunium, Assos, Segesta and the temple of Apollo at Syracuse; 18 in one of the temples of Selinus and the temple of Diana at Syracuse, and 24 in the temple of Neptune at Paestum. The depth of the flute also varies; in the Propylaea at Athens the radius is equal to the width of the flute and the flute is segmental. In the Parthenon the radius of the central part of the flute is greater than the width, but the smaller arcs on either side accentuate better the arris. A similar accentuation is found in the Ionic and Corinthian orders, where the flutes are separated by fillets, and their section is always elliptical in Greek work, the depth of the flute, however, being always greater than in the Doric order. Thus, in the temple of Ilissus and the Ionic column in the cella of the temple at Bassae,

the depth is about one-quarter of the width, in the Propylaea at Priene it is about one-third, and in the Erechtheum and other examples of the Greek Ionic order it is little more than one-half. The width of the fillet also varies, being as a rule one quarter of the width of the flute; and the same applies to the Greek Corinthian order. In the Roman Doric, Ionic and Corinthian orders, the flute is either segmental or semicircular, its depth being about one third of the width in the Doric column, and in all Ionic, Corinthian and Composite columns half the width of the flute. The fillet also is much broader in Roman examples, being about one-third of the width of the flute. In Roman columns sometimes the flutes of the lower part of the shaft, about one-third of the height, are partly filled with a convex moulding, “cabling” being the usual term applied to this treatment. The French architects of the 16th and 17th centuries carried this decorative feature much farther, and in the Tuileries and the Louvre carved a series of leaves in the flutes. In a few Italian buildings, instead of the fluting of the column being vertical, it twines round the column and is known as spiral fluting; a fine example is found in the Bevilacqua palace at Verona by San Michele. Fluting is sometimes introduced into capitals, as in the tomb of Mylasa, and in friezes, as in the theatre at Cnidos, the Incantada at Salonica, and a doorway at Patara. In one of the museums at Rome is a fine sarcophagus, the sides of which are sculptured with flutes in waved lines. The coronas of many of the Roman temples were carved with flutes. In medieval buildings, fluting was occasionally introduced in imitation of Roman work, as in the churches of central Syria and of Autun and Langres in France, but in the south of Italy and Sicily it would seem to have been brought in as a variety of treatment, in the decoration of the shafts carrying the arches of cloisters, as at Monreale in Sicily and in those of St John Lateran and St Paul-outside-the-Walls at Rome.

(R. P. S.)

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1 See E.F.F. Chladni, *Die Akustik* (Leipzig, 1802), p. 87.

2 See Sonreck, “Über die Schwingungserregung und die Bewegung der Luftsäule in offenen und gedeckten Röhren,” *Pogg. Ann.*, 1876, vol. 158.

3 *The Flute* (London, 1890), § 90-105, pp. 34-40.

4 *Theorie der Luftschwingungen in Röhren mit offenen Enden* (Berlin, 1896). Ostwald’s *Klassiker der exacten Wissenschaften*, No. 80.

5 V.C. Mahillon, *Experimental Studies on the Resonance of Trunco-Conical and Cylindrical Air Columns*, translated by F.A. Mahan (London, 1901); D.J. Blaikley, *Acoustics in Relation to Wind Instruments* (London, 1890); Friedrich Zamminer, *Die Musik und die musikalischen Instrumente, &c.* (Giessen, 1855); *idem.* “Sur le mouvement vibratoire de l’air dans les tuyaux,” *Comptes rendus*, 1855, vol. 41, &c.

6 *Op. cit.*, § 73, pp. 87-88, note 1.

7 “Akustik der Blasinstrumente,” *Allgem. musikal. Zeit.* (Leipzig, 1816), Bd. xviii. No. 5, p. 65 et seq. See also Ernst Euting, *Zur Geschichte der Blasinstrumente im 16. und 17. Jahrhundert.* Inaugural Dissertation, Friedrich-Wilhelms Universität. (Berlin, 15th of March 1899), p. 9.

8 *Lehre von der Tonempfindung* (Braunschweig, 1877).

9 See additions by D. J. B. to article “Flute” in Grove’s *Dictionary of Music and Musicians* (London, 1904).

10 *Musica instrumentalis deutsch* (Wittenberg, 1528).

11 See also L’Artusi, *Delle imperfettioni della musica moderna* (Venice, 1600), p. 4; Gottfried Weber in Cäcilia, Bd. ix. p. 99.

12 See “Les Anciennes Flûtes égyptiennes,” by Victor Loret in *Journal asiatique* (Paris, 1889), vol. xiv. p. 133 et seq., two careful articles based on the ancient Egyptian instruments still extant. See also Lauth, “Über die ägyptische Instrumente,” *Sitzungs. der philos., philolog. und histor. Klasse. der Kgl. bayer. Akad. zu München* (1873).

13 See Albert A. Howard, “The Aulos or Tibia,” *Harvard Studies*, iv. (Boston, 1893), pp. 16-17.

14 Representations of flutes blown as here described have been found in Europe. See *Comptes rendus de la commission impériale archéologique* (St Petersburg, 1867), p. 45, and atlas for the same date, pl. vi. Pompeian painting given by Helbig, *Wandgemälde*, No. 7607; Zahn, vol. iii. pl. 31; Museo Borbonnico, pl. xv. No. 18; Clarac, pl. 130, 131, 139; Heuzey, *Les Figurines*, p. 136.

15 There are two flutes at the British Museum (Catal. No. 84, 4-9 and 5 and 6), belonging to the Castellani collection, made of wood encased in bronze in which the mouthpiece, consisting of the head of a maenad, has a lateral hole bored obliquely into the main tube. This hole was probably intended for the reception of a reed. The pipe is stopped at the end beyond the mouthpiece as in the modern flute. There are six holes. See also the plagiaulos from Halicarnassus in the British Museum described by C.T. Newton in *History of Discoveries at Halicarnassus* (London), vol. ii. p. 339. The Louvre has two ancient statues (from the villa Borghese) representing satyrs playing upon transverse flutes. Unfortunately these marbles have been restored, especially in the details affecting our present subject, and are therefore examples of no value to us. Another statue representing a flute-player occurs in the British Museum. The instrument has been supposed to be a transverse flute, but erroneously, for the insufflation of the lateral tube against which the instrumentalist presses his lips, could not, without the intervention of a reed, excite the vibratory movement of the column of air.

16 Florence, Carrand Collection. See Museo Nazionale Firenze, *Catalogo* (1898), p. 205, No. 26 (description only). Illustration in *Gallerie nazionali italiane*, A. Venturi, vol. iii. (1897), p. 263, L’Arte (Rome, 1894), vol. i. p. 24, Hans Graeven, “Antike Vorlagen byzantinischer Elfenbeinreliefs,” in *Jahrb. d. K. Preuss. Kunst-Sammlungen* (Berlin, 1897), Bd. xviii. p. 11; Hans Graeven, “Ein Reliquienkästchen aus Pirano,” id., 1899, Bd. xx. fig. 2 and pl. iii.

17 Greek MS. 510, Grégoir de Nazance 10th century, Bibliothèque Nationale, Paris; illustration in Gustave L. Schlumberger, *L’Épopée byzantine à la fin du dizième siècle* (Paris, 1896 and 1900), vol. i. p. 503. British Museum, Greek Psalter, add. MS. 19352, fol. 189b. written and illuminated cir. 1066 by Theodorus of Caesarea. A cylindrical flute is shown turned to the right, the left hand being uppermost. Smyrna, Library of the Evaggelike Schole B. 18, fol. 72a, A.D. 1100, illustration by Strzygowski, “Der Bilderkreis des griechischen Physiologus,” in *Byzantinisches Archiv* (Leipzig, 1899), Heft 2, Taf. xi.; N.P. Kondakoff, *Histoire de l’art byzantin* (Paris, 1886 and 1891), pl. xii. 5; “Kuseyr’ Amra,” issued by *K. Akad. d. Wissenschaften* (Vienna, 1907), vol. ii. pl. xxxiv.

18 A fine volume containing coloured drawings of these frescoes has been published in St Petersburg (British Museum library catalogue, sect. “Academies,” St Petersburg, 1874-1887, vol. iv. Tab. 1325a).

19 This manuscript, written towards the end of the 12th century, was preserved in the Strassburg library until 1870, when it was burnt during the bombardment of the city. See the fine reproduction in facsimile published by the *Soc. pour la conservation des monuments historiques d’Alsace.* Texte explicatif de A. Straub and G. Keller (Strassburg, 1901), pl. lvii., also C.M. Engelhardt, *Herrad von Landsperg und ihr Werk* (Stuttgart and Tübingen, 1818), twelve plates.

20 MS. j. b. 2. Illustrated in *Critical and Bibliographical Notes on Early Spanish Music* (London, 1887), p. 119.

21 *Musica getutscht und auszgezogen* (Basel, 1511).

22 *Organographia* (Wolfenbüttel. 1618), pp. 24, 25, 40.

23 *Harmonie universelle* (Paris, 1636), *Livre* v. p. 241.

24 Principes de la flûte traversière ou flûte d’Allemagne, de la flûte à bec et du hautbois (Paris, 1722), p. 38.

25 *Musicus* αὐτοδιδακτός *oder der sich selbst informirende Musicus* (Erfurt, 1738), p. 85.

26 Fétis, *Rapport sur la fabrication des instruments de musique à l’Exposition Universelle de Paris, en 1855*.

27 See *Recueil de planches*, vol. iv., and article “Basse de flûte traversière,” vol. ii. (Paris, 1751). See also *The Flute*, by R.S.

Rockstro (London, 1890), p. 238, where the wood cut is reproduced together with a translation of the article. The Museum of the Conservatoire in Paris also possesses a bass flute by the noted French maker Delusse.

28 *Versuch einer Anweisung die Flöte traversière zu spielen* (Berlin, 1752).

29 Unless the contrary is stated, we have always in view, in describing the successive improvements of the flute, the treble flute in D, which is considered to be typical of the family.

30 "Herrn Johann Joachim Quantzens-Lebenslauf, von ihm selbst entworfen," in the *Historisch-Kritische Beyträge zur Aufnahme der Musik*, by Marpurg (Berlin, 1754), p. 239. Quantz was professor of the flute to Frederick the Great.

31 See Johann Georg Tromlitz, *Ausführlicher und gründlicher Unterricht die Flöte zu spielen* (Leipzig, 1791), 1, § 7, and *Über Flöten mit mehrern Klappen* (Leipzig, 1800), cap. vii. § 21.

32 Antonio Lorenzoni, *Saggio per ben sonare il flauto traverso* (Vicenza, 1779).

33 See *Anweisung*, i. § 15.

34 See *Lebenslauf*, *loc. cit.* p. 248, where Quantz states that he invented the adjustable head for the flute.

35 See *Anweisung*, i. §§ 10-13 and iv. § 26.

36 *Ausführlicher und gründlicher Unterricht die Flöte zu spielen* (Leipzig, 1791), i. cap. § 20. Compare Schilling, *Univ.-Lexikon* (Leipzig, 1835).

37 Stendal, 1782 (published under his initials only, J. J. H. R., see p. 2).

38 *Kurze Abhandlung von Flötenspielen* (Leipzig, 1786), p. 27.

39 *Über Flöten*, &c., pp. 133 and 134.

40 See *The Flute*, pp. 242-244 and 561 and 562.

41 See *op. cit.* pp. 51 and 62.

42 English patent, No. 1499.

43 See Rockstro, *op. cit.* p. 197.

44 *Saggio per costruire e suonare un flauto traverso enarmonico che ha i suoni bassi del violino* (Rome, 1797).

45 The idea of this large flute was taken up again in 1819 by Trexler of Vienna, who called it the "panaulon."

46 Patent, No. 3183. Part of the specification together with a diagram is reproduced by Rockstro, *op. cit.* pp. 273-274.

47 Patent, No. 3349. Part of the specification together with a diagram is reproduced by Rockstro, *op. cit.* pp. 273-274.

48 Another specimen, almost the same, constructed about 1775, and called "Basse de Musette," may be seen in the Museum of the Paris Conservatoire.

49 See account of Capeller's inventions by Carl Maria von Weber in *Allgem. musikal. Zeit.* (Leipzig, 1811), pp. 377-379, a translation of which is given by Rockstro, *op. cit.* pp. 279 and 280.

50 See *Über den Flötenbau und die neuesten Verbesserungen desselben* (Mainz, 1847); and W.S. Broadwood, *An Essay on the Construction of Flutes originally written by Theobald Boehm, published with the addition of Correspondence and other Documents* (London, 1882).

51 *Examen critique de la flûte ordinaire comparée à la flûte Boehm* (Paris, 1838).

52 They existed long before, however, in the Chinese *Ty* and the Japanese *Fuye*.

53 The reader may consult with advantage Mr C. Welch's *History of the Boehm Flute* (London, 1883), wherein all the documents relating to this interesting discussion have been collected with great impartiality.

54 For further details see Kathleen Schlesinger, *The Instruments of the Orchestra*, part i. pp. 192-194, where an illustration is given, and Paul Wetzger, *Die Flöte* (Heilbronn, 1906), pp. 23-24, and Tafel iv. No. 20.

FLUX (Lat. *fluxus*, a flowing; this being also the meaning of the English term in medicine, &c.), in metallurgy, a substance introduced in the smelting of ores to promote fluidity, and to remove objectionable impurities in the form of a slag. The substances in commonest use are:—lime or limestone, to slag off silica and silicates, fluor-spar for lead, calcium and barium sulphates and calcium phosphate, and silica for removing basic substances such as limestone. Other substances are also used, but more commonly in assaying than in metallurgy. Sodium and potassium carbonates are valuable for fluxing off silica; mixed with potassium nitrate sodium carbonate forms a valuable oxidizing fusion mixture; "black flux" is a reducing flux composed of finely divided carbon and potassium carbonate, and formed by deflagrating a mixture of argol with ¼ to ½ its weight of nitre. Borax is very frequently employed; it melts to a clear liquid and dissolves silica and many metallic oxides. Potassium bisulphate is useful in the preliminary treatment of refractory aluminous ores. Litharge and red lead are used in silver and gold assays, acting as solvents for silica and any metallic oxides present. 584

FLY (formed on the root of the supposed original Teut. *fleugan*, to fly), a designation applied to the winged or perfect state of many insects belonging to various orders, as in butterfly (see Lepidoptera), dragon-fly (*q.v.*), may-fly (*q.v.*), caddis-fly (*q.v.*), &c.; also specially employed by entomologists to mean any species of the two-winged flies, or Diptera (*q.v.*). In ordinary parlance *fly* is often used in the sense of the common house-fly (*Musca domestica*); and by English colonists and sportsmen in South Africa in that of a species of tsetse-fly (*Glossina*), or a tract of country ("belt") in which these insects abound (see Tsetse-Fly).

Apart from the house-fly proper (*Musca domestica*), which in England is the usual one, several species of flies are commonly found in houses; *e.g.* the *Stomoxys calcitrans*, or stable-fly; *Pollenia rudis*, or cluster-fly; *Muscina stabulans*, another stable-fly; *Calliphora erythrocephala*, blue-bottle fly, blow-fly or meat-fly, with smaller sorts of blue-bottle, *Phormia terraenovae* and *Lucilia caesar*; *Homalomyia canicularis* and *brevis*, the small house-fly; *Scenopinus fenestralis*, the black window-fly, &c. But *Musca domestica* is far the most numerous, and in many places, especially in hot weather and in hot climates, is a regular pest. Mr L.O. Howard (Circular 71 of the Bureau of Entomology U.S. Dept. of Agriculture, Washington, 1906) says that in 1900 he made a collection of the flies in dining-rooms in different parts of the United

States, and out of a total of 23,087 flies, 22,808 were the common house-fly. Its geographical distribution is of the widest, and its rapidity of breeding, in manure and door-yard filth, so great that, as a carrier of germs of disease, especially cholera and typhoid, the house-fly is now recognized as a potent source of danger; and various sanitary regulations have been made, or precautions suggested, for getting rid of it. These are discussed by Mr Howard in the paper referred to, but in brief they all amount to measures of general hygiene, and the isolation, prompt removal, or proper sterilization of the animal or human excrement in which these flies breed.

FLYCATCHER, a name introduced in ornithology by Ray, being a translation of the *Muscicapa* of older authors, and applied by Pennant to an extremely common English bird, the *M. grisola* of Linnaeus. It has since been used in a general and very vague way for a great many small birds from all parts of the world, which have the habit of catching flies on the wing. Ornithologists who have trusted too much to this characteristic and to certain merely superficial correlations of structure, especially those exhibited by a broad and rather flat bill and a gape beset by strong hairs or bristles, have associated under the title of *Muscicapidae* an exceedingly heterogeneous assemblage of forms much reduced in number by later systematists. Great advance has been made in establishing as independent families the *Todidae* and *Eurylaemidae*, as well as in excluding from it various members of the *Ampelidae*, *Cotingidae*, *Tyrannidae*, *Vireonidae*, *Mniotiltidae*, and perhaps others, which had been placed within its limits. These steps have left the *Muscicapidae* a purely Old-World family of the order *Passeres*, and the chief difficulty now seems to lie in separating it from the *Campephagidae* and the *Laniidae*. Only a very few of the forms of flycatchers (which, after all the deductions above mentioned, may be reckoned to include some 60 genera or subgenera, and perhaps 250 species) can here be even named.[1]

The best-known bird of this family is that which also happens to be the type of the Linnaean genus *Muscicapa*—the spotted or grey flycatcher (*M. grisola*). It is a common summer visitant to nearly the whole of Europe, and is found throughout Great Britain, though less abundant in Scotland than in England, as well as in many parts of Ireland, where, however, it seems to be but locally and sparingly distributed. It is one of the latest migrants to arrive, and seldom reaches the British Islands till the latter part of May, when it may be seen, a small dust-coloured bird, sitting on the posts or railings of gardens and fields, ever and anon springing into the air, seizing with an audible snap of its bill some passing insect as it flies, and returning to the spot it has quitted, or taking up some similar station to keep watch as before. It has no song, but merely a plaintive or peevish call-note, uttered from time to time with a jerking gesture of the wings and tail. It makes a neat nest, built among the small twigs which sprout from the bole of a large tree, fixed in the branches of some plant trained against a wall, or placed in any hole of the wall itself that may be left by the falling of a brick or stone. The eggs are from four to six in number, of a pale greenish-blue, closely blotched or freckled with rust-colour. Silent and inconspicuous as is this bird, its constant pursuit of flies in the closest vicinity of houses makes it a familiar object to almost everybody. A second British species is the pied flycatcher (*M. atricapilla*), a much rarer bird, and in England not often seen except in the hilly country extending from the Peak of Derbyshire to Cumberland, and more numerous in the Lake District than elsewhere. It is not common in Scotland, and has only once been observed in Ireland. More of a woodland bird than the former, the brightly-contrasted black and white plumage of the cock, together with his agreeable song, readily attracts attention where it occurs. It is a summer visitant to all western Europe, but farther eastward its place is taken by a nearly allied species (*M. collaris*) in which the white of the throat and breast extends like a collar round the neck. A fourth European species (*M. parva*), distinguished by its very small size and red breast, has also strayed some three or four times to the extreme south-west of England. This last belongs to a group of more eastern range, which has received generic recognition under the name of *Erythrosterna*, and it has several relations in Asia and particularly in India, while the allies of the pied flycatchers (*Ficedula* of Brisson) are chiefly of African origin, and those of the grey or spotted flycatcher (*Muscicapa* proper[2]) are common to the two continents.

One of the most remarkable groups of *Muscicapidae* is that known as the paradise flycatchers, forming the genus *Tchitrea* of Lesson. In nearly all the species the males are distinguished by the growth of exceedingly long feathers in their tail, and by their putting on, for some part of the year at least, a plumage generally white, but almost always quite different from that worn by the females, which is of a more or less deep chestnut or bay colour, though in both sexes the crown is of a glossy steel-blue. They are found pretty well throughout Africa and tropical Asia to Japan, and seem to affect the deep shade of forests rather than the open country. The best-known species is perhaps the Indian *T. paradisi*; but the Chinese *T. incii*, and the Japanese *T. princeps*, from being very commonly represented by the artists of those nations on screens, fans and the like, are hardly less so; and the cock of the last named, with his bill of a pale greenish-blue and eyes surrounded by bare skin of the same colour—though these are characters possessed in some degree by all the species—seems to be the most beautiful of the genus. *T. bourbonnensis*, which is peculiar to the islands of Mauritius and Réunion, appears to be the only species in which the outward difference of the sexes is but slight. In *T. corvina* of the Seychelles, the adult male is wholly black, and his middle tail-feathers are not only very long but very broad. In *T. mutata* of Madagascar, some of the males are found in a blackish plumage, though with the elongated median rectrices white, while in others white predominates over the whole body; but whether this sex is here actually dimorphic, or whether the one dress is a passing phase of the other, is at present undetermined. Some of the African species, of which many have been described, seem always to retain the rufous plumage, but the long tail-feathers serve to mark the males. 585

A few other groups are distinguished by the brilliant blue they exhibit, as *Myiagra azurea*, and others as *Monarcha* (or *Arses*) *chrysomela* by their golden yellow. The Australian forms assigned to the *Muscicapidae* are very varied. *Sisura inquieta* has some of the habits of a water-wagtail (*Motacilla*), and hence has received the name of “dishwasher,” bestowed in many parts of England on its analogue; and the many species of *Rhipidura* or fantailed flycatchers, which occur in various parts of the Australian Region, have manners still more singular—turning over in the air, it is said, like a tumbler pigeon, as they catch their prey; but concerning the mode of life of the majority of the *Muscicapidae*, and especially of the numerous African forms, hardly anything is known.

(A. N.)

1 Of the 30 genera or subgenera which Swainson included in his *Natural Arrangement and Relations of the Family of Flycatchers* (published in 1838), at least 19 do not belong to the *Muscicapidae* at all, and one of them, *Todus*, not even to the order *Passeres*. It is perhaps impossible to name any ornithological work whose substance so fully belies its title as does this treatise. Swainson wrote it filled with faith in the so-called “Quinary System”—that fanciful theory, invented by W.S. Macleay, which misled and kept back so many of the best English zoologists of his generation from the truth,—and, unconsciously swayed by his bias, his judgment was warped to fit his hypothesis.

2 By some writers this section is distinguished as *Butalis* of Boie, but to do so seems contrary to rule.

FLYGARE-CARLÉN, EMILIE (1807-1892), Swedish novelist, was born in Strömstad on the 8th of August 1807. Her father, Rutger Smith, was a retired sea-captain who had settled down as a small merchant, and she often accompanied him on the voyages he made along the coast. She married in 1827 a doctor named Axel Flygare, and went with him to live in the province of Småland. After his death in 1833 she returned to her old home and published in 1838 her first novel, *Waldemar Klein*. In the next year she removed to Stockholm, and married, in 1841, the jurist and poet, Johan Gabriel Carlén (1814-1875). Her house became a meeting-place for Stockholm men of letters, and for the next twelve years she produced one or two novels annually. The premature death of her son Edvard Flygare (1829-1853), who had already published three books, showing great promise, was followed by six years of silence, after which she resumed her writing until 1884. The most famous of her tales are *Rosen på Tistelön* (1842; Eng. trans. *The Rose of Tistelön*, 1842); *Enslingen på Johannesskäret* (1846; Eng. trans. *The Hermit*, 4 vols., 1853); and *Ett Köpemanshus i skärgården* (1859; *The Merchant's House on the Cliffs*). Fru Carlén published in 1878 *Minnen af svenskt författarlif* 1840-1860, and in 1887-1888 three volumes of *Efterskörd från en 80- årings författarbana*, containing her last tales. She died at Stockholm on the 5th of February 1892. Her daughter, Rosa Carlén (1836-1883), was also a popular novelist.

Emilie Flygare-Carlén's novels were collected in thirty-one volumes (Stockholm, 1869-1875).

FLYING BUTTRESS, in architecture, the term given to a structural feature employed to transmit the thrust of a vault across an intervening space, such as an aisle, chapel or cloister, to a buttress built outside the latter. This was done by throwing a semi-arch across to the vertical buttress. Though employed by the Romans and in early Romanesque work, it was generally masked by other constructions or hidden under a roof, but in the 12th century it was recognized as rational construction and emphasized by the decorative accentuation of its features, as in the cathedrals of Chartres, Le Mans, Paris, Beauvais, Reims, &c. Sometimes, owing to the great height of the vaults, two semi-arches were thrown one above the other, and there are cases where the thrust was transmitted to two or even three buttresses across intervening spaces. As a vertical buttress, placed at a distance, possesses greater power of resistance to thrust than if attached to the wall carrying the vault, vertical buttresses as at Lincoln and Westminster Abbey were built outside the chapterhouse to receive the thrust. All vertical buttresses are, as a rule, in addition weighted with pinnacles to give them greater power of resistance.

FLYING COLUMN, in military organization, an independent corps of troops usually composed of all arms, to which a particular task is assigned. It is almost always composed in the course of operations, out of the troops immediately available. Mobility being its *raison d'être*, a flying column is when possible composed of picked men and horses accompanied with the barest minimum of baggage. The term is usually, though not necessarily, applied to forces under the strength of a brigade. The "mobile columns" employed by the British in the South African War of 1899-1902, were usually of the strength of two battalions of infantry, a battery of artillery, and a squadron of cavalry—almost exactly half that of a mixed brigade. Flying columns are mostly used in savage or guerrilla warfare.

"FLYING DUTCHMAN," a spectre-ship popularly believed to haunt the waters around the Cape of Good Hope. The legend has several variants, but the commonest is that which declares that the captain of the vessel, Vanderdecken, was condemned for his blasphemy to sail round the cape for ever, unable to "make" a port. In the Dutch version the skipper is the ghost of the Dutch seaman Van Straaten. The appearance of the "Flying Dutchman" is considered by sailors as ominous of disaster. The German legend makes one Herr Von Falkenberg the hero, and alleges that he is condemned to sail for ever around the North Sea, on a ship without helm or steersman, playing at dice for his soul with the devil. Sir Walter Scott says the "Flying Dutchman" was originally a vessel laden with bullion. A murder was committed on board, and thereafter the plague broke out among the crew, which closed all ports to the ill-fated craft. The legend has been used by Wagner in his opera *Der fliegende Holländer*.

FLYING-FISH, the name given to two different kinds of fish. The one (*Dactylopterus*) belongs to the gurnard family (*Triglidae*), and is more properly called flying gurnard; the other (*Exocoetus*) has been called flying herring, though more nearly allied to the gar-pike than to the herring. Some other fishes with long pectoral fins (*Pterois*) have been stated to be able to fly, but this has been proved to be incorrect.

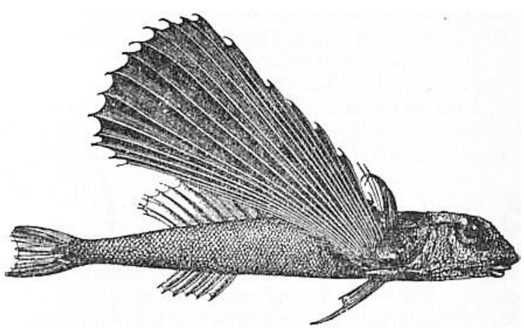


Fig. 1.—*Dactylopterus volitans.*

The flying gurnards are much less numerous than the *Exocoeti* with regard to individuals as well as species, there being only three or four species known of the former, whilst more than fifty have been described of the latter, which, besides, are found in numerous shoals of thousands. The *Dactylopteri* may be readily distinguished by a large bony head armed with spines, hard keeled scales, two dorsal fins, &c. The *Exocoeti* have thin, deciduous scales, only one dorsal fin, and the ventrals placed far backwards, below the middle of the body; some have long barbels at the chin. In both kinds the pectoral fins are greatly prolonged and enlarged, modified into an organ of flight, and in many species of *Exocoetus* the ventral fins are similarly enlarged, and evidently assist in the aerial evolutions of these fishes. Flying-fishes are found in the tropical and sub-tropical seas only, and it is a singular fact that the geographical distribution of the two kinds is nearly identical. Flying-fish are more frequently observed in rough weather and in a disturbed sea than during calms; they dart out of the water when pursued by their enemies or frightened by an approaching vessel, but frequently also without any apparent cause, as is also observed in many other fishes; and they rise without regard to the direction of the wind or waves. The fins are kept quietly distended, without any motion, except an occasional vibration caused by the air whenever the surface of the wing is parallel with the current of the wind. Their flight is rapid, greatly exceeding that of a ship going 10 m. an hour, but gradually decreasing in velocity and not extending beyond a distance of 500 ft. Generally it is longer when the fishes fly against, than with or at an angle to, the wind. Any vertical or horizontal deviation from a straight line is not caused at the will of the fish, but by currents of the air; thus they retain a horizontally straight course when flying with or against the wind, but are carried towards the right or left whenever the direction of the wind is at an angle with that of their flight. However, it sometimes happens that the fish during its flight immerses its caudal fin in the water, and by a stroke of its tail turns towards the right or left. In a calm the line of their flight is always also vertically straight or rather parabolic, like the course of a projectile, but it may become undulated in a rough sea, when they are flying against the course of the waves; they then frequently overtop each wave, being carried over it by the pressure of the disturbed air. Flying-fish often fall on board of vessels, but this never happens during a calm or from the lee side, but during a breeze only and from the weather side. In day time they avoid a ship, flying away from it, but during the night when they are unable to see, they frequently fly against the weather board, where they are caught by the current of the air, and carried upwards to a height of 20 ft. above the surface of the water, whilst under ordinary circumstances they keep close to it. All these observations point clearly to the fact that any deflection from a straight course is due to external circumstances, and not to voluntary action on the part of the fish. 586

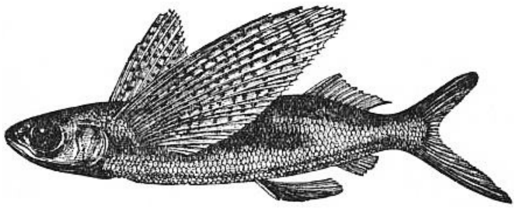


Fig. 2.—*Exocoetus callopterus.*

A little Malacopterygian fish about 4 in. long has recently been discovered in West Africa which has the habits of a fresh-water flying-fish. It has been named *Pantodon buchholzi*. It has very large pectoral fins with a remarkable muscular process attached to the inner ray. It lives in fresh-water lakes and rivers in the Congo region, and has been caught in its flight above the water in a butterfly-net.

FLYING-FOX, or, more correctly, Fox-Bat. The first name is applied by Europeans in India to the fruit-eating bats of the genus *Pteropus*, which contains more than half the family (*Pteropidae*). This genus is confined to the tropical regions of the Eastern hemisphere and Australia. It comprises numerous species, a considerable proportion of which occur in the islands of the Malay Archipelago. The flying-foxes are the largest of the bats, the kalong of Java (*Pteropus edulis*) measuring about a foot in length, and having an expanse of wing-membrane measuring 5 ft. across. Flying-foxes are gregarious, nocturnal bats, suspending themselves during the day head-downwards by thousands from the branches of trees, where with their wings gathered about them, they bear some resemblance to huge shrivelled-up leaves or to clusters of some peculiar fruit. In Batchian, according to Wallace, they suspend themselves chiefly from the branches of dead trees, where they are easily caught or knocked down by sticks, the natives carrying them home in basketfuls. They are then cooked with abundance of spices, and "are really very good eating, something like hare." Towards evening these bats bestir themselves, and fly off in companies to the village plantations, where they feed on all kinds of fruit, and so numerous and voracious are they that no garden crop has much chance of being gathered which is not specially protected from their attacks. The flying-fox of India (*Pteropus medius*) is a smaller species, but is found in great numbers wherever fruit is to be had in the Indian peninsula.

FLYING-SQUIRREL, properly the name of such members of the squirrel-group of rodent mammals as have a parachute-like expansion of the skin of the flanks, with attachments to the limbs, by means of which they are able to take long flying-leaps from tree to tree. The parachute is supported by a cartilage attached to the wrist or carpus; in addition to the lateral membrane, there is a narrow one from the cheek along the front of each shoulder to the wrist, and in the larger species a third (interfemoral) connecting the hind-limbs with the base of the long tail. Of the two widely distributed genera, *Pteromys* includes the larger and *Sciuropterus* the smaller species. The two differ in certain details of dentition, and in the greater development in the former of the parachute, especially the interfemoral portion, which in the latter is almost absent. In *Pteromys* the tail is cylindrical and comparatively thin, while in *Sciuropterus* it is broad, flat and laterally expanded, so as to compensate for the absence of the interfemoral membrane by acting as a supplementary parachute.

In general appearance flying-squirrels resemble ordinary squirrels, although they are even more beautifully coloured. Their habits, food, &c., are also very similar to those of the true squirrels, except that they are more nocturnal, and are therefore less often seen. The Indian flying-squirrel (*P. oral*) leaps with its parachute extended from the higher branches of a tree, and descends first directly and then more and more obliquely, until the flight, gradually becoming slower, assumes a horizontal direction, and finally terminates in an ascent to the branch or trunk of the tree to which it was directed. The presence of these rodents at night is made known by their screaming cries. *Sciuropterus* is represented by *S. velucella* in eastern Europe and northern Asia, and by a second species in North America, but the other species of this genus and all those of *Pteromys* are Indo-Malayan. A third genus, *Eupetaurus*, typified by a very large, long-haired, dark-grey species from the mountains to the north-west of Kashmir (*Eu. cinereus*), differs from all other members of the squirrel-family by its tall-crowned molar teeth. It has a total length of 37 in., of which 22 are taken up by the tail.

Pigmy African Flying-Squirrel (*Idiurus zenkeri*).

In Africa the name of flying-squirrel is applied to the members of a very different family of rodents, the *Anomaluridae*, which are provided with a parachute. Since, however, this parachute is absent in some members of the family, the most distinctive character is the presence of a double row of spiny scales on the under surface of the tail, which apparently aid in climbing. The flying species are also distinguished from ordinary flying-squirrels by the circumstance that the additional bone serving for the support of the fore part of the flying-membrane rises from the elbow-joint instead of from the wrist. The family is represented by two flying genera, *Anomalurus* and *Idiurus*; the latter containing only one very minute species (shown in the cut) characterized by its small ears and elongated tail. Most of the species are West African. In habits these rodents appear to be very similar to the true flying-squirrels. The species without a parachute constitutes the genus *Zenkerella*, and looks very like an ordinary squirrel (see Rodentia). 587

In Australia and Papua the name flying-squirrel is applied to such marsupials as are provided with parachutes; animals which naturalists prefer to designate flying-phalangers (see Marsupialia)

(R. L.*)

FLYSCH, in geology, a remarkable formation, composed mainly of sandstones, soft marls and sandy shales found extending from S.W. Switzerland eastward along the northern Alpine zone to the Vienna basin, whence it may be followed round the northern flanks of the Carpathians into the Balkan peninsula. It is represented in the Pyrenees, the Apennines, the Caucasus and extends into Asia; similar flysch-like deposits are related to the Himalayas as the European formations are to the Alps. The Flysch is not of the same age in every place; thus in the western parts of Switzerland the oldest portions probably belong to the Eocene period, but the principal development is of Oligocene age; as it is traced eastward we find in the east Alps that it descends into the upper Cretaceous, and in the Vienna region and the Carpathians it contains intercalations which clearly indicate a lower Cretaceous horizon for the lower parts. It appears indeed that this type of formation was in progress of deposition at one point or another in the regions enumerated above from Jurassic to late Tertiary times. The absence of fossils from enormous thicknesses of Flysch makes the correlation with other formations difficult; often the only indications of organisms are the abundant markings supposed to represent Algae (Chondrites, &c.), which have given rise to the term “Hieroglyphic-sandstone.” The most noteworthy exceptions are perhaps the Oligocene fish-bed of Glarus, the Eocene nummulitic beds in Calabria, and the *Aptychus* beds of Waidhofen. Local phases of the Flysch have received special names; it is the “Vienna” or “Carpathian” sandstone of those regions; the “macigno” (a soft sandstone with calcareous cement) of the Maritime Alps and Apennines; the “scagliose” (scaly clays) and “alberese” (limestones) of the same places are portions of this formation. The *gris de Menton*, the *gris d’Annot* of the Basses Alps, and the *gris d’Embrun* of Chaillot appear in Switzerland as the *gris de Taveyannaz*. At several places the upper layers of the Flysch are iron-stained, as in the region of Léman and at the foot of the Dent du Midi; it is then styled the “Red-Flysch.” Lenticular intercalations of gabbro, diabase, &c., occur in the Flysch in Calabria on the Pyrenees. Large exotic blocks of granite, gneiss and other crystalline rocks in coarse conglomerates are found near Vienna, near Sonthofen in Bavaria, near Lake Thun (Wild Flysch) and at other points, which have been variously regarded as indications of glaciation or of coastal conditions.

FOČA (pronounced *Fáwtcha*), a town of Bosnia, situated at the confluence of the Drina and Čehotina rivers, and encircled by wooded mountains. Pop. (1895) 4217. The town is the headquarters of a thriving industry in silver filigree-work and inlaid weapons, for which it was famous. With its territories enclosed by the frontiers of Montenegro and Novi Bazar, Foča, then known as *Chocha*, was the scene of almost incessant border warfare during the middle ages. No monuments of this period are left except the Bogomil cemeteries, and the beautiful mosques, which are the most ancient in Bosnia. The three adjoining towns of Foča, Goražda and Ustikolina were trading-stations of the Ragusans in the 14th century, if not earlier. In the 16th century, Benedetto Ramberti, ambassador from Venice to the Porte, described the town, in his *Libri Tre delle Cose dei Turchi*, as *Cozza*, “a large settlement, with good houses in Turkish style, and many shops and merchants. Here dwells the governor of Herzegovina, whose authority extends over the whole of Servia. Through this place all goods must pass, both going and returning, between Ragusa and Constantinople.”

FOCHABERS, a burgh of barony and village of Elginshire, Scotland. Pop. (1901) 981. It is delightfully situated on the Spey, about 9 m. E. by S. of Elgin, the terminus of a branch of the Highland railway connecting at Orbliston Junction with the main line from Elgin to Keith. The town was rebuilt in its present situation at the end of the 18th century, when its earlier site was required for alterations in the grounds of Gordon Castle, in which the old town cross still stands. The streets all lead at right angles to the central square, where fairs and markets are held. The public buildings include a library and reading-room, the court-house and the Milne school, named after Alexander Milne, who endowed it with a legacy of £20,000. Adjoining the town, surrounded by a park containing many magnificent old trees, stands Gordon Castle, the chief seat of the duke of Richmond and Gordon, erected in the 18th century. The antiquary George Chalmers (1742-1825) and the composer William Marshall (1748-1833) were natives of the burgh.

FOCSHANI (Rumanian *Focşani*, sometimes incorrectly written *Fokshani* or *Fokshan*), the capital of the department of Putna, Rumania; on the river Milcov, which formed the ancient frontier of the former principalities of Moldavia and Walachia. Pop. (1900) 23,783; of whom 6000 were Jews. The chief buildings are the prefecture, schools, synagogues, and many churches, including those of the Armenians and Protestants. Focshani is a commercial centre of some importance, the chief industries being oil and soap manufacture and tannery. A large wine trade is also carried on, and corn is shipped in lighters to Galatz. The annual fair is held on the 29th of April. Government explorations in the vicinity of this town show it to be rich in minerals, such as iron, copper, coal and petroleum. The line Focshani-Galatz is covered by a very strong line of fortifications, known as the Sereth Line. A congress between Russian and Turkish diplomatists was held near the town in 1772. In the neighbourhood the Turks suffered a severe defeat from the Austrians and Russians in 1789.

FOCUS (Latin for “hearth” or “fireplace”), a point at which converging rays meet, toward which they are directed, or from which diverging rays are directed; in the latter case called the virtual focus (see Microscope; Telescope; Lens). In geometry the word is used to denote certain points (see Geometry; Conic Section; and Perspective).

FOG, the name given to any distribution of solid or liquid particles in the surface layers of the atmosphere which renders surrounding objects notably indistinct or altogether invisible according to their distance. In its more intense forms it hinders and delays travellers of all kinds, by sea or land, by railway, road or river, or by the mountain path. It is sometimes so thick as to paralyse traffic altogether. According to the *New English Dictionary* the word “appears to be” a back formation from the adjective “foggy,” a derivative of “fog” used with its old meaning of aftermath or coarse grass, or, in the north of Britain, of “moss.” Such a formation would be reasonable, because wreaths of fog in the atmospheric sense are specially characteristic of meadows and marshes where fog, in the more ancient sense, grows.

Two other words, *mist* and *haze*, are also in common use with reference to the deterioration of transparency of the surface layers of the atmosphere caused by solid or liquid particles, and in ordinary literature the three words are used almost according to the fancy of the writer. It seems possible to draw a distinction between mist and haze that would be fairly well supported by usage. Mist may be defined as a cloud of water particles at the surface of land or sea, and would only occur when the air is nearly or actually saturated, that is, when there is little or no difference between the readings of the dry and wet bulbs; the word haze, on the other hand, may be reserved for the obscuration of the surface layers of the atmosphere when the air is dry.

It would not be difficult to quote instances in which even this distinction is disregarded in practice. Indeed, the telegraphic code of the British Meteorological Office uses the same figure for mist and haze, and formerly the Beaufort weather notation had no separate letter for haze (now indicated by *z*), though it distinguished between *f*, fog, and *m*, mist. 588
It is possible, however, that these practices may arise, not from confusion of idea, but from economy of symbols, when the meaning can be made out from a knowledge of the associated observations.

As regards the distinction between mist and fog, careful consideration of a number of examples leads to the conclusion that the word “fog” is used to indicate not so much the origin or meteorological nature of the obscurity as its effect upon traffic and travellers whether on land or sea. It is, generally speaking, “in a fog” that a traveller loses himself, and indeed the phrase has become proverbial in that sense. A “fog-bell” or “fog-horn” is sounded when the atmosphere is so thick that the aid of sound is required for navigation. A vessel is “fog-logged” or “fog-bound” when it is stopped or detained on account of thick atmosphere. A “fog-signal” is employed on railways when the ordinary signals are obliterated within working distances. A “fog-bow” is the accompaniment of conditions when a mountain traveller is apt to lose his way.

These words are used quite irrespective of the nature of the cloud which interferes with effective vision and necessitates the special provision; the word “mist” is seldom used in similar connexion. We may thus define a fog as a surface cloud sufficiently thick to cause hindrance to traffic. It will be a *thick mist* if the cloud consists of water particles, a *thick haze* if it consists of smoke or dust particles which would be persistent even in a dry atmosphere.

It is probable that sailors would be inclined to restrict the use of the word to the surface clouds met with in comparatively calm weather, and that the obscurity of the atmosphere when it is blowing hard and perhaps raining hard as well should be indicated by the terms “thick weather” or “very thick weather” and not by “fog”; but the term “fog” would be quite correctly used on such occasions from the point of view of cautious navigation. If cloud, drizzling rain, or heavy rain cause such obscurity that passing ships are not visible within working distances the sounding of a fog-horn becomes a duty.

The number of occasions upon which fog and mist may be noted as occurring with winds of different strengths may be exemplified by the following results of thirty years for St Mary’s, Scilly Isles, where the observations have always been made by men of nautical experience.

Wind Force.	0 & 1	2	3	4	5	6	7	8-12	All Winds.
Number of occasions of fog per 1000 observations	8	7	9	14	6	3	<1	<1	47
Number of occasions of mist per 1000 observations	5	6	11	22	20	12	6	2	84

The use of the word “fog” in the connexion “high fog,” to describe the almost total darkness in the daytime occasionally noted in London and other large cities due to the persistent opaque cloud in the upper air without serious obscuration of the surface layers, is convenient but incorrect.

Regarding “fog” as a word used to indicate the state of the atmosphere as regards transparency considered with reference to its effect upon traffic, a scale of fog intensity has been introduced for use on land or at sea, whereby the intensity of obscurity is indicated by the numbers 1 to 5 in the table following. At sea or in the country a fog, as a rule, is white and consists of a cloud of minute water globules, of no great vertical thickness, which disperses the sunlight by repeated reflection but is fully translucent. In dust-storms and sand-storms dark or coloured fog clouds are produced such as those which are met with in the Harmattan winds off the west coast of Africa. In large towns the fog cloud is darkened and intensified by smoke, and in some cases may be regarded as due entirely to the smoke.

Description of Effects.

Name.	No.	On Land.	On Sea.	On River.
Slight Fog or Mist	1	Objects indistinct, but traffic by rail or road unimpeded	Horizon invisible, but lights and landmarks visible at working distances	Objects indistinct, but navigation unimpeded
Moderate Fog	2	Traffic by rail requires additional caution	Lights, passing vessels and landmarks generally indistinct under a mile. Fog signals are sounded	Navigation impeded, additional caution required
	3	Traffic by rail or road impeded		
Thick Fog	4	Traffic by rail or road impeded	Ships’ lights and vessels invisible at ¼ mile or less	Navigation suspended
	5	Traffic by rail or road totally disorganized		

The physical processes which produce fogs of water particles are complicated and difficult to unravel. We have to account for the formation and maintenance of a cloud at the earth’s surface; and the process of cloud-formation which is probably most usual in nature, namely, the cooling of air by rarefaction due to the reduction of pressure on ascent, cannot be invoked, except in the case of the fogs forming the cloud-caps of hills, which are perhaps not fairly included. We have to fall back upon the only other process hitherto recognized as causing cloudy condensation in the atmosphere, that is to say, the mixing of masses of mist air of different temperatures. The mixing is brought about by the slow motion of air masses, and this slow motion is probably essential to the phenomenon.

Table I.—*Air travelling from Northern Africa to Northern Russia, round by the Azores.*

Successive Temperatures of sea	68°	68°	67°	59°	54° F.
Successive Temperatures of air	68°	70°	67°	60°	56° F.
Successive States of the atmosphere	clear	clear	clear	shower	mist

Table II.—*Air travelling from N.W. Africa to Scotland.*

Successive Temperatures of sea	67°	63°	54° F.
Successive Temperatures of air	66°	64°	53° F.
Successive State of atmosphere	fair	shower	mist with shower

Over the sea fog is most frequently due to the cooling of a surface layer of warm air by the underlying cold water. The amount of motion of the air must be sufficient to prevent the condensation taking place at the sea surface without showing itself as a cloud. In a research on the Life History of Surface Air Currents the changes incidental to the movement of the air over the north Atlantic Ocean were traced with great care, and the above examples (Tables I, II) taken from page 72 of the work referred to are typical of the formation of sea fog by the cooling of a relatively warm current passing over cold water.

In conformity with this suggestion we find that fog is most liable to occur over the open ocean in those regions where, as off the Newfoundland banks, cold-water currents underlie warm air, and that it is most frequent at the season of the year when the air temperature is increasing faster than the water temperature. But it is difficult to bring this hypothesis always to bear upon actual practice, because the fog is representative of a temperature difference which has ceased to exist. One cannot therefore observe under ordinary circumstances both the temperature difference and the fog. Doubtless one requires not only the initial temperature difference but also the slow drift of air which favours cooling of the lower layers without too much mixing and consequently a layer of fog close to the surface. Such a fog, the characteristic sea fog, may be called a cold surface fog. From the conditions of its formation it is likely to be less dense at the mast-head 589
than it is on deck.

One would expect that a cold-air current passing over a warm sea surface would give rise to an ascending current of warmed air and hence cause cumulus cloud and possibly thunder showers rather than surface fog, but one cannot resist the conclusion that sea fog is sometimes formed by slow transference of cold air over relatively warm water, giving rise to what may be called a “steaming-pot” fog. In such a case the actual surface layer in contact with the warm water would be clear, and the fog would be thicker aloft where the mixing of cold air and water vapour is more complete. Such fogs are, however, probably rare in comparison with the cold-water fogs. If the existence of a cold current over warm water were a sufficient cause of fog, as a current of warm air over cold water appears to be, the geographical distribution of notable fog would be much more widespread than it actually is, and the seasonal distribution of fog would also be other than it is.

The formation of fog over land seems to be an even more complicated process than over the sea. Certainly in some cases mistiness amounting to fog arises from the replacement of cold surface air which has chilled the earth and the objects thereon by a warm current. But this process can hardly give rise to detached masses or banks of fog. The ordinary land or valley fog of the autumn evening or winter morning is due to the combination of three causes, first the cooling of the surface layer of air at or after sunset by the radiation of the earth, or more particularly of blades of grass, secondly the slow downward flow (in the absence of wind) of the air thus cooled towards lower levels following roughly the course of the natural water drainage of the land, and thirdly the supply of moisture by evaporation from warm moist soil or from the relatively warm water surface of river or lake. In this way steaming-pot fog gradually forms and is carried downward by the natural though slow descent of the cooled air. It thus forms in wreaths and banks in the lowest parts, until perhaps the whole valley becomes filled with a cloud of mist or fog. A case of this kind in the Lake District is minutely described by J.B. Cohen (*Q.J. Roy. Met. Soc.* vol. 30, p. 211, 1904).

It will be noticed that upon this hypothesis the circumstances favourable for fog formation are (1) a site near the bottom level of the drainage area, (2) cold surface air and no wind, (3) an evening or night of vigorous radiation, (4) warm soil, and (5) abundant moisture in the surface-soil. These conditions define with reasonable accuracy the circumstances in which fog is actually observed.

The persistence of these fog wreaths is always remarkable when one considers that the particles of a fog cloud, however small they may be, must be continually sinking through the air which holds them, and that unless some upward motion of the air keeps at least a balance against this downward fall, the particles of the cloud must reach the earth or water and to that extent the cloud must disappear. In sheltered valleys it is easy to suppose that the constant downward drainage of fresh and colder fog-laden material at the surface supplies to the layers displaced from the bottom the necessary upward motion, and the result of the gradual falling of drops is only that the surface cloud gets thicker; but there are occasions when the extent and persistence of land fog seems too great to be accounted for by persistent radiation cooling. For example, in the week before Christmas of 1904 the whole of England south of the Humber was covered with fog for several days. It is of course possible that so much fog-laden air was poured down from the sides of mountains and hills that did project above the surface of the fog, as to keep the lower reaches supplied for the whole time, but without more particulars such a statement seems almost incredible. Moreover, the drifting of fog banks over the sea seems capricious and unrelated to any known circumstances of fog-formation, so that one is tempted to invoke the aid of electrification of the particles or some other abnormal condition to account for the persistence of fog. The observations at Kew observatory show that the electrical potential is abnormally high during fog, but whether that is the cause or the result of the presence of the water particles, we are not yet in a position to say. It must be remembered that a fog cloud ought to be regarded as being, generally speaking, *in process of formation* by mixing. Observations upon clouds formed experimentally in globes tend to show that if a mass of fog-bearing air could be enclosed and kept still for only a short while the fog would settle and leave the air clear. The apparently capricious behaviour of fog banks may be due to the fact that mixing is still going on in the persistent ones, but is completed in the disappearing ones.

One remarkable characteristic of a persistent fog is the coldness of the foggy air at the surface in spite of the heat of the sun’s rays falling upon the upper surface of the fog. A remarkable example may be quoted from the case of London, which was under fog all day on 28th January 1909. The maximum temperature only reached 31° F., whereas at Warlingham in Surrey from which the fog lifted it was as high as 46° F.

A priori we might suppose that the formation of fog would arrest cooling by radiation, and that fog would thus act as a protection of plants against frost. The condensation of water evaporated from wet ground, which affords the material for making fog, does apparently act as a protection, and heavy watering is sometimes used to protect plants from frost, but the same cannot be said of fog itself—cooling appears to go on in spite of the formation of fog.

A third process of fog-formation, namely, the descent of a cloud from above in the form of light drizzling rain, hardly calls for remark. In so far as it is subject to rules, they are the rules of clouds and rain and are therefore independent of surface conditions.

These various causes of fog-formation maybe considered with advantage in relation to the geographical distribution of fog. Statistics on this subject are not very satisfactory on account of the uncertainty of the distinction between fog and mist, but a good deal may be learned from the distribution of fog over the north Atlantic Ocean and its various coasts as shown in the Monthly Meteorological Charts of the north Atlantic issued by the Meteorological Office, and the Pilot charts of the North Atlantic of the United States Hydrographic Office. Coast fog, which is probably of the same nature as land fog, is most frequent in the winter months, whereas sea fog and ocean fog is most extensive and frequent in the spring and summer. By June the fog area has extended from the Great Banks over the ocean to the British Isles, in July it is most intense, and by August it has notably diminished, while in November, which is proverbially a foggy month on land, there is hardly any fog shown over the ocean.

The various meteorological aspects of fog and its incidence in London were the subject of reports to the Meteorological Council by Captain A. Carpenter and Mr R.G.K. Lempfert, based upon special observations made in the winters of 1901-1902 and 1902-1903 in order to examine the possibility of more precise forecasts of fog.

The study of the properties and behaviour of fog is especially important for large towns in consequence of the economic and hygienic results which follow the incidence of dense fogs. The fogs of London in particular have long been a subject of inquiry. It is difficult to get trustworthy statistics on the subject in consequence of the vagueness of the practice as regards the classification of fog. For large towns there is great advantage in using a fog scale such as that given above, in which one deals only with the practical range of vision irrespective of the meteorological cause.

Accepting the classification which distinguishes between fog and haze or mist, but not between the two latter terms, as equivalent to specifying fog when the thickness amounts to the figure 2 or more on the fog scale, we are enabled to compare the frequency of fog in London by the comparison of the results at the London observing stations. The comparison was made by Mr Brodie in a paper read before the Royal Meteorological Society (*Quarterly Journal*, vol. 31, p. 15), and it appears therefrom that in recent years there has been a notable diminution of fog frequency, as indicated in 590
the following table of the total number of days of fog in the years from 1871:—

1871.	1872.	1873.	1874.	1875.	1876.	1877.	1878.	1879.	1880.	1881.	1882.	1883.	1884.	1885.	1886.	1887.	1888.	18
42	35	75	53	49	40	46	63	69	74	59	69	61	53	69	86	83	62	7

1890.	1891.	1892.	1893.	1894.	1895.	1896.	1897.	1898.	1899.	1900.	1901.	1902.	1903.	1904.	1905.	1906.	1907.	19
65	69	68	31	51	48	43	48	47	56	13	45	42	26	44	19	16	37	1

But from any statistics of the frequency occurrence of fog it must not be understood that the atmosphere of London is approaching that of the surrounding districts as regards transparency. Judged by the autographic records it is still almost opaque to sunshine strong enough to burn the card of the recorder during the winter months.

The bibliography of fog is very extensive. The titles referring to fog, mist and haze in the *Bibliography of Meteorology* (part ii.) of the U.S. Signal Office, published in 1889, number 306. Among more recent authors on the subject, besides those referred to in the text, may be mentioned:—Köppen, “Bodennebel,” *Met. Zeit.* (1885); Trabert, *Met. Zeit.* (1901), p. 522; Elias in *Ergebnisse des aëronautischen Observatoriums bei Berlin*, ii. (Berlin, 1904); Scott, *Q.J.R. Met. Soc.* xix. p. 229; A.G. McAdie, “Fog Studies,” *Amer. Inv.* ix. (Washington, D.C., 1902), p. 209; Buchan, “Fogs on the Coasts of Scotland,” *Journ. Scot. Met. Soc.* xii. p. 3.

(W. N. S.)

FOGAZZARO, ANTONIO (1842-   ), Italian novelist and poet, was born at Vicenza in 1842. He was a pupil of the Abate Zanella, one of the best of the modern Italian poets, whose tender, thoughtful and deeply religious spirit continued to animate his literary productions. He began his literary career with *Miranda*, a poetical romance (1874), followed in 1876 by *Valsolda*, which, republished in 1886 with considerable additions, constitutes perhaps his principal claim as a poet, which is not inconsiderable. To the classic grandeur of Carducci and D'Annunzio's impetuous torrent of melody Fogazzaro opposes a Wordsworthian simplicity and pathos, contributing to modern Italian literature wholesome elements of which it would otherwise be nearly destitute. His novels, *Malombra* (1882), *Daniele Cortis* (1887), *Misterio del Poeta* (1888), obtained considerable literary success upon their first publication, but did not gain universal popularity until they were discovered and taken up by French critics in 1896. The demand then became prodigious, and a new work, *Piccolo Mondo antico* (1896), which critics far from friendly to Fogazzaro's religious and philosophical ideas pronounced the best Italian novel since *I Promessi Sposi*, went through numerous editions. Even greater sensation was caused by his novel *Il Santo* (*The Saint*, 1906), on account of its being treated as unorthodox by the Vatican; and Fogazzaro's sympathy with the Liberal Catholic movement—his own Catholicism being well known—made this novel a centre of discussion in the Roman Catholic world.

See the biography by Molmenti (1900).

FOGELBERG, BENEDICT (or Bengt) **ERLAND** (1786-1854), Swedish sculptor, was born at Gothenburg on the 8th of August 1786. His father, a copper-founder, encouraging an early-exhibited taste for design, sent him in 1801 to Stockholm, where he studied at the school of art. There he came much under the influence of the sculptor Sergell, who communicated to him his own enthusiasm for antique art and natural grace. Fogelberg worked hard at Stockholm for many years, although his instinct for severe beauty rebelled against the somewhat rococo quality of the art then prevalent in the city. In 1818 the grant of a government pension enabled him to travel. He studied from one to two years in Paris, first under Pierre Guérin, and afterwards under the sculptor Bosio, for the technical practice of sculpture. In 1820 Fogelberg realized a dream of his life in visiting Rome, where the greater part of his remaining years were spent in the assiduous practice of his art, and the careful study and analysis of the works of the past. Visiting his native country by royal command in 1854, he was received with great enthusiasm, but nothing could compensate him for the absence of those remains of antiquity and surroundings of free natural beauty to which he had been so long accustomed. Returning to Italy, he died suddenly of apoplexy at Trieste on the 22nd of December 1854. The subjects of Fogelberg's earlier works are mostly taken from classic mythology. Of these, "Cupid and Psyche," "Venus entering the Bath," "A Bather" (1838), "Apollo Citharede," "Venus and Cupid" (1839) and "Psyche" (1854) may be mentioned. In his representations of Scandinavian mythology Fogelberg showed, perhaps for the first time, that he had powers above those of intelligent assimilation and imitation. His "Odin" (1831), "Thor" (1842), and "Balder" (1842), though influenced by Greek art, display considerable power of independent imagination. His portraits and historical figures, as those of Gustavus Adolphus (1849), of Charles XII. (1851), of Charles XIII. (1852), and of Birger Jarl, the founder of Stockholm (1853), are faithful and dignified works.

See Casimir Leconte, *L'Œuvre de Fogelberg* (Paris, 1856).

FOGGIA, a town and episcopal see (since 1855) of Apulia, Italy, the capital of the province of Foggia, situated 243 ft. above sea-level, in the centre of the great Apulian plain, 201 m. by rail S.E. of Ancona and 123 m. N.E. by E. of Naples. Pop. (1901) town, 49,031; commune, 53,134. The name is probably derived from the pits or cellars (*foveae*) in which the inhabitants store their grain. The town is the medieval successor of the ancient Arpi, 3 m. to the N.; the Normans, after conquering the district from the Eastern empire, gave it its first importance. The date of the erection of the cathedral is probably about 1179; it retains some traces of Norman architecture, and the façade has a fine figured cornice by Bartolommeo da Foggia; the crypt has capitals of the 11th (?) century. The whole church was, however, much altered after the earthquake of 1731. A gateway of the palace of the emperor Frederick II. (1223, by Bartolommeo da Foggia) is also preserved. Here died his third wife, Isabella, daughter of King John of England. Charles of Anjou died here in 1284. After his son's death, it was a prey to internal dissensions and finally came under Alphonso I. of Aragon, who converted the pastures of the Apulian plain into a royal domain in 1445, and made Foggia the place at which the tax on the sheep was to be paid and the wool to be sold. The other buildings of the town are modern. Foggia is a commercial centre of some importance for the produce of the surrounding country, and is also a considerable railway centre, being situated on the main line from Bologna to Brindisi, at the point where this is joined by the line from Benevento and Caserta. There are also branches to Rocchetta S. Antonio (and thence to either Avellino, Potenza, or Gioia del Colle), to Manfredonia, and to Lucera.

FÖHN (Ger., probably derived through Romansch *favongn*, *favoign*, from Lat. *favonius*), a warm dry wind blowing down the valleys of the Alps from high central regions, most frequently in winter. The Föhn wind often blows with great violence. It is caused by the indraft of air from the elevated region to areas of low barometric pressure in the neighbourhood, and the warmth and dryness are due to dynamical compression of the air as it descends to lower levels. Similar local winds occur in many parts of the world, as Greenland, and on the slopes of the Rocky Mountains. In the southern Alpine valleys the Föhn wind is often called sirocco, but its nature and cause are different from the true sirocco. The belief that the warm dry wind comes from the Sahara dies hard; and still finds expression in some textbooks.

For a full account of these winds see Hann, *Lehrbuch der Meteorologie*, p. 594.

FÖHR, a German island in the North Sea, belonging to the province of Schleswig-Holstein, and situated off its coast. Pop. 4500. It comprises an area of 32 sq. m., and is reached by a regular steamboat service from Husum and Dagebüll on the mainland to Wyk, the principal bathing resort on the E. coast of the island. The chief attraction of Wyk is the Sandwall, a promenade which is shaded by trees and skirts the beach. Föhr, the most fertile of the North Frisian islands, is principally marshland, and comparatively well wooded. There are numerous pleasantly-situated villages and hamlets scattered over it, of which the most frequented are Boldixum, Nieblum and Alkersum. The inhabitants are mainly engaged in the fishing industry, and are known as excellent sailors. 591

FOIL. 1. (Through O. Fr. from Lat. *folium*, a leaf, modern Fr. *feuille*), a leaf, and so used in heraldry and in plant names, such as the “trefoil” clover; and hence applied to anything resembling a leaf. In architecture, the word appears for the small leaf-like spaces formed by the cusps of tracery in windows or panels, and known, according to the number of such spaces, as “quatrefoil,” “cinquefoil,” &c. The word is also found in “counterfoil,” a leaf of a receipt or cheque book, containing memoranda or a duplicate of the receipt or draft, kept by the receiver or drawer as a “counter” or check. “Foil” is particularly used of thin plates of metal, resembling a leaf, not in shape as much as in thinness. In thickness foil comes between “leaf” and “sheet” metal. In jewelry, a foil of silvered sheet copper, sometimes known as Dutch foil, is used as a backing for paste gems, or stones of inferior lustre or colour. This is coated with a mixture of isinglass and translucent colour, varying with the stones to be backed, or, if only brilliancy is required, left uncoloured, but highly polished. From this use of “foil,” the word comes to mean, in a figurative sense, something which by contrast, or by its own brightness, serves to heighten the attractive qualities of something else placed in juxtaposition. The commonest “foil” is that generally known as “tinfoil.” The ordinary commercial “tinfoil” usually consists chiefly of lead, and is used for the wrapping of chocolate or other sweetmeats, tobacco or cigarettes. A Japanese variegated foil gives the effect of “damaskeening.” A large number of thin plates of various metals, gold, silver, copper, together with alloys of different metals are soldered together in a particular order, a pattern is hammered into the soldered edges, and the whole is hammered or rolled into a single thin plate, the pattern then appearing in the order in which the various metals were placed.

2. (From an O. Fr. *fuler* or *foler*, modern *fouler*, to tread or trample, to “full” cloth, Lat. *fullo*, a fuller), an old hunting term, used of the running back of an animal over its own tracks, to confuse the scent and baffle the hounds. It is also used in wrestling, of a “throw.” Thus comes the common use of the word, in a figurative sense, with reference to both these meanings, of baffling or defeating an adversary, or of parrying an attack.

3. As the name of the weapon used in fencing (see Foil-Fencing) the word is of doubtful origin. One suggestion, based on a supposed similar use of Fr. *fleuret*, literally a “little flower,” for the weapon, is that foil means a leaf, and must be referred in origin to Lat. *folium*. A second suggestion is that it means “blunted,” and is the same as (2). A third is that it is an adaptation of an expression “at foils,” *i.e.* “parrying.” Of these suggestions, according to the *New English Dictionary*, the first has nothing to support it, the second is not supported by any evidence that in sense (2) the word ever meant to blunt. The third has some support. Finally a suggestion is made that the word is an alteration of an old word “foin,” meaning a thrust with a pointed weapon. The origin of this word is probably an O. Fr. *foisne*, from the Lat. *fuscina*, a three-pronged fork.

FOIL-FENCING, the art of attack and defence with the fencing-foil. The word is used in several spellings (foyle, file, &c.) by the English writers of the last half of the 16th century, but less in the sense of a weapon of defence than merely as an imitation of a real weapon. Blunt swords for practice in fencing have been used in all ages. For the most part these were of wood and flat in general form, but when, towards the close of the 17th century, all cutting action with the small-sword was discarded (see Fencing), foil-blades were usually made of steel, and either round, three-cornered or four-cornered in form, with a button covering the point. The foil is called in French *fleuret*, and in Italian *fioretto* (literally “bud”) from this button. The classic small-sword play of the 17th and 18th centuries is represented at the present time by fencing with the *épée de combat* (fighting-rapier), which is merely the modern duelling-sword furnished with a button (see Épée-de-Combat), and by foil-fencing. Foil-fencing is a conventional art, its characteristic limitation lying in the rule that no hits except those on the body shall be considered good, and not even those unless they be given in strict accordance with certain standard precepts. In épée-fencing on the contrary, a touch on any part of the person, however given, is valid. Foil-fencing is considered the basis, so far as practice is concerned, of all sword-play, whether with foil, épée or sabre.

There are two recognized schools of foil-fencing, the French and the Italian. The French method, which is now generally adopted everywhere except in Italy, is described in this article, reference being made to the important differences between the two schools.

The Foil.—The foil consists of the “blade” and the “handle.” The blade, which is of steel and has a quadrangular section, consists of two parts: the blade proper, extending from the guard to the button, and the “tongue,” which runs through the handle and is joined to the pommel. The blade proper is divided into the “forte,” or thicker half (next the handle), and the “foible” or thinner half. Some authorities divide the blade proper into three parts, the “forte,” “middle” and “foible.” The handle is comprised of the “guard,” the “grip” and the “pommel.” The guard is a light piece of metal shaped like the figure 8 (Fr. *lunettes*, spectacles) and backed with a piece of stiff leather of the same shape. The grip, which is grasped by the hand, is a hollow piece of wood, usually wound with twine, through which the tongue of the blade passes. The pommel is a piece of metal, usually pear-shaped, to which the end of the tongue is joined and which forms the extremity of the handle. The blade from guard to button is about 33 in. long (No. 5), though a somewhat shorter and lighter blade is generally used by ladies. The handle is about 8 in. long and slightly curved downwards.

The genuine Italian foil differs from the French in having the blade a trifle longer and more whippy, and in the form of the handle, which consists of a thin, solid, bell-shaped guard from 4 to 5 in. in diameter, a straight grip and a light metal bar joining the grip with the guard, beyond the edge of which it extends slightly on each side. Of late years many Italian masters use French blades and even discard the cross-bar, retaining, however, the bell-guard.

In holding the foil, the thumb is placed on the top or convex surface of the grip (the sides of which are a trifle narrower than the top and bottom), while the palm and fingers grasp the other three sides. This is the position of “supination,” or thumb-up. “Pronation” is the reverse position, with the knuckles up. The French lay stress upon holding the foil lightly, the necessary pressure being exerted mostly by the thumb and forefinger, the other fingers being used more to guide the direction of the executed movements. This is in order to give free scope to the *doigté* (fingering), or the faculty of directing the point of the foil by the action of the fingers alone, and includes the possibility of changing the position of the hand on the grip. Thus, in parrying, the end of the thumb is placed within half an inch, or even less, of the guard, while in making a lunge, the foil is held as near the pommel as possible, in order to gain additional length. It will be seen that *doigté* is impossible with the Italian foil, in holding which the forefinger is firmly interlaced with the cross-bar, preventing any movement of the hand. The lightness of grasp inculcated by the French is illustrated by the rule of the celebrated master Lafaugère: "Hold your sword as if you had a little bird in your hand, firmly enough to prevent its escape, yet not so firmly as to crush it." This lightness has for a consequence that a disarmament is not considered of any value in the French school.

To Come on Guard.—The position of "on guard" is that in which the fencer is best prepared both for attack and defence. It is taken from the position of "attention"; the feet together and at right angles with each other, head and body erect, facing forward in the same direction as the right foot, left arm and hand hanging in touch with the body, and the right arm and foil forming a straight line so that the button is about 1 yd. in front of the feet and 4 in. from the floor. From this position the movements to come "on guard" are seven in number:— 592

1. Raise the arm and foil and extend them towards the adversary (or master) in a straight line, the hand being opposite the eye.

2. Drop the arm and foil again until the point is about 4 in. from the floor.

3. Swing the button round so that it shall point horizontally backwards, and hold the hilt against the left thigh, the open fingers of the left hand being held, knuckles down, against the guard and along the blade.

4. Carry the foil, without altering the position of the hands, above the head until the arms are fully extended, the foil being kept horizontal and close to the body as it is lifted.

5. Let the left arm fall back behind the head to a curved position, the hand being opposite the top of the head; at the same time bring the right hand down opposite the right breast and about 8 in. from it; keeping the elbow well in and the point of the foil directed towards the opponent's eye.

6. Bend the legs by separating them at the knees but without moving the feet.

7. Shift the weight of the body on to the left leg and advance the right foot a short distance (from 14 to 18 in., according to the height of the fencer).

In the Italian school the fencer stands on guard with the right arm fully extended, the body more effaced, *i.e.* the left shoulder thrown farther back, and the feet somewhat farther apart. At the present time, however, many of the best Italian fencers have adopted the guard with crooked sword-arm, owing to their abandonment of the old long-foil blade.

The Recover (at the close of the lesson or assault).—To recover "in advance": extend the right arm at right angles with the body, drop the left arm and straighten the legs by drawing the rear foot up to the one in advance. To recover "to the rear": extend the right arm and drop the left as before, and straighten the legs by drawing the forward foot back to that in the rear.

The Salute always follows the recover, the two really forming one manœuvre. Having recovered, carry the right hand to a position just in front of the throat, knuckles out, foil vertical with point upwards; then lower and extend the arm with nails up until the point is 4 in. from the floor and slightly to the right.

To Advance.—Being on guard, take a short step forward with the right foot and let the left foot follow immediately the same distance, the position of the body not being changed. However the step, or series of steps, is made, the right foot should always move first.

To Retreat.—This is the reverse of the advance, the left foot always moving first.

The Calls (*deux appels*).—Being on guard, tap the floor twice with the right foot without altering the position of any other part of the person. The object of the calls is to test the equilibrium of the body, and they are usually executed as a preliminary to the recover.

The Lunge is the chief means of attack. It is immediately preceded by the movement of "extension," in fact the two really form one combined movement. Extension is executed by quickly extending the right arm, so that point, hand and shoulder shall have the same elevation; no other part of the person is moved. The "lunge" is then carried out by straightening the left leg and throwing forward the right foot, so that it shall be planted as far forward as possible without losing the equilibrium or preventing a quick recovery to the position of guard. The left foot remains firmly in its position, the right shoulder is advanced, and the left arm is thrown down and back (with hand open and thumb up), to balance the body. The recovery to the position of guard is accomplished by smartly throwing the body back by the exertion of the right leg, until its weight rests again on the left leg, the right foot and arms resuming their on-guard positions. The point upon which the French school lays most stress is, that the movement of extension shall, if only by a fraction of a second, actually precede the advance of the right foot. The object of this is to ensure the accuracy of the lunge, *i.e.* the direction of the point.

The Gain.—This consists in bringing up the left foot towards the right (the balance being shifted), keeping the knees bent. In this manner a step is gained and an exceptionally long lunge can be made without the knowledge of the adversary. It is a common stratagem of fencers whose reach is short.

Defence.—For the purpose of nomenclature the space on the fencer's jacket within which hits count is divided into quarters, the two upper ones being called the "high lines," and the two lower ones the "low lines." Thus a thrust directed at the upper part of the breast is called an attack in the high lines. In like manner the parries are named from the different quarters they are designed to protect. There are four traditional parries executed with the hand in supination, and four others, practically identical in execution, made with the hand held in pronation. Thus the parries defending the upper right-hand quarter of the jacket are "sixte" (sixth; with the hand in supination) and "tierce" (third; hand in pronation). Those defending the upper left-hand quarter are "quarte" (fourth; in supination) and "quinte" (fifth; in pronation). Those defending the lower right-hand quarter are "octave" (eighth; in supination) and "seconde" (second; in pronation). Those defending the lower left-hand quarter are "septime" (seventh; in supination), more generally called "demicircle," or "half-circle"; and "prime" (first; in pronation).

The Parries.—The tendency of the French school has always been towards simplicity, especially of defence, and at the present day the parries made with the knuckles up (pronation), although recognized and taught, are seldom if ever used against a strong adversary in foil-fencing, owing principally to the time lost in turning the hand. The theory of parrying is to turn aside the opponent's foil with the least possible expenditure of time and exertion, using the arm as little as possible while letting the hand and wrist do the work, and opposing the "forte" of the foil to the "foible" of the adversary's. The foil is kept pointed as directly as possible towards the adversary, and the parries are made rather with the corners than the sides of the blade. The slightest movement that will turn aside the opponent's blade is the most perfect parry. There are two kinds of parries, “simple,” in which the attack is warded off by a single movement, and “counter,” in which a narrow circle is described by the point of the foil round that of the opponent, which is thus enveloped and thrown aside. There are also complex parries, composed of combinations of two or more parries, which are used to meet complicated attacks, but they are all resolvable into simple parries. In parrying, the arm is bent about at right angles.

Simple Parries.—The origin of the numerical nomenclature of the parries is a matter of dispute, but it is generally believed that they received their names from the positions assumed in the process of drawing the sword and falling on guard. Thus the position of the hand and blade, the moment it is drawn from the scabbard on the left side, is practically that of the first, or “prime,” parry. To go from “prime” to “seconde” it is only necessary to drop the hand and carry it across the body to the left side; thence to “tierce” is only a matter of raising the point of the sword, &c.

Parry of Prime (to ward off attacks on the—usually lower—left-hand side of the body). Hold the hand, knuckles up, opposite the left eye and the point directed towards the opponent’s knee. This parry is now regarded more as an elegant evolution than a sound means of defence, and is little employed.

Parry of Seconde (against thrusts at the lower right-hand side). This is executed by a quick, not too wide movement of the hand downwards and slightly to the right, knuckles up.

Parry of Tierce (against thrusts at the upper right-hand side). A quick, dry beat on the adversary’s “foible” is given, forcing it to the right, the hand, in pronation, being held opposite the middle of the right breast. This parry has been practically discarded in favour of “sixte.”

Parry of Quarte (against thrusts at the upper left-hand side). This parry, perhaps the most used of all, is executed by forcing the adversary’s blade to the left by a dry beat, the hand being in supination, opposite the left breast.

Parry of Quinte (against thrusts at the left-hand side, like “quarte”). This is practically a low “quarte,” and is little used.

Parry of Sixte (against thrusts at the upper right-hand side). This parry is, together with “quarte,” the most important of 593
all. It is executed with the hand held in supination opposite the right breast, a quick, narrow movement throwing the adversary’s blade to the right.

Parry of Septime or Half-Circle (against thrusts at the lower left-hand side) is executed by describing with the point of the foil a small semicircle downward and towards the left, the hand moving a few inches in the same direction, but kept thumb up.

Parry of Octave (against thrusts at the lower right-hand side) is executed by describing with the point of the foil a small semicircle downward and towards the right, the hand moving a few inches in the same direction, but kept thumb up.

Counter Parries (Fr. *contre*).—Although the simple parries are theoretically sufficient for defence, they are so easily deceived by feints that they are supplemented by counter parries, in which the blade describes narrow circles, following that of the adversary and meeting and turning it aside; thus the point describes a complete circle while the hand remains practically stationary. Each simple parry has its counter, made with the hand in the same position and on the same side as in the simple parry. The two most important are the “counter of quarte” and the “counter of sixte,” while the counters of “septime” and “octave” are less used, and the other four at the present time practically never.

Counter of Quarte.—Being on guard in quarte (with your adversary’s blade on the left of yours), if he drops his point under and thrusts in sixte, in other words at your right breast, describe a narrow circle with your point round his blade, downward to the right and then up over to the left, bringing hand and foil back to their previous positions and catching and turning aside his blade on the way. The “Counter of Sixte” is executed in a similar manner, but the circle is described in the opposite direction, throwing off the adverse blade to the right. The “Counters of Septime and Octave” are similar to the other two but are executed in the low lines.

Complex or Combined Parries are such as are composed of two or more parries executed in immediate succession, and are made in answer to feint attacks by the adversary (see below); *e.g.* being on guard in quarte, should the adversary drop his point under and feint at the right breast but deflect the point again and really thrust on the left, it is evident that the simple parry of sixte would cover the right breast but would leave the real point of attack, the left, entirely uncovered. The sixte parry is therefore followed, as a continuation of the movement, by the parry of quarte, or a counter parry. The complex parries are numerous and depend upon the attack to be met.

Engagement is the junction of the blades, the different engagements being named from the parries. Thus, if both fencers are in the position of quarte, they are said to be engaged in quarte. To engage in another line (Change of Engagement) *e.g.* from quarte to sixte, the point is lowered and passed under the adversary’s blade, which is pressed slightly outward, so as to be well covered (called “opposition”). “Double Engagement” is composed of two engagements executed rapidly in succession in the high lines, the last with opposition.

Attack.—The attack in fencing comprises all movements the object of which is to place the point of the foil upon the adversary’s breast, body, sides or back, between collar and belt. The space upon which hits count is called the “target” and differs according to the rules prevailing in the several countries, but is usually as above stated. In Great Britain no hits above the collar-bones count, while in America the target is only the left breast between the median line and a line running from the armpit to the belt. The reason for this limitation is to encourage accuracy.

Attacks are either “primary” or “secondary.” *Primary Attacks* are those initiated by a fencer before his adversary has made any offensive movement, and are divided into “Simple,” “Feint” and “Force” attacks.

Simple Attacks, the characteristic of which is pace, are those made with one simple movement only and are four in number, viz. the “Straight Lunge,” the “Disengagement,” the “Counter-disengagement” and the “Cut-over.” The Straight-Lunge (*coup droit*), used when the adversary is not properly covered when on guard, is described above under “Lunge.” The Disengagement is made by dropping the point of the foil under the opponent’s blade and executing a straight lunge on the other side. It is often used to take an opponent unawares or when he presses unduly hard on your blade. The Counter-disengagement is used when the adversary moves his blade, *i.e.* changes the line of engagement, upon which you execute a narrow circle, avoiding his blade, and thrust in your original line. The Cut-over (*coupé*) is a disengagement executed by passing the point of the foil over that of the adversary and lunging in the opposite line. The preliminary movement of raising the point is made by the action of the hand only, the arm not being drawn back.

Feint Attacks, deceptive in character, are those which are preceded by one or more feints, or false thrusts made to lure the adversary into thinking them real ones. A feint is a simple extension, often with a slight movement of the body, threatening the adversary in a certain line, for the purpose of inducing him to parry on that side and thus leave the other open for the real thrust. At the same time any movement of the blade or any part of the body tending to deceive the adversary in regard to the nature of the attack about to follow, must also be considered a species of feint. The principal feint attacks are the “One-Two,” the “One-Two-Three” and the “Double.”

The “One-Two” is a feint in one line, followed (as the adversary parries) by a thrust in the original line of engagement.

Thus, being engaged in quarte, you drop your point under the adversary’s blade and extend your arm as if to thrust at his left breast, but instead of doing this, the instant he parries you move your point back again and lunge in quarte, *i.e.* on the side on which you were originally engaged. In feinting it is necessary that the extension of the arm and blade be so complete as really to compel the adversary to believe it a part of a real thrust in that line.

The “One-Two-Three” consists of two feints, one at each side, followed by a thrust in the line opposite to that of the original engagement. Thrusts preceded by three feints are also sometimes used. It is evident that the above attacks are useless if the adversary parries by a counter (circular parry), which must be met by a “Double.” This is executed by feinting and, upon perceiving that the adversary opposes with a circular parry, by following the circle described by his point with a similar circle, deceiving (*i.e.* avoiding contact with) his blade and thrusting home.

The “Double,” which is a favourite manœuvre in fencing, is a combination of a disengagement and a counter-disengagement.

Force-Attacks, the object of which is to disconcert the opponent by assaulting his blade, are various in character, the principal ones being the “Beat,” the “Press,” the “Glide” and the “Bind.” The “Beat” is a quick, sharp blow of the forte of the foil upon the foible of the adversary’s, for the purpose of opening a way for a straight lunge which follows instantly. The blow is made with the hand only. A “false beat” is a lighter blow made for the purpose of drawing out or disconcerting the opponent, and is often followed by a disengagement. The “Press” is similar in character to the beat, but, instead of striking the adverse blade, a sudden pressure is brought to bear upon it, sufficiently heavy to force it aside and allow one’s own blade to be thrust home. A “false press” may be used to entice the adversary into a too heavy responsive pressure, which may then be taken advantage of by a disengagement. The “Traverse” (Fr. *froissé*, Ital. *striscio*) is a prolonged press carried sharply down the adverse blade towards the handle. The “Glide” (“Graze,” Fr. *coulé*) is a stealthy sliding of one’s blade down that of the adversary, without his notice, until a straight thrust can be made inside his guard. It is also used as a feint before a disengage. The “Bind” (*liement*) consists in gaining possession of the adversary’s foible with one’s forte, and pressing it down and across into the opposite low line, when one’s own point is thrust home, the adversary’s blade being still held by one’s hilt. It may be also carried out from a low line into a high one. The bind is less 594 used in the French school than in the Italian. The “Flanconnade” is a bind made by capturing the adversary’s blade in high quarte, carrying it down and thrusting in the outside line with strong opposition. Another attack carried out by means of a twist and thrust is the “Cross” (*croisé*), which is executed when the adversary’s blade is held low by passing one’s point over his wrist and forcing down both blades into seconde with a full extension of the arm. The result is to create a sudden and wide opening, and often disarms the adversary.

Secondary Attacks are those made (1) just as your adversary himself starts to attack; (2) during his attack; and (3) on the completion of his attack if it fails.

1. “Attacks on the Preparation” are a matter of judgment and quickness. They are usually attempted when the adversary is evidently preparing a complicated attack, such as the “one-two-three” or some other manœuvre, involving one or more preliminary movements. At such a time a quick thrust will often catch him unawares and score. Opportunities for preparation attacks are often given when the adversary attempts a beat preliminary to his thrust; the beat is frustrated by an “absence of the blade,” *i.e.* your blade is made to avoid contact with his by a narrow movement, and your point thrust home into the space left unguarded by the force of his unresisted beat. Or the adversary himself may create an “absence” by suddenly interrupting the contact of the blades, in the hope that, by the removal of the pressure, your blade will fly off to one side, leaving an opening; if, however, you are prepared for his “absence” a straight thrust will score.

2. The chief “Attacks on the Development,” or “Counter Attacks,” are the “Stop Thrust” and the “Time Thrust,” both made while the adversary is carrying out his own attack. The “Stop Thrust” (*coup d’arrêt*) is one made after the adversary has actually begun an attack involving two or more movements, and is only justified when it can be brought off without your being hit by the attacking adversary’s point on any part of the person. The reason for this is, that the rules of fencing decree that the fencer attacked must parry, and that, if he disregards this and attempts a simultaneous counter attack, he must touch his opponent while totally avoiding the latter’s point. Should he, however, be touched, even on the foot or mask, by the adversary, his touch, however good, is invalid. If both touches are good, that of the original attacker only counts. Stop thrusts are employed mostly against fencers who attack wildly or without being properly covered. The “Time Thrust” is delivered with opposition upon the adversary’s composite attack (one involving several movements), and, if successful, generally parries the original attack at the same time. It is not valid if the fencer employing it is touched on any part of the person.

3. “Attacks on the Completion” (*i.e.* of the adversary’s attack) are “Ripostes,” “Counter-ripostes,” “Remises” and “Renewals of Attack.”

The *Riposte* (literally, response) is an attack made, immediately after parrying successfully, by merely straightening the arm, the body remaining immovable. The “counter-riposte” is a riposte made after parrying the adversary’s riposte, and generally from the position of the lunge, or while recovering from it, since one must have attacked with a full lunge if the adversary has had an opportunity to deliver a riposte. There are three kinds of ripostes: direct, with feints and after a pause.

The “direct *riposte*” may be made instantly after parrying the adversary’s thrust by quitting his blade and straightening the arm, so that the point will touch his body on the nearest and most exposed part; or by not quitting his blade but running yours quickly down his and at the same time keeping a strong opposition (“riposte d’opposition”). The quickest direct riposte is that delivered after parrying quarte (for a right-hand fencer), and is called by the French the riposte of “*tac-au-tac*,” imitative of the sudden succession of the click of the parry and the tap of the riposting fencer’s point on his adversary’s breast. In making “ripostes with a feint” the point is not jabbed on to the opponent’s breast immediately after the parry, but one or more preliminary movements precede the actual riposte, such as a disengagement, a cut-over or a double.

Ripostes with a pause (*à temps perdu*, with lost time) are made after a second’s hesitation, and are resorted to when the fencers are too near for an accurate direct riposte, or to give the adversary time to make a quick parry, which is then deceived.

The *remise* is a thrust made after one’s first thrust has been parried and in the same line; it must be made in such a way that the adversary’s justified riposte is at the same time parried by opposition or completely avoided. It is really a renewal of the attack in the original line, while the so-called “renewal of attack” (“*redoublement d’attaque*”) is a second thrust which ignores the adversary’s riposte, but made in a different line. Both the remise and the renewal are valid only when the adversary’s riposte does not hit.

“False Attacks” are broad movements made for the purpose of drawing the adversary out or of disconcerting him. They may consist of an advance, an extension, a change of engagement, an intentional uncovering by taking a wide guard (called “invitation guard”), or any movement or combination of movements tending to make the adversary believe that a real attack is under way.

“The Assault” is a formal fencing bout or series of bouts in public, while formal fencing in private is called “loose play” or a “friendly bout.” Bouts between fencers take place on a platform about 24 ft. long and 6 ft. wide (in the United States 20 × 3 ft.). Formal bouts are usually for a number of touches, or for a certain number of minutes, the fencer who touches oftenest winning. The judges (usually three or five) are sometimes empowered to score one or more points against a competitor for breaches of good form, or for overstepping the space limits. In the United States bouts are for four minutes, with a change of places after two minutes, and the competitors are not interrupted, the winner being indicated by a vote of the judges, who take into account touches and style. In all countries contestants are required to wear jackets of a light colour, so that hits may be easily seen. Audible acknowledgment of all touches, whether on the target or not, is universally considered to be a fencer’s duty. Fencing competitions are held in Great Britain under the rules of the Amateur Fencing Association, and in the United States under those of the Amateur Fencers’ League of America.

Fencing Terms (not mentioned above): “*Cavazione*,” Ital. for disengagement. “Contraction, Parries of,” those which do not parry in the simplest manner, but drag the adverse blade into another line, *e.g.* to parry a thrust in high sixte by counter of quarte. “*Controtempo*,” Ital. for time-thrust. “Coronation,” an attack preceded by a circular movement from high sixte to high quarte (and vice versa) made famous by Lafaugère. “*Corps-à-corps*” (body to body), the position of two fencers who are at such close quarters that their persons touch: when this occurs the fencers must again come on guard. “*Coulé*,” Fr. for glide. “Disarm,” to knock the foil out of the adversary’s hand; it is of no value in the French school. “Double Hit,” when both fencers attack and hit at the same time; neither hit counts. “*Filo*,” Ital. for glide (graze). “Flying Cut-over,” a cut-over executed as a continuation of a parry, the hand being drawn back towards the body. “*Incontro*,” Ital. for double attack. “Give the blade,” to allow the adversary easy contact with the foil; it is often resorted to in order to tempt the adversary into a beat or bind. “Menace,” to threaten the adversary by an extension and forward movement of the trunk. “*Mur*,” see “Salute.” “Passage of arms,” a series of attacks and parries, ending in a successful hit. “Phrase of arms,” a series of attacks and parries ending in a hit or invalidation. “Invalidation,” a hit on some part of the person outside the target, made by the fencer whose right it is at that moment to attack or riposte; such a hit invalidates one made simultaneously or subsequently by his opponent, however good. “Rebeat,” two beats, executed as quickly as possible together, one on each side of the adversary’s blade. “*Reprises d’attaque*,” Fr. for renewed attacks. “Salute,” the courteous salutation of the public and the adversary before and after a bout. A more elaborate salute, called by the French the *Mur*, consists of a series of parries, lunges and other evolutions carried out by both fencers at the same time. Important exhibition assaults are usually preceded by the *Mur*, which is called in English the Grand Salute. “*Septime enveloppée*,” a riposte by means of a twist and thrust after a parry in septime. It envelops and masters the adverse blade, whence the name. “Secret thrusts,” the French “*bottes secrètes*,” pretended infallible attacks of which the user is supposed alone to know the method of execution; they have no real existence. “*Sforza,*” Ital. for disarmament. 595
“*Scandaglio,*” Ital for examination, studying the form of an opponent at the beginning of a bout. “*Toccato!*” Ital. for “Touched!”,. Fr. “*Touché*.”

Bibliography.—The literature of foil-fencing is practically identical with that of the art in general (see Fencing). The following modern works are among the best. French School: *Fencing*, in the Badminton library (1897); *Foil and Sabre*, by L. Rondelle (Boston, 1892); “Fencing,” by C. Prevost in the *Encyclopaedia of Sport* (1901); *Fencing*, by Edward Breck (New York, 1906). Italian school: *Istruzione per la scherma, &c.*, by S. de Frae (Milan, 1885); *La Scherma italiana di spada e di sciabola*, by F. Masiello (Florence, 1887).

(E. B.)

FOIX, PAUL DE (1528-1584), French prelate and diplomatist. He studied Greek and Roman literature at Paris, and jurisprudence at Toulouse, where shortly after finishing his curriculum he delivered a course of lectures on civil law, which gained him great reputation. At the age of nineteen he was named councillor of the parlement of Paris. Having in this capacity expressed himself favourable to the adoption of mild measures in regard to certain persons accused of Lutheranism, he was arrested, but escaped punishment, and subsequently regained the favour of the French court. At the end of 1561 he was sent ambassador to England, where he remained four years. He was then sent to Venice, and returned a short time afterwards to England to negotiate a marriage between Queen Elizabeth and the duke of Anjou. He again fulfilled several important missions during the reign of Henry III. of France. In 1577 he was made archbishop of Toulouse, and in 1579 was appointed ambassador to Rome, where he remained till his death in 1584.

Les Lettres de Messire de Paul de Foix, archevesque de Toloze et ambassadeur pour le roy auprès du pape Grégoire XIII, au roi Henry III, were published in 1628, but there are some doubts as to their authenticity. See *Gallia Christiana* (1715 seq.); M.A. Muret, *Oraison funèbre de Paul de Foix* (Paris, 1584); “Lettres de Catherine de Médicis,” edited by Hector de la Ferrière (Paris, 1880 seq.) in the *Collection de documents inédits sur l’histoire de France*.

FOIX, a town of south-western France, in the middle ages capital of the counts of Foix, and now capital of the department of Ariège, 51 m. S. of Toulouse, on the Southern railway from that city to Ax. Pop. (1906) town, 4498; commune, 6750. It is situated between the Ariège and the Arget at their confluence. The old part of the town, with its ill-paved winding streets and old houses, is dominated on the west by an isolated rock crowned by the three towers of the castle (12th, 14th and 15th centuries), while to the south it is limited by the shady Promenade de Villotte. The chief church is that of St Volusien, a Gothic building of the 14th century. The town is the seat of a prefecture, a court of assizes and a tribunal of first instance, and has a lycée, training colleges, a chamber of commerce and a branch of the Bank of France. Flour-milling and iron-working are carried on. Foix probably owes its origin to an oratory founded by Charlemagne. This afterwards became an abbey, in which were laid the remains of St Volusien, archbishop of Tours in the 5th century.

The county of Foix included roughly the eastern part of the modern department of Ariège, a region watered chiefly by the Ariège and its affluents. During the later middle ages it consisted of an agglomeration of small holdings ruled by lords, who, though subordinate to the counts of Foix, had some voice in the government of the district. Protestantism obtained an early entrance into the county, and the religious struggles of the 16th and 17th centuries were carried on with much implacability therein. The estates of the county, which can be traced back to the 14th century, consisted of three orders and possessed considerable power and virility. In the 17th and 18th centuries Foix formed one of the thirty-three governments of France, and in 1790 it was incorporated in the department of Ariège.

Counts of Foix.—The counts of Foix were an old and distinguished French family which flourished from the 11th to the 15th century. They were at first feudatories of the counts of Toulouse, but chafing under this yoke they soon succeeded in throwing it off, and during the 13th and 14th centuries were among the most powerful of the French feudal nobles. Living on the borders of France, having constant intercourse with Navarre, and in frequent communication with England, they were in a position peculiarly favourable to an assertion of independence, and acted rather as the equals than as the dependents of the kings of France.

The title of count of Foix was first assumed by Roger, son of Bernard Roger, who was a younger son of Roger I., count of Carcassonne (d. 1012), when he inherited the town of Foix and the adjoining lands, which had hitherto formed part of the county of Carcassonne. Dying about 1064, Roger was succeeded by his brother Peter, who died six years later, and was succeeded in turn by his son, Roger II. This count took part in the crusade of 1095, and was afterwards excommunicated by Pope Paschal II. for seizing ecclesiastical property; but subsequently he appeased the anger of the church by rich donations, and when he died in 1125 he was succeeded by his son, Roger III. The death of Roger III. about 1149, and of his son, Roger Bernard I., in 1188, brought the county to Roger Bernard’s only son, Raymond Roger, who, in 1190, accompanied the French king, Philip Augustus, to Palestine and distinguished himself at the capture of Acre. He was afterwards engaged in the wars of the Albigenses, and on being accused of heresy his lands were given to Simon IV., count of Montfort. Raymond Roger, who came to terms with the church and recovered his estates before his death in 1223, was a patron of the Provençal poets, and counted himself among their number. He was succeeded by his son, Roger Bernard II., called the Great, who assisted Raymond VII., count of Toulouse, and the Albigenses in their resistance to the French kings, Louis VIII. and Louis IX., was excommunicated on two occasions and died in 1241. His son, Roger IV., who followed, died in 1265, and was succeeded by his son, Roger Bernard III., who, more famous as a poet than as a warrior, was taken prisoner both by Philip III. of France and by Peter III. of Aragon. This count married Marguerite, daughter and heiress of Gaston VII., viscount of Béarn (d. 1290), and this union led to the outbreak of a long feud between the houses of Foix and Armagnac; a quarrel which was continued by Roger Bernard’s son and successor, Gaston I., who became count in 1302, inheriting both Foix and Béarn. Becoming embroiled with the French king, Philip IV., in consequence of the struggle with the count of Armagnac, Gaston was imprisoned in Paris; but quickly regaining his freedom he accompanied King Louis X. on an expedition into Flanders in 1315, and died on his return to France in the same year. His eldest son, Gaston II., was the next count. Having become reconciled with the house of Armagnac, Gaston took part in various wars both in France and Spain, dying at Seville in 1343, when he was succeeded by his son, Gaston III. (1331-1391). Gaston III., who was surnamed Phoebus on account of his beauty, was the most famous member of the old Foix family. Like his father he assisted France in her struggle against England, being entrusted with the defence of the frontiers of Gascony; but when the French king, John II., showed a marked preference for the count of Armagnac, Gaston left his service and went to fight against the heathen in Prussia. Returning to France about 1357 he delivered some noble ladies from the attacks of the adherents of the *Jacquerie* at Meaux, and was soon at war with the count of Armagnac. During this struggle he also attacked the count of Poitiers, the royal representative in Languedoc, but owing to the intervention of Pope Innocent VI. he made peace with the count in 1360. Gaston, however, continued to fight against the count of Armagnac, who, in 1362, was defeated and compelled to pay a ransom; and this war lasted until 1377, when peace was made. Early in 1380 the count was appointed governor of Languedoc, but when Charles VI. succeeded Charles V. as king later in the same year, this appointment was cancelled. Refusing, however, to heed the royal command, and supported by the communes of Languedoc, Gaston fought for about two years against John, duke of Berry, who had been chosen as his successor, until, worsted in the combat, he abandoned the struggle and retired to his estates, remaining neutral and independent. In 1348 the count had married Agnes, daughter of Philip, count of Evreux (d. 1343), by his wife Jeanne II., queen of Navarre. By Agnes, whom he divorced in 1373, he had an only son, Gaston, who is said to have been incited by 596
his uncle, Charles II., king of Navarre, to poison his father, and who met his death in 1381. It is probable, as Froissart says, that he was killed by his father. Left without legitimate sons, Gaston was easily persuaded to bequeath his lands to King Charles VI., who thus obtained Foix and Béarn when the count died at Orthes in 1391. Gaston was very fond of hunting, but was not without a taste for art and literature. Several beautiful manuscripts are in existence which were executed by his orders, and he himself wrote *Déduits de la chasse des bestes sauvaiges et des oiseaulx de proye*. Froissart, who gives a graphic description of his court and his manner of life, speaks enthusiastically of Gaston, saying: “I never saw none like him of personage, nor of so fair form, nor so well made,” and again, “in everything he was so perfect that he cannot be praised too much.”

Almost immediately after Gaston’s death King Charles VI. granted the county of Foix to Matthew, viscount of Castelbon, a descendant of Count Gaston I. Dying without issue in 1398, Matthew’s lands were seized by Archambault, count of Grailly and captal de Buch, the husband of his sister Isabella (d. 1426), who became count of Foix in 1401. Archambault’s eldest son, John (*c.* 1382-1436), who succeeded to his father’s lands and titles in 1412, had married in 1402 Jeanne, daughter of Charles III., king of Navarre. Having served the king of France in Guienne and the king of Aragon in Sardinia, John became the royal representative in Languedoc, when the old quarrel between Foix and Armagnac broke out again. During the struggle between the Burgundians and the Armagnacs, he intrigued with both parties, and consequently was distrusted by the dauphin, afterwards King Charles VII. Deserting the cause of France, he then allied himself with Henry V. of England; but when Charles VII. became king in 1422, he returned to his former allegiance and became the king’s representative in Languedoc and Guienne. He then assisted to suppress the marauding bands which were devastating France; fought for Aragon against Castile; and aided his brother, the cardinal of Foix, to crush some insurgents in Aragon. Peter, cardinal of Foix (1386-1464), was the fifth son of Archambault of Grailly, and was made archbishop of Arles in 1450. He took a prominent part in the struggle between the rival popes, and founded and endowed the Collège de Foix at Toulouse. The next count was John’s son, Gaston IV., who married Leonora (d. 1479), a daughter of John, king of Aragon and Navarre. In 1447 he bought the viscounty of Narbonne, and having assisted King Charles VII. in Guienne, he was made a peer of France in 1458. In 1455 his father-in-law designated him as his successor in Navarre, and Louis XI. of France gave him the counties of Rousillon and Cerdagne, and made him his representative in Languedoc and Guienne; but these marks of favour did not prevent him from joining a league against Louis in 1471. His eldest son, Gaston, the husband of Madeleine, a daughter of Charles VII. of France, died in 1470, and when Gaston IV. died two years later, his lands descended to his grandson, Francis Phoebus (d. 1483), who became king of Navarre in 1479, and was succeeded by his sister Catherine (d. 1517), the wife of Jean d’Albret (d. 1516). Thus the house of Foix-Grailly was merged in that of Albret and subsequently in that of Bourbon; and when Henry of Navarre became king of France in 1589 the lands of the counts of Foix-Grailly became part of the French royal domain. A younger son of Count Gaston IV. was John (d. 1500), who received the viscounty of Narbonne from his father and married Marie, a sister of the French king Louis XII. He was on good terms both with Louis XI. and Louis XII., and on the death of his nephew Francis Phoebus, in 1483, he claimed the kingdom of Navarre against Jean d’Albret and his wife, Catherine de Foix. The ensuing struggle lasted until 1497, when John renounced his claim. He left a son, Gaston de Foix (1489-1512), the distinguished French general, and a daughter, Germaine, who became the second wife of Ferdinand I., king of Spain. In 1507 Gaston exchanged his viscounty of Narbonne with King Louis XII. for the duchy of Nemours, and as duke of Nemours he took command of the French troops in Italy. Having delivered Bologna and taken Brescia, Gaston encountered the troops of the Holy League at Ravenna in April 1512, and after putting the enemy to flight was killed during the pursuit. From the younger branch of the house of Foix-Grailly have also sprung the viscounts of Lautrec and of Meilles, the counts of Bénanges and Candale, and of Gurson and Fleix.

See D.J. Vaissète, *Histoire générale de Languedoc*, tome iv. (Paris, 1876); L. Flourac, *Jean Ier, comte de Foix, vicomte souverain de Béarn* (Paris, 1884); Le Père Anselme, *Histoire généalogique*, tome iii. (Paris, 1726-1733); Castillon, *Histoire du comte de Foix* (Toulouse, 1852); Madaune, *Gaston Phœbus, comte de Foix et souverain de Béarn* (Pau, 1865); and

Froissart's *Chroniques*, edited by S. Luce and G. Raynaud (Paris, 1869-1897).

FOLARD, JEAN CHARLES, Chevalier de (1669-1752), French soldier and military author, was born at Avignon on the 13th of February 1669. His military ardour was first awakened by reading Caesar's *Commentaries*, and he ran away from home and joined the army. He soon saw active service, and, young as he was, wrote a manual on partisan warfare, the manuscript of which passed with Folard's other papers to Marshal Belleisle on the author's death. In 1702 he became a captain, and aide-de-camp to the duke of Vendôme, then in command of the French forces in Italy. In 1705, while serving under Vendôme's brother, the Grand Prior, Folard won the cross of St Louis for a gallant feat of arms, and in the same year he distinguished himself at the battle of Cassano, where he was severely wounded. It was during his tedious recovery from his wounds that he conceived the tactical theories to the elucidation of which he devoted most of his life. In 1706 he again rendered good service in Italy, and in 1708 distinguished himself greatly in the operations attempted by Vendôme and the duke of Burgundy for the relief of Lille, the failure of which was due in part to the disagreement of the French commanders; and it is no small testimony to the ability and tact of Folard that he retained the friendship of both. Folard was wounded at Malplaquet in 1709, and in 1711 his services were rewarded with the governorship of Bourbourg. He saw further active service in 1714 in Malta, under Charles XII. of Sweden in the north, and under the duke of Berwick in the short Spanish War of 1719. Charles XII. he regarded as the first captain of all time, and it was at Stockholm that Folard began to formulate his tactical ideas in a commentary on Polybius. On his way back to France he was shipwrecked and lost all his papers, but he set to work at once to write his essays afresh, and in 1724 appeared his *Nouvelles Découvertes sur la guerre dans une dissertation de Polybe*, followed (1727-1730) by *Histoire de Polybe traduite par ... de Thuillier avec un commentaire ... de M. de Folard, Chevalier de l'Ordre de St Louis*. Folard spent the remainder of his life in answering the criticisms provoked by the novelty of his theories. He died friendless and in obscurity at Avignon in 1752.

An analysis of Folard's military writings brings to light not a connected theory of war as a whole, but a great number of independent ideas, sometimes valuable and suggestive, but far more often extravagant. The central point of his tactics was his proposed column formation for infantry. Struck by the apparent weakness of the thin line of battle of the time, and arguing from the ἔμβολον or *cuneus* of ancient warfare, he desired to substitute the shock of a deep mass of troops for former methods of attack, and further considered that in defence a solid column gave an unshakable stability to the line of battle. Controversy at once centred itself upon the column. Whilst some famous commanders, such as Marshal Saxe and Guido Starhemberg, approved it and put it in practice, the weight of military opinion throughout Europe was opposed to it, and eventually history justified this opposition. Amongst the most discriminating of his critics was Frederick the Great, who is said to have invited Folard to Berlin. The Prussian king certainly caused a *précis* to be made by Colonel von Seers, and wrote a preface thereto expressing his views. The work (like others by Frederick) fell into unauthorized hands, and, on its publication (Paris, 1760) under the title *Esprit du Chev. Folard*, created a great impression. "Thus kept within bounds," said the prince de Ligne, "Folard was the best author of the time." Frederick himself said tersely that 597
"Folard had buried diamonds in a rubbish-heap." Thus began the controversy between line and column formations, which long continued and influenced the development of tactics up to the most modern times. Folard's principal adherents in the 18th century were Joly de Maizeroy and Menil Durand.

See *Mémoires pour servir à l'histoire de M. le Chevalier de Folard* (Paris and Regensburg, 1753), and for a detailed account of Folard's works and those of his critics and supporters. Max Jähns, *Geschichte der Kriegswissenschaften*, vol. ii. pp. 1478-1493 (Munich and Leipzig, 1890).

FOLD, a pleat or bend in a flexible material, or a curve in any surface, whence its particular application in geology with which this article deals. The verb "to fold" (O. Eng. *fealdan*) meant originally to double back a piece of cloth or other material so as to form a pleat, whence has evolved its various senses of to roll up, to enclose, enfold or embrace as with the arms, to clasp the hands or arms together, &c. The word is common to Teutonic languages, cf. Ger. *falten*, Dutch *vouwen* (for *vouden*), &c., and the ultimate Indo-European root is found in Gr. πλέκειν, Lat. *plicare*, *plectere*, to plait, pleat, weave, and in the suffixes of such words as διπλάσιος, *duplex*, double, *simplex*, &c. Similarly the termination "-fold" is added to numbers implying "so many," *e.g.* twofold, hundredfold, cf. "manifold." The similar word for an enclosure or pen for animals, especially for sheep, and hence applied in a spiritual sense to a community of worshippers, or to the whole body of Christians regarded as Christ's flock, must be distinguished. In O. Eng. it is *falæd*, and cognate forms are found in Dutch *vaalt*, &c. It apparently meant a planked or boarded enclosure, cf. Dan. *fjael*, Swed. *fjöl*, plank.

In geology, a fold is a bend or curvature in the stratified rocks of the earth's crust, whereby they have been made to take up less horizontal space. The French equivalents are *pli*, *plissement*, *ridement*; in Germany, *Falte*, *Faltung*, *Sattelung* are the terms usually employed. It is comparatively rarely that bedded rocks are observed in the position in which they were first deposited, a certain amount of buckling up or sagging down of the crust being continually in progress in one region or another. In every instance therefore where, in walking over the surface, we traverse a series of strata which gradually, and without dislocations, increase or diminish in inclination, we cross part of a great curvature in the strata of the earth's crust.

Such foldings, however, can often be distinctly seen, either on some cliff or coast-line, or in the traverse of a piece of hilly or mountainous ground. The observer cannot long continue his researches in the field without discovering that the rocks of the earth's crust have been almost everywhere thrown into curves, usually so broad and gentle as to escape observation except when specially looked for. The outcrop of beds at the surface is commonly the truncation of these curves. The strata must once have risen above the present surface, and in many cases may be found descending to the surface again with a contrary dip, the intervening portion of the undulation having been worn away.

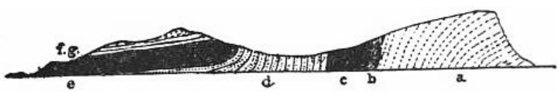


Fig. 1.—Section of the Isle of Wight—a Monoclinal Curve, *a*, Chalk; *b*, Woolwich and Reading beds; *c*, London clay; *d*, Bagshot series; *e*, Headon series; *f, g*, Osborne and Bembridge series.

The curvature occasionally shows itself among horizontal or gently inclined strata in the form of an abrupt inclination, and then an immediate resumption of the previous flat or sloping character. The strata are thus bent up and continue on the other side of the tilt at a higher level. Such bends are called *monoclines*, *monoclinal folds* or *flexures*, because they present only one fold, or one half of a fold, instead of the two which we see in an arch or trough. The most notable instance of this structure in Britain is that of the Isle of Wight, of which a section is given in fig. 1. The Cretaceous rocks on the south side of the island rapidly rise in inclination till they become nearly vertical. The Lower Tertiary strata follow with a similar steep dip, but rapidly flatten down towards the north coast. Some remarkable cases of the same structure have been brought to light by J.W. Powell in his survey of the Colorado region.

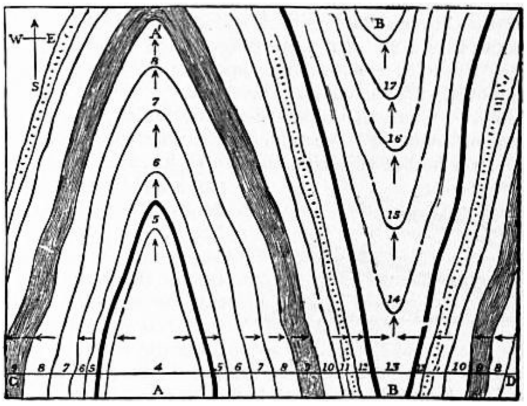


Fig. 2.—Plan of Anticlinal and Synclinal Folds.

It much more frequently happens that the strata have been bent into arches and troughs, so that they can be seen dipping under the surface on one side of the axis of a fold, and rising up again on the other side. Where they dip away from the axis of movement the structure is termed an *anticline* or *anticlinal fold*; where they dip towards the axis, it is a *syncline* or *synclinal fold*. The diagram in fig. 2 may be taken to represent a series of strata (1-17) thrown into an anticline (AA′) and syncline (BB′). A section drawn across these folds in the line CD would show the structure given in fig. 3. Here we see that, at the part of the anticlinal axis (A) where the section crosses, bed No. 4 forms the crown of the arch, Nos. 1, 2 and 3 being concealed beneath it. On the east side of the axis the strata follow each other in regular succession as far as No. 13, which, instead of passing here under the next in order, turns up with a contrary dip and forms the centre of a trough or syncline (B). From underneath No. 13 on the east side the same beds rise to the surface which passed beneath it on the west side. The particular bed marked EF has been entirely removed by denudation from the top of the anticline, and is buried deep beneath the centre of the syncline.

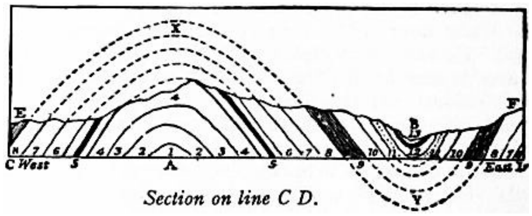


Fig. 3.—Section of Anticlinal and Synclinal Folds on the line CD (fig. 2).

Such foldings of strata must always die out unless they are abruptly terminated by dislocations. In the cases given in fig. 2, both the arch and trough are represented as diminishing, the former towards the north, the latter towards the south. The observer in passing northwards along the axis of that anticline finds himself getting into progressively higher strata as the fold sinks down. On the other hand, in advancing southwards along the synclinal axis, he loses stratum after stratum and gets into lower portions of the series. When a fold diminishes in this way it is said to “nose out.” In fig. 2 there is obviously a general inclination of the beds towards the north, besides the outward dip from the anticline and the inward dip from the syncline. Hence the anticline noses out to the north and the syncline to the south.

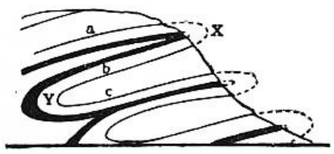


Fig. 4.

Simple Folds.—In describing rock-folds special terms have been assigned to certain portions of the fold; thus, the sloping sides of an anticline or syncline are 598
known as the “limbs,” “slopes,” “flanks” or “members” of the fold; in an anticline, the part X, fig. 3, the angle of the bend, is the “crest” or “crown” (Ger. *Gewölbebiegung*, Fr. *charnière anticlinale*), the corresponding part of a syncline being the “trough-core” or “base,” Y, fig. 3 (Ger. *Muldenbiegung*, Fr. *charnière synclinale*). The portion of an anticline which has been removed by denudation is the “aerial arch,” dotted in fig. 3. The innermost strata in a fold constitute the “core,” arch-core A, fig. 3, or trough-core B, in the same figure. In the majority of folds the bending of the strata has taken place about an “axial plane” (often called the “axis”), which in the examples illustrated in fig. 3 would pass through the points A and B, perpendicularly to the horizontal line CD. In powerfully folded regions the axial planes of the folds are no longer upright; they may be moderately inclined, producing an “inversion,” “inverted fold” or “overfold.” When the inclination of the axial plane is great a “recumbent overfold” is produced (Fr. *pli couché*, Ger, *liegende Falte*). In a fold of this kind (fig. 4) we have an “arch limb” (*a*), a middle limb (*b*) and a floor or “trough limb” (*c*). X and Y are the upper and lower bends respectively. One of the important functions of a fold is its direction; this of course depends upon the orientation of the axial plane. The crest-line of an anticline or trough-line of a syncline is rarely horizontal for any great distance; its departure from horizontality is designated the “pitch,” and the fold is said to pitch (or dip) towards the north, &c. Most simple folds—with the exception of very shallow curvatures of wide area,—when considered in their entirety, are seen to be somewhat canoe-shaped in form. There are three variations of the simple fold dependent upon the position of the limbs, (1) the limbs may tend to diverge as they recede from the crest (fig. 3), sometimes styled an “open anticline”; (2) the limbs may be parallel in “closed” folds (commonly known as isoclinal folding); (3) the limbs may make an open angle or widen out towards the crest (fig. 4). This is known as a fan-shaped fold (Fr. *pli en éventail*, Ger. *Fächerfalte*); another variant of the same form is the mushroom fold (Fr. *pli en champignon*). The axial plane is not always extended: it may be so abbreviated that the folding appears to have taken place about a point; anticlines of this type are variously designated “short-anticlines,” “*brachyanticlinaux*” or “domes”; similarly, there are “short-synclines,” “*brachysynclinaux*” or “cuvettes.” The dip in cases of this kind has been described as “qua-qua versal” or “periclinal.”

Complex Folding.—Sometimes a simple fold has been itself subjected to further folding repeated more than once, it is then termed a "refolded fold" (Fr. *pli replié*); fine examples may be observed in the Alps and in other mountain chains. A great regional major fold containing within itself a number of minor "special" or subsidiary folds is described as a "geanticline" (Fr. *structure en éventail composé*), or as a "geosyncline" (Fr. *structure en éventail renversé*). Even folds of lesser magnitude may be highly complex in regions of extreme crustal movement, and may contain smaller folds of the first, second, third or higher order (Fr. *couches gaufrées* [fig. 5]). In its smaller manifestation, this class of folding passes into "crumpling" or "puckering," where quite a large number of folds may be crowded into a single hand specimen. In "frilling" or "frilled structure" the folds have still smaller amplitude, and in many highly corrugated rocks minute folds are observable with the microscope that do not appear to the unaided eye. When a series of adjacent isoclinal overfolds has passed into a series of thrusts (see FAULT), the so-called "imbricated" structure (Fr. *structure imbriquée*, Ger. *Schuppenstruktur*) is generated. Occasionally crust-blocks resembling "graben" and "horsts" are circumscribed by folds instead of faults; when this is so they have been called respectively "infolded graben" or "overfolded horsts."

The heterogeneous character of great masses of strata has always had a marked influence on the nature of the folding; some beds have yielded much more readily than others, certain beds will be found to be faulted, while those above and below have folded without fracture. In many examples of apparent plasticity it can be shown that this effect has been produced by an infinite number of minute slippings within the rock substance.

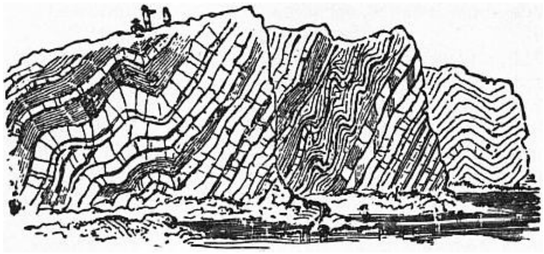


FIG. 5.—Curved and Contorted Rocks, near Old Head of Kinsale. (Du Noyer.)

The larger rock folds have produced important economic results. For example, in many coal regions the deposits have been conserved in some districts in the synclines or "basins," while they have been removed by denudation from the uplifted anticlines in others. Near the crest of anticlines is commonly an enriched portion of the ground in mineralized districts; and, in the case of water supply, the tilt of the strata determines the direction of the underground flowage. Again, the most convenient site for oil wells is the crest of an anticline or "dome," where an impervious stratum imprisons the gas and oil in a subjacent saturated layer under pressure.

For a discussion of the question of the distribution and arrangement of the great folded regions of the earth's crust, see E. Suess, *Das Antlitz der Erde*, English translation. *The Face of the Earth*, vols. i., ii., iii., iv. (Oxford). See also E. de Margerie and A. Heim, *Les Dislocations de l'écorce terrestre* (Zurich, 1888); A. Rothpletz, *Geotektonische Probleme* (Stuttgart, 1894).

FOLENGO, TEOFILO (1491-1544), otherwise known as Merlino Coccajo or Cocajo, one of the principal Italian macaronic poets, was born of noble parentage at Cipada near Mantua on the 8th of November 1491, From his infancy he showed great vivacity of mind, and a remarkable cleverness in making verses. At the age of sixteen he entered the monastery of Monte Casino near Brescia, and eighteen months afterwards he became a professed member of the Benedictine order. For a few years his life as a monk seems to have been tolerably regular, and he is said to have produced a considerable quantity of Latin verse, written, not unsuccessfully, in the Virgilian style. About the year 1516 he forsook the monastic life for the society of a well-born young woman named Girolama Dieda, with whom he wandered about the country for several years, often suffering great poverty, having no other means of support than his talent for versification. His first publication was the *Merlini Cocaii macaronicon*, which relates the adventures of a fictitious hero named Baldus. The coarse buffoonery of this work is often relieved by touches of genuine poetry, as well as by graphic descriptions and acute criticisms of men and manners. Its macaronic style is rendered peculiarly perplexing to the foreigner by the frequent introduction of words and phrases from the Mantuan patois. Though frequently censured for its occasional grossness of idea and expression, it soon attained a wide popularity, and within a very few years passed through several editions. Folengo's next production was the *Orlandino*, an Italian poem of eight cantos, written in rhymed octaves. It appeared in 1526, and bore on the title-page the new pseudonym of Limerno Pitocco (Merlin the Beggar) da Mantova. In the same year, wearied with a life of dissipation, Folengo returned to his ecclesiastical obedience; and shortly afterwards wrote his *Chaos del tri per uno*, in which, partly in prose, partly in verse, sometimes in Latin, sometimes in Italian, and sometimes in macaronic, he gives a veiled account of the vicissitudes of the life he had lived under his various names, We next find him about the year 1533 writing in rhymed octaves a life of Christ entitled *L'Umanità del Figliuolo di Dio*; and he is known to have composed, still later, another religious poem upon the creation, fall and restoration of man, besides a few tragedies. These, however, have never been published. Some of his later years were spent in Sicily under the patronage of Don Fernando de Gonzaga, the viceroy; he even appears for a short time to have had charge of a monastery there. In 1543 he retired to Santa Croce de Campesio, near Bassano; and there he died on the 9th of December 1544. 599

Folengo is frequently quoted and still more frequently copied by Rabelais. The earlier editions of his *Opus macaronicum* are now extremely rare. The often reprinted edition of 1530 exhibits the text as revised by the author after he had begun to amend his life.

FOLEY, JOHN HENRY (1818-1874), Irish sculptor, was born at Dublin on the 24th of May 1818. At thirteen he began to study drawing and modelling at the schools of the Royal Dublin Society, where he took several first-class prizes. In 1835 he was admitted a student in the schools of the Royal Academy, London. He first appeared as an exhibitor in 1839 with his "Death of Abel and Innocence." "Ino and Bacchus," exhibited in 1840, gave him immediate reputation, and the work itself was afterwards commissioned to be done in marble for the earl of Ellesmere. "Lear and Cordelia" and "Death of Lear” were exhibited in 1841. “Venus rescuing Aeneas” and “The Houseless Wanderer” in 1842, “Prospero and Miranda” in 1843. In 1844 Foley sent to the exhibition at Westminster Hall his “Youth at a Stream,” and was, with Calder Marshall and John Bell, chosen by the commissioners to do work in sculpture for the decoration of the Houses of Parliament. Statues of John Hampden and Selden were executed for this purpose, and received liberal praise for the propriety, dignity and proportion of their treatment. Commissions of all kinds now began to come rapidly. Fanciful works, busts, bas-reliefs, tablets and monumental statues were in great numbers undertaken and executed by him with a steady equality of worthy treatment. In 1849 he was made an associate and in 1858 a member of the Royal Academy. Among his numerous works the following may be noticed, besides those mentioned above:—“The Mother”; “Egeria,” for the Mansion House; “The Elder Brother in Comus,” his diploma work; “The Muse of Painting,” the monument of James Ward, R.A.; “Caractacus,” for the Mansion House; “Helen Faucit”; “Goldsmith” and “Burke,” for Trinity College, Dublin; “Faraday”; “Reynolds”; “Barry,” for Westminster Palace Yard; “John Stuart Mill,” for the Thames embankment; “O’Connell” and “Cough,” for Dublin; “Clyde,” for Glasgow; “Clive,” for Shrewsbury; “Hardinge,” “Canning” and “Outram,” for Calcutta; “Hon. James Stewart,” for Ceylon; the symbolical group “Asia,” as well as the statue of the prince himself, for the Albert Memorial in Hyde Park; and “Stonewall Jackson,” in Richmond, Va. The statue of Sir James Outram is probably his masterpiece. Foley’s early fanciful works have some charming qualities; but he will probably always be best remembered for the workmanlike and manly style of his monumental portraits. He died at Hampstead on the 27th of August 1874, and on the 4th of September was buried in St Paul’s cathedral. He left his models to the Royal Dublin Society, his early school, and a great part of his property to the Artists’ Benevolent Fund.

See W. Cosmo Monkhouse, *The Works of J.H. Foley* (1875).

FOLEY, SIR THOMAS (1757-1833), British admiral, entered the navy in 1770, and, during his time as midshipman, saw a good deal of active service in the West Indies against American privateers. Promoted lieutenant in 1778, he served under Admiral (afterwards Viscount) Keppel and Sir Charles Hardy in the Channel, and with Rodney’s squadron was present at the defeat of De Lángara off Cape St Vincent in 1780, and at the relief of Gibraltar. Still under Rodney’s command, he went out to the West Indies, and took his part in the operations which culminated in the victory of the 12th of April 1782. In the Revolutionary War he was engaged from the first. As flag-captain to Admiral John Gell, and afterwards to Sir Hyde Parker, Foley took part in the siege of Toulon in 1793, the action of Golfe Jouan in 1794, and the two fights off Toulon on the 13th of April and the 13th of July 1795. At St Vincent he was flag-captain to the second in command, and in the following year was sent out in command of the “Goliath” (74), to reinforce Nelson’s fleet in the Mediterranean. The part played by the “Goliath” in the battle of the Nile was brilliant. She led the squadron round the French van, and this manœuvre contributed not a little to the result of the day. Whether this was done by Foley’s own initiative, or intended by Nelson, has been a matter of controversy (see *Journal of the Royal United Service Institution*, 1885, p. 916). His next important service was with Nelson in the Baltic. The “Elephant” carried Nelson’s flag at the battle of Copenhagen, and her captain acted as his chief-of-staff. Ill-health obliged Foley to decline Nelson’s offer (made when on the point of starting for the battle of Trafalgar) of the post of Captain of the Fleet. From 1808 to 1815 he commanded in the Downs and at the peace was made K.C.B. Sir Thomas Foley rose to be full admiral and G.C.B. He died while commanding in chief at Portsmouth in 1833.

See J.B. Herbert, *Life and Services of Sir Thomas Foley* (Cardiff, 1884).

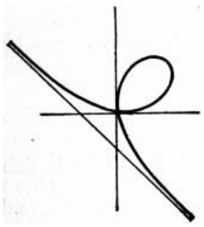
FOLI (Foley), **ALLAN JAMES** (1837-1899), Irish bass singer, was born at Cahir, Tipperary, on the 7th of August 1837; originally a carpenter, he studied under Bisaccia at Naples, and made his first appearance at Catania in 1862. From the opera in Paris he was engaged by Mapleson for the season of 1865, and appeared with much success in various parts. He sang in the first performance of *The Flying Dutchman* (Daland) in England in 1870, and in the first performance of Gounod’s *Redemption* in 1882. He was distinguished in opera and oratorio alike for his vigorous, straightforward way of singing, and was in great request at ballad concerts. He died on the 20th of October 1899.

FOLIGNO (anc. *Fulginiae*, *q.v.*), a town and episcopal see of Umbria, Italy, 771 ft. above sea-level, in the province of Perugia, from which it is 25 m. S.E. by rail. Pop. (1901) 9532 (town), 26,278 (commune). It lies in a fertile plain, on the Topino, a tributary of the Tiber; it is almost square in shape and is surrounded by walls. It is a picturesque and interesting town; several of its churches contain paintings by Umbrian masters, notably works by Niccolò di Liberatore (or Niccolò Alunno, 1430-1502), and among them his chief work, a large altar-piece (the predella of which is in the Louvre) in S. Niccolò. The cathedral has a romanesque S. façade of 1133, restored in 1903; the interior was modernized in the 18th century. To the left of the choir is an octagonal chapel by Antonio da Sangallo the younger (1527). In the same piazza as the S. façade is the Palazzo del Governo, erected in 1350, which has a chapel with frescoes by Ottaviano Nelli of Gubbio (1424). S. Maria infra Portas is said to date from the 7th century, but from this period only the columns of the portico remain. Raphael’s “Madonna di Foligno,” now in the Vatican, was originally painted for the church of S. Anna. The Palazzo Orfini and the Palazzo Deli are two good Renaissance buildings.

Foligno seems to have been founded about the middle of the 8th century A.D. It changed hands often during the wars of the 13th century, and was destroyed by Perugia in 1281. From 1305 to 1439 it was governed by the family of the Trinci as deputies of the Holy See, until in the latter year one of its members went against the church. Pope Eugene IV. sent a force against Foligno, to which the inhabitants opened their gates, and the last of the Trinci, Corrado II., was beheaded. Henceforth Foligno belonged to the states of the church until 1860. It suffered from a severe earthquake in 1832. Foligno is a station on the main line from Rome (via Orte) to Ancona, and is the junction for Perugia. Three miles to the E. is the abbey of Sassovivo with cloisters of 1229, very like those of S. Paolo fuori le Mura at Rome, with pairs of small columns supporting arches, and decorations in coloured mosaic (“Cosmatesque” work). The church has been modernized.

FOLIO (properly the ablative case of the Lat. *folium*, leaf, but also frequently an adaptation of the Ital. *foglio*), a term in bibliography and printing, with reference either to the size of paper employed, or of the book, or to the pagination. In the phrase "in folio" it means a sheet of paper folded once, and thus a book bound up in sheets thus folded is a book of the largest size and is known as a "folio" (see Bibliography). Similarly, "folio" is one of the sizes of paper adapted to be thus folded (see Paper). In book-keeping the word is used for a page in a ledger on which the credit and debtor account is written; in law-writing, for a fixed number of words in a legal document, used for measurement of the length and for the addition of costs. In Great Britain, a "folio" is taken to contain 72 words, except in parliamentary and chancery documents, when the number is 90. In the U.S.A. 100 words form a "folio."

FOLIUM, in mathematics, a curve invented and discussed by René Descartes. Its cartesian equation is $x^3 + y^3 = 3axy$. The curve is symmetrical about the line $x = y$, and consists of two infinite branches asymptotic to the line $x + y + a = o$ and a loop in the first quadrant. It may be traced by giving m various values in the equations $x = 3am / (1 + m^3)$, $y = 3am^2 (1 + m^3)$, since by eliminating m between these relations the equation to the curve is obtained. Hence it is *unicursal* (see Curve). The area of the loop, which equals the area between the curve and its asymptote, is 3a/2.



FOLKES, MARTIN (1690-1754), English antiquary, was born in London on the 29th of October 1690. He was educated at Saumur University and Clare College, Cambridge, where he so distinguished himself in mathematics that when only twenty-three years of age he was chosen a fellow of the Royal Society. He was elected one of the council in 1716, and in 1723 Sir Isaac Newton, president of the society, appointed him one of the vice-presidents. On the death of Newton he became a candidate for the presidency, but was defeated by Sir Hans Sloane, whom, however, he succeeded in 1741; in 1742 he was made a member of the French Academy; in 1746 he received honorary degrees from Oxford and Cambridge. In 1733 he set out on a tour through Italy, in the course of which he composed his *Dissertations on the Weights and Values of Ancient Coins*. Before the Society of Antiquaries, of which he was president from 1749 to 1754, he read in 1736 his *Observations on the Trajan and Antonine Pillars at Rome* and his *Table of English Gold Coins from the 18th Year of King Edward III*. In 1745 he printed the latter with another on the history of silver coinage. He also contributed both to the Society of Antiquaries and to the Royal Society other papers, chiefly on Roman antiquities. He married in 1714 Lucretia Bradshaw, an actress who had appeared at the Haymarket and Drury Lane (see Nichols's Lit. *Anecdot.* ii. 578-598).

For Sir John Hill's attack on Folkes (*Review of the Works of the Royal Soc.*, 1751), see D'Israeli, *Calamities and Quarrels of Authors* (1860), pp. 364-366.

FOLKESTONE, a municipal borough, seaport and watering-place of Kent, England, within the parliamentary borough of Hythe, 71 m. S.E. by E. of London by the South-Eastern & Chatham railway. Pop. (1891) 23,905; (1901) 30,650. This is one of the principal ports in cross-Channel communications, the steamers serving Boulogne, 30 m. distant. The older part of Folkestone lies in a small valley which here opens upon the shore between steep hills. The more modern portions extend up the hills on either hand. To the north the town is sheltered by hills rising sharply to heights of 400 to 500 ft., on several of which, such as Sugarloaf and Castle Hills, are ancient earthworks. Above the cliff west of the old town is a broad promenade called the Lees, commanding a notable view of the channel and connected by lifts with the shore below. On this cliff also stands the parish church of St Mary and St Eanswith, a cruciform building of much interest, with central tower. It is mainly Early English, but the original church, attached to a Benedictine priory, was founded in 1095 on the site of a convent established by Eanswith, daughter of Eadbald, king of Kent in 630. The site of this foundation, however, became endangered by encroachments of the sea. The monastery was destroyed at the dissolution of religious houses by Henry VIII. Folkestone inner harbour is dry at low water, but there is a deep water pier for use at low tide by the Channel steamers, by which not only the passenger traffic, but also a large general trade are carried on. The fisheries are important. Among institutions may be mentioned the grammar school, founded in 1674, the public library and museum, and a number of hospitals and sanatoria. The discontinued Harveian Institution for young men was named after William Harvey, discoverer of the circulation of the blood, a native of Folkestone (1578), who is also commemorated by a tercentenary memorial on the Lees. Folkestone is a member of the Cinque Port of Dover. It is governed by a mayor, 7 aldermen and 21 councillors. Area, 2522 acres. To the west of Folkestone, close to Shorncliffe camp, is the populous suburb of Cheriton (an urban district, pop. 7091).

Folkestone (Folcestan) was among the possessions of Earl Godwine and was called upon to supply him with ships when he was exiled from England; at the time of the Domesday Survey it belonged to Odo, bishop of Bayeux. From early times it was a member of the Cinque Port of Dover, and had to find one out of the twenty-one ships furnished by that port for the royal service. It shared the privileges of the Cinque Ports, whose liberties were exemplified at the request of the barons of Folkestone by Edward III. in 1330. The corporation, which was prescriptive, was entitled the mayor, jurats and commonalty of Folkestone. The history of Folkestone is a record of its struggle against the sea, which was constantly encroaching upon the town. In 1629 the inhabitants, impoverished by their losses, obtained licence to erect a port. By the end of the 18th century the town had become prosperous by the increase of its fishing and shipping trades, and by the middle of the 19th century one of the chief health and pleasure resorts of the south coast.

FOLKLAND (*folcland*). This term occurs three times in Anglo-Saxon documents. In a law of Edward the Elder (c. i. 2) it is contrasted with bookland in a way which shows that these two kinds of tenure formed the two main subdivisions of landownership: no one is to deny right to another in respect of folkland or bookland. By a charter of 863 (Cod. Dipl. 281), King Æthelberht exchanges five hides of folkland for five hides of bookland which had formerly belonged to a thane, granting the latter for the newly-acquired estates exemption from all fiscal exactions except the threefold public obligation of attending the fyrd and joining in the repair of fortresses and bridges. Evidently folkland was not free from the payment of *gafål* (land tax) and providing quarters for the king's men. In ealdorman Alfred's will the testator disposes freely of his bookland estates in favour of his sons and his daughter, but to a son who is not considered as rightful offspring five hides of folkland are left, provided the king consents. It is probable that folkland is meant in two or three cases when Latin documents speak of *terra rei publicae jure possessa*.

Two principal explanations have been given to this term. Allen thought that folkland was similar to the Roman *ager publicus*: it was the common property of the nation (*folc*), and the king had to dispose of it by carving out dependent tenures for his followers more or less after the fashion of continental *beneficia*. These estates remained subject to the superior ownership of the folk and of the king: they could eventually be taken back by the latter and, in any case, the heir of a holder of folkland had to be confirmed in possession by the king. A letter of Bede to the archbishop Ecgbert of York may be interpreted to apply to this kind of tenure. Kemble, K. Maurer, H.C. Lodge, Stubbs and others followed Allen's lead.

Another theory was started by Professor Vinogradoff in an article on folkland in the *English Hist. Review* for 1893. It considers folkland as landownership by folkright—at common law, as might be said in modern legal speech. In opposition to it bookland appears as landownership derived from royal privilege. The incidents recorded in the charters characterize folkland as subject to ordinary fiscal burdens and to limitations in respect of testamentary succession. Thane Wallaf has to 601
be relieved from fiscal exactions when his estate is converted from folkland into bookland (C.D. 281). Ealdorman Alfred's son, not being recognized as legitimate, has to claim folkland not by direct succession or devise, but by the consent of the king. These incidents and limitations are thrown into relief by copious illustrations as to the fundamental features of bookland contained in the numberless "books." These are exemptions from fiscal dues and freedom of disposition of the owner. This view of the matter has been accepted by the chief modern authorities.

Bibliography.—J. Allen, *Inquiry into the Rise and Growth of Royal Prerogative in England* (London, 1849); K. Maurer, *Kritische Überschau* (1853), Band i. 102 ff.; F.W. Maitland, *Domesday Book and Beyond*, 244 ff. (Cambridge, 1897); P. Vinogradoff, "Folcland," in the *Eng. Hist. Rev.* (1893), p. 1 ff.; Sir F. Pollock, *Land Laws* (London, 1896); H. Brunner, *Deutsche Rechtsgeschichte*, Band i. (2nd ed., 293, Leipzig, 1887-1892).

(P. Vi.)

FOLKLORE, a term invented in 1846 by Mr W.J. Thoms as a designation for the traditional learning of the uncultured classes of civilized nations. The word has been adopted in this sense into many foreign languages; it is sometimes regarded as the equivalent of the Ger. *Volkskunde*. But folklore is, properly speaking, the "lore *of* the folk," while *Volkskunde* is lore or learning *about* the folk, and includes not only the mental life of a people, but also their arts and crafts. The term folklore is also used to designate the science which deals with folklore; the study of survivals involves the investigation of the similar customs, beliefs, &c., of races on lower planes of culture; consequently folklore, as interpreted by the English and American societies, concerns itself as much or more with savage races as with the popular superstitions of the white races.

History.—The scientific study of folklore dates back to the first quarter of the 19th century, but folklore was collected long before that date. The organized study of folklore is a thing of recent growth. The first Folklore Society was founded in London in 1878; similar bodies now exist in the United States, France, Italy, Switzerland and especially in Germany and Austria. The folk-tale makes its appearance in literature at a very early period; Egyptian examples have come down to us from the 28th century B.C. In Greece the Homeric poems contain many folk-tale incidents; for India we have the *Jatakas* and *Panchatantra*; and for the Arabs the great collection of the *Thousand and One Nights*. Another type of folk-narrative is represented by Aesop's *Fables*. Not unnaturally beliefs and customs received less attention; our knowledge of them among the ancients is as a rule pieced together. Among the oldest professed collections are J.B. Thiers (1606-1703), *Traité des superstitions* (1679), Aubrey's *Miscellanies* (1686) and H. Bourne's (1696-1733) *Antiquitates vulgares* (1725); but they belong to the antiquarian, non-scientific period.

The pioneers of the modern scientific treatment of folklore were the brothers Grimm, by the publication of their *Kinder- und Hausmärchen* (1812-1815) and *Deutsche Mythologie* (1835). They were the first to present the folk-tale in its genuine unadulterated form. They differed from their predecessors in regarding the myth, not as the result of conscious speculation, but of a mythopoeic impulse. They were, however, disposed to press modern linguistic evidence too far and make the figures of the folk-tale the lineal representatives of ancient gods, as the folk-tales themselves were of the myths. This tendency was exaggerated by their successors, J.W. Wolf, W. Rochholz and others. At the outset of his career, W. Mannhardt (1831-1880), the forerunner of the anthropological school of folklore, shared in this mistake. Breaking away eventually from the philological schools, which interpreted myths and their supposed descendants, the folk-tales, as relating to the storm, the sun, the dawn, &c. (see Mythology), Mannhardt made folk-custom and belief his basis. To this end he set himself to collect and compare the superstitions of the peasantry; but his health was always feeble and he never completed his scheme. For a time Mannhardt's researches bore fruit neither in his own country nor abroad. In 1878 the foundation of the Folklore Society marked a new era in England, where the philological school had had few adherents; and the anthropological school soon produced evidence of its vitality in the works of Mr Andrew Lang, Dr J.G. Frazer and Professor Robertson Smith.

With the growth of our knowledge of European folk-custom and belief on the one hand, and of rites and religions of people in the lower stages of culture on the other hand, it has become abundantly clear that there is no line of demarcation between the two. Each throws light upon the other, and the superstitions of Europe are the lineal descendants of savage creeds which have their parallels all over the world in the culture of primitive peoples.

Subdivisions.—The folklore of civilized peoples may be conveniently classified under three main heads: (1) belief and custom; (2) narratives and sayings; (3) art. These again may be subdivided. The first division, *Belief and Custom*, includes (A) Superstitious beliefs and practices, including (*a*) those connected with natural phenomena or inanimate nature, (*b*) tree and plant superstitions, (*c*) animal superstitions, (*d*) ghosts and goblins, (*e*) witchcraft, (*f*) leechcraft, (*g*) magic in general and divination, (*h*) eschatology, and (*i*) miscellaneous superstitions and practices; and (B) Traditional customs, including (*a*) festival customs for which are set aside certain days and seasons, (*b*) ceremonial customs on the occasion of events such as birth, death or marriage, (*c*) games, (*d*) miscellaneous local customs, such as agricultural rites connected with the corn-spirit (see Demonology), and (*e*) dances. The second head of *Narratives and Sayings* may be subdivided (A) into (*a*) sagas or tales told as true, (*b*) Märchen or nursery tales, (*c*) fables, (*d*) drolls, apologues, cumulative tales, &c., (*e*) myths (see Mythology), and (*f*) place legends; (B) into ballads and songs (in so far as they do not come under art); and (C) into nursery rhymes, riddles, jingles, proverbs, nicknames, place rhymes, &c. The third head, *Art*, subdivides into (*a*) folk music with ballads and songs, (*b*) folk drama. Any classification, however, labours under the disadvantage of separating items which properly belong together. Thus, myths are obviously the form in which some superstitions are expressed. They may also be aetiological in their nature and form an elaborate record of a custom. Eschatological beliefs naturally take the form of myths. Traditional narratives can also be classified under art, and so on.

Literature.—The literature of the subject falls into two sharply defined classes—synthetic works and collections of folklore—of which the latter are immensely more numerous. Of the former class the most important is Dr J.G. Frazer's *Golden Bough*, which sets out from the study of a survival in Roman religion and covers a wide field of savage and civilized beliefs and customs. Especially important are the chapters on agricultural rites, in which are set forth the results of Mannhardt's researches. Other important lines of folklore research in the *Golden Bough* are those dealing with spring ceremonies, with the primitive view of the soul, with animal cults, and with sun and rain charms. Mr E.S. Hartland's *Legend of Perseus* is primarily concerned with the origin of a folk-tale, and this problem in the end is dismissed as insoluble. A large part of the book is taken up with a discussion of sympathetic magic, and especially with the "life index," an object so bound up with the life of a human being that it acts as an indication of his well-being or otherwise. The importance of children's games in the study of folklore has been recognized of recent years. An admirable collection of the games of England has been published by Mrs G.L. Gomme. With the more minute study of uncivilized peoples the problem of the diffusion of games has also come to the fore. In particular it is found that the string-game called "cat's cradle" in various forms is of very wide diffusion, being found even in Australia. The question of folk-music has recently received much attention (see Song).

Bibliography.—**Introductory works:** M.R. Cox, *Introduction to Folklore*; Kaindl, *Die Volkskunde*; Marillier in *Revue de l'histoire des religions*, xliii. 166, and other works mentioned by Kaindl.

General works: J.G. Frazer, *The Golden Bough*; E.S. Hartland, *The Legend of Perseus*; A. Lang, *Custom, and Myth, Myth, Ritual and Religion*; Tylor, *Primitive Culture*; Liebrecht, *Zur Volkskunde*.

British Isles. England: Burne, *Shropshire Folklore*; *Denham Tracts* (F.L.S.); Harland and Wilkinson, *Lancashire Folklore*; Henderson, *Folklore of Northern Counties*; *County Folklore Series* (Printed Extracts) of the F.L.S. Wales: Elias Owen, *Welsh Folklore*; Rhys, *Celtic Folklore*. Scotland: Dalyell, *Darker Superstitions*; Gregor, *Folklore of N.E. of Scotland*; the works of J.G. Campbell, &c. 602

Germany: Grimm, *Deutsche Mythologie*, English translation by Stallybrass; Wuttke, *Der deutsche Volksaberglaube*; Meyer, *Deutsche Volkskunde*; Tetzner, *Die Slaven in Deutschland*; Mogk in Paul's *Grundriss der germanischen Philologie*, and the works cited by Kaindl (see above).

France: Sebillot's works; Rolland, *Faune populaire*; Laisnel de la Salle, *Croyances et légendes*.

On the Slavs see the works of Krauss and v. Wlislochi; for Bohemia, Grohmann, *Aberglaube*; for Greece, Abbott, *Macedonian Folklore*, and Rennell Rodd, *Folklore of Greece*; for Italy, Pitré's bibliography; for India, Crooke's works, and the *Indian Antiquary*. For questionnaires see *Handbook of Folklore* (Folklore Soc.); Sebillot, *Essai de questionnaires*; *Journal of American Folklore* (1890, &c.); and Kaindl's *Volkskunde*. For a bibliography of folk-tales see Hartland, *Mythology and Folk-tales*; to his list may be added Petitot's *Légendes indiennes*; Rand, *Legends of the Micmacs*; Lummis, *The Man who Married the Moon*; and the publications of the American Folklore Society. For other works see bibliographies in *Folklore* and other periodicals. On special points may be mentioned Miss Cox's *Cinderella* (Folklore Society); Kohler's works, &c. (see also bibliography to the article Tale). For games see Gomme, *English Games*; Culin, *Korean Games*; Rochholz, *Alemannisches Kinderlied*; Böhme, *Deutsches Kinderlied*; Handelmann, *Volks- und Kinderspiele*; Jayne, *String Figures*, &c.; and the bibliography to Doll. See also Sonnenschein's *Best Books*.

The following is a list of the more important Societies and publications:—

England: Folklore Society; Folksong Society; Gipsy-lore Society.

U.S.A.: American Folklore Society.

France: *Société des traditions populaires*.

Germany: *Verein für Volkskunde; Hessische Vereinigung für Volkskunde*; and minor societies in Saxony, Silesia and other provinces.

Austria: *Verein für österreichische Volkskunde*.

Switzerland: *Schweizerische Gesellschaft für Volkskunde*.

Italy: *Società per lo studio delle tradizioni popolari*.

In addition to these, the anthropological societies devote more or less attention to folklore. Besides the publications of the societies mentioned above, minor societies or individuals are responsible for the following among others: Belgium, *Wallonia*; Poland, *Wisla*; France, *Melusine* (1878, 1883-1901); Bohemia, *Cesky Lid*; Denmark, *Dania*, &c.; Germany, *Zeitschrift für Völkerpsychologie* (1859-1890); *Am Urguell* (1890-1898).

(N. W. T.)

FOLLEN, AUGUST (or, as he afterwards called himself, Adolf) **LUDWIG** (1794-1855), German poet, was born at Giessen on the 21st of January 1794, the son of a district judge. He studied theology at Giessen and law at Heidelberg, and after leaving the university edited the Elberfeld *Allgemeine Zeitung*. Suspected of being connected with some radical plots, he was imprisoned for two years in Berlin. When released in 1821 he went to Switzerland, where he taught in the canton school at Aarau, farmed from 1847-1854 the estate of Liebenfels in Thurgau, and then retired to Bern, where he lived till his death on the 26th of December 1855. Besides a number of minor poems he wrote *Harfengrüsse aus Deutschland und der Schweiz* (1823) and *Malegys und Vivian* (1829), a knightly romance after the fashion of the romantic school. Of his many translations, mention may be made of the Homeric Hymns in collaboration with R. Schwenck (1814), Tasso's *Jerusalem Delivered* (1818) and *Siegfrieds Tod* from the *Nibelungenlied* (1842); he also collected and translated Latin hymns and sacred poetry (1819). In 1846 he published a brief collection of sonnets entitled *An die gottlosen Nichtswüteriche*. This was aimed at the liberal philosopher Arnold Ruge, and was the occasion of a literary duel between the two authors. Follen's posthumous poem *Tristans Eltern* (1857) may also be mentioned, but his best-known work is a collection of German poetry entitled *Bildersaal deutscher Dichtung* (1827).

FOLLEN, KARL (1795-1840), German poet and patriot, brother of A.L. Follen, was born at Romrod in Hesse-Darmstadt, on the 5th of September 1795. He first studied theology at Giessen, but after the campaign of 1814, in which, like his brother August, he took part as a Hessian volunteer, began the study of jurisprudence, and in 1818 established himself as *Privatdocent* of civil law at Giessen. Owing to being suspected of political intrigues, he removed to Jena, and thence, after the assassination of Kotzebue, fled to France. Here again the political murder of the duc de Berry, on the 14th of January 1820, led to Follen being regarded as a suspect, and he accordingly took refuge in Switzerland, where he taught for a while at the cantonal school at Coire and at the university of Basel; but the Prussian authorities imperatively demanding his surrender, he sought in 1824 the hospitality of the United States of America. Here he became an instructor in German at Harvard in 1825, and in 1830 obtained an appointment as professor of German language and literature there; but his anti-slavery agitation having given umbrage to the authorities, he forfeited his post in 1835, and was ordained Unitarian minister of a chapel at Lexington in Massachusetts in 1836. He perished at sea on board a steamboat which was totally consumed by fire while on a voyage from New York to Boston, on the night of the 13th-14th of January 1840. Follen was the author of several celebrated patriotic songs written in the interests of liberty. The best is perhaps *Horch auf, ihr Fürsten! Du Volk, horch auf!* of which Johannes Wit, called von Dörring (1800-1863), was long, though erroneously, considered the author. It was published in A.L. Follen’s collection of patriotic songs, *Freie Stimmen frischer Jugend*.

His wife Elisa Lee (1787-1860), an American authoress of some reputation, published after his death his lectures and sermons, with a biography written by herself (5 vols., Boston, 1846).

FOLLETT, SIR WILLIAM WEBB (1798-1845), English lawyer, was born at Topsham in Devonshire on the 2nd of December 1798. He was the son of Captain Benjamin Follett, who had retired from the army in 1790, and engaged in business at Topsham. He received his education at Exeter grammar school and Trinity College, Cambridge, graduating in 1818. He had entered the Inner Temple in 1816 and began to practise as a pleader below the bar in 1821, but was called to the bar in 1824, and joined the western circuit in 1825. At the very outset his great qualifications were universally recognized. He was thoroughly master of his profession, and his rapid rise in it was due not only to his quick perception and sound judgment, but to his singular courtesy, kindness and sweetness of temper. In 1830 he married the eldest daughter of Sir Ambrose Harding Gifford, chief justice of Ceylon. In 1835 he was returned to parliament for Exeter. In parliament he early distinguished himself, and under the first administration of Sir Robert Peel was appointed solicitor-general (November 1834); but resigned with the ministry in April 1835. In the course of this year he was knighted. On the return of Peel to power in 1841 Sir William was again appointed solicitor-general, and in April 1844 he succeeded Sir Frederick Pollock as attorney-general. But his health, which had begun to fail him in 1838, and had been permanently injured by a severe illness in 1841, now broke down, and he was compelled to relinquish practice and to visit the south of Europe. He returned to England in March 1845; but the disease, consumption, reasserted itself, and he died in London on the 28th of June following. A statue of Follett, executed by Behnes, was erected by subscription in Westminster Abbey.

FONBLANQUE, ALBANY WILLIAM (1793-1872), English journalist, descended from a noble French Huguenot family, the Greniers of Languedoc, was born in London in 1793. John Grenier, a banker, became naturalized in England under the name of Fonblanque; and his son John Samuel Martin Fonblanque (1760-1838), a distinguished equity lawyer, and the author of a standard legal work, a *Treatise on Equity*, was the father of Albany Fonblanque; he represented the borough of Camelford in parliament; and was one of the Whig friends of George IV. when prince of Wales. At fourteen young Fonblanque was sent to Woolwich to prepare for the Royal Engineers. His health, however, failed, and for two years his studies had to be suspended. Upon his recovery he studied for some time with a view to being called to the bar. At the age of nineteen (1812) he commenced writing for the newspapers, and very soon attracted notice both by the boldness and liberality of his opinions, and by the superiority of his style to what Macaulay, when speaking of him, justly called the 603
“rant and twaddle of the daily and weekly press” of the time. While he was eagerly taking his share in all the political struggles of this eventful period, he was also continuing his studies, devoting no less than six hours a day to the study of classics and political philosophy. Under this severe mental training his health once more broke down. His energy, however, was not impaired. He became a regular contributor to the newspapers and reviews, realizing a fair income which, as his habits were simple and temperate, secured him against pecuniary anxieties.

From 1820 to 1830 Albany Fonblanque was successively employed upon the staff of *The Times* and the *Morning Chronicle*, whilst he contributed to the *Examiner*, to the *London Magazine* and to the *Westminster Review*. In 1828 the *Examiner* newspaper, which had been purchased by the Rev. Dr Fellowes, author of the *Religion of the Universe*, &c., was given over to Fonblanque’s complete control; and for a period of seventeen years (1830 to 1847) he not only sustained the high character for political independence and literary ability which the *Examiner* had gained under the direction of Leigh Hunt and his brother, John Hunt, but even compelled his political opponents to acknowledge a certain delight in the boldness and brightness of the wit directed against themselves. When it was proposed that the admirers and supporters of the paper should facilitate a reduction in its price by the payment of their subscription ten years in advance, not only did Mr Edward Bulwer (Lord Lytton) volunteer his aid, but also Mr Disraeli, who was then coquetting with radicalism. During his connexion with the *Examiner*, Fonblanque had many advantageous offers of further literary employment; but he devoted his energies and talents almost exclusively to the service of the paper he had resolved to make a standard of literary excellence in the world of journalism. Fonblanque was offered the governorship of Nova Scotia; but although he took great interest in colonial matters, and had used every effort to advocate the more generous political system which had colonial self-government for its goal, he decided not to abandon his beloved *Examiner* even for so sympathetic an employment. In 1847, however, domestic reasons induced him to accept the post of statistical secretary of the Board of Trade. This of course compelled him to resign the editorship of the *Examiner*, but he still continued to contribute largely to the paper, which, under the control of John Forster, continued to sustain its influential position. During the later years of his life Fonblanque took no prominent part in public affairs; and when he died at the age of seventy-nine (1872) he seemed, as his nephew, Edward Fonblanque, rightly observes, “a man who had lived and toiled in an age gone by and in a cause long since established.”

The character of Albany Fonblanque’s political activity may be judged of by a study of his *England under Seven Administrations* (1837), in comparison with the course of social and political events in England from 1826 to 1837. As a journalist, he must be regarded in the light of a reformer. Journalism before his day was regarded as a somewhat discreditable profession; men of true culture were shy of entering the hot and dusty arena lest they should be confounded with the ruder combatants who fought there before the public for hire. But the fact that Fonblanque, a man not only of strong and earnest political convictions but also of exceptional literary ability, did not hesitate to choose this field as a worthy one in which both a politician and a man of letters might usefully as well as honourably put forth his best gifts, must have helped, in no small degree, to correct the old prejudice.

See the *Life and Labours of Albany Fonblanque*, edited by his nephew, Edward Barrington de Fonblanque (London, 1874); a collection of his articles with a brief biographical notice.

FOND DU LAC, a city and the county-seat of Fond du Lac county, Wisconsin, U.S.A., about 60 m. N. of Milwaukee, at the S. end of Lake Winnebago, and at the mouth of the Fond du Lac river, which is navigable for only a short distance. Pop. (1890) 12,024; (1900) 15,110, of whom 2952 were foreign-born; (1910) 18,797. The city is a railway centre of some importance, and is served by the Chicago, Milwaukee & St Paul, the Minneapolis, St Paul & Sault St Marie, and the Chicago & North-Western railways, by interurban electric lines, and by steamboat lines connecting through the Fox river with vessels on the Great Lakes. At North Fond du Lac, just beyond the city limits, are car-shops of the two last-mentioned railways, and in the city are manufactories of machinery, automobiles, wagons and carriages, awnings, leather, beer, flour, refrigerators, agricultural implements, toys and furniture. The total value of the city’s factory products in 1905 was $5,599,606, an increase of 95.7% since 1900. The city has a Protestant Episcopal cathedral, the Grafton Hall school for girls, and St Agnes hospital and convent, and a public library with about 25,000 volumes in 1908. The first settlers on the site of Fond du Lac arrived about 1835. Subsequently a village was laid out which was incorporated in 1847; a city charter was secured in 1852.

FONDI (anc. *Fundi*), a town of Campania, Italy, in the province of Caserta, 12 m. N.W. of Formia, and 11 m. E.N.E. of Terracina by road. Pop. (1901) 9930. It lies 25 ft. above sea-level, at the N. end of a plain surrounded by mountains, which extend to the sea. It occupies the site of the ancient Fundi, a Volscian town, belonging later to *Latium adjectum*, on the Via Appia, still represented by the modern high-road which passes through the centre of the town. It is rectangular in plan, and portions of its walls, partly in fine polygonal work and partly in *opus incertum*, are preserved. Both plan and walls date, no doubt, from the Roman period. The gate on the north-east still exists, and bears the inscription of three aediles who erected the gate, the towers and the wall. A similar inscription of three different aediles from the N.W. gate still exists, but not *in situ*. In the neighbourhood are the remains of several ancient villas, and along the Via Appia still stands an ancient wall of *opus reticulatum*, with an inscription, in large letters, of one Varronianus, the letters being at intervals of 25 ft. The engineering of the ancient Via Appia between Fondi and Formia, where it passes through the mountains near Itri, is remarkable.

The modern town is still enclosed by the ancient walls. The castle on the S.E. side has some 15th-century windows with beautiful tracery. Close by is the Gothic church of S. Pietro (formerly S. Maria), which was the cathedral until the see was suppressed in 1818 and united with that of Gaeta; it contains a fine pulpit with “cosmatesque” work and the fine tomb of Cristoforo Caetani (1439), two interesting 15th-century triptychs and an episcopal throne, which served for the coronation of the anti-pope Clement VII. in 1378. In the Dominican monastery the cell which St Thomas Aquinas sometimes occupied is shown.

The ancient city of Fundi in 338 B.C. (or 332) received (with Formiae) the *civitas sine suffragio*, because it had always secured the Romans safe passage through its territory; the people as a whole did not join Privernum in its war against Rome three years later, though Vitruvius Vacca, the leader, was a native of Fundi. It acquired the full citizenship in 188 B.C., and was partly under the control of a *praefectus*. The inscription upon some waterpipes which have been discovered shows that later it became a *municipium*. It was governed by three aediles: Horace’s jest against the officious praetor (sic) is due to the exigencies of metre (Th. Mommsen in *Hermes*, xiii. p. 113). The family of Livia, the consort of Augustus, belonged to Fundi. During the Lombard invasions in 592 Fundi was temporarily abandoned, but it seems to have come under the rule of the papacy by A.D. 754 at any rate. Pope John VIII. ceded it with its territory to Docibile, duke of Gaeta, but its history is somewhat intricate after this period. Sometimes it appears as an independent countship, though held by members of the Caetani family, who about 1297 returned to it. In 1504 it was given to Prospero Colonna. In 1534 Khair-ed-Din Barbarossa tried to carry off Giulia Gonzaga, countess of Fondi, and sacked the city. After this Fondi was much neglected; in 1721 it was sold to the Di Sangro family, in which it still remains. Its position as a frontier town between the papal states and the kingdom of Naples, just in the territory of the latter—the Via Appia can easily be blocked either N.W. at the actual frontier called Portella[1] or S.E. of it—affected it a good deal during the French Revolution and the events 604
which led up to the unification of Italy.

The Lago di Fondi, which lies in the middle of the plain, and the partially drained marshes surrounding it, compelled the ancient Via Appia, followed by the modern road, to make a considerable détour. The lake was also known in classical times ass, *lacus Amyclanu* from the town of Amyclae or Amunclae, which was founded, according to legend, by Spartan colonists, and probably destroyed by the Oscans in the 5th century B.C. (E. Pais in *Rendiconti dei Lincei*, 1906, 611 seq.); the bay was also known as *mare Amunclanum*.

The ancient Speluncae (mod. *Sperlonga*) on the coast also belonged to the territory of Fundi. Here was the imperial villa in which Sejanus saved the life of Tiberius, who was almost crushed by a fall of rock. Considerable remains of it, and of the caves from which it took its name, still exist 1 m. S.E. of the modern village. For modern discoveries see P. di Tucci in *Notizie degli scavi* (1880), 480; G. Patroni, *ibid.* (1898), 493. The wine of Fundi is spoken of by ancient writers, though the *ager Caecubus*, the coast plain round the Lago di Fundi, was even more renowned, and Horace frequently praises its wine; and though Pliny the Elder speaks as if its production had almost entirely ceased in his day (attributing this to neglect, but even more to the excavation works of Nero’s projected canal from the lacus Avernus to Ostia), Martial mentions it often, and it is spoken of in the inscription of a wine-dealer of the time of Hadrian, together with Falernian and Setian wines (*Corpus inscript. Lat.* vi. Berlin, 1882, 9797). The plain of Fondi is the northernmost point in Italy where the cultivation of oranges and lemons is regularly carried on in modern times.

See G. Conte Colino, *Storia di Fondi* (Naples, 1902); B. Amante and R. Bianchi, *Memorie storiche e statutarie di Fondi in Campania* (Rome, 1903); T. Ashby, in *English Historical Review*, xix. (1904) 557 seq.

(T. As.)

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1 For the pass of Ad Lautulas see Terracina.

FONNI, a town of Sardinia, in the province of Sassari, 3280 ft. above sea-level, to the N.W. of Monte Gennargentu, 21 m. S. of Nuoro by road. Pop. (1901) 4323. It is the highest village in Sardinia, and situated among fine scenery with some chestnut woods. The church of the Franciscans, built in 1708, contains some curious paintings by local artists. The costumes are extremely picturesque, and are well seen on the day of St John the Baptist, the patron saint. The men's costume is similar to that worn in the district generally; the linen trousers are long and black gaiters are worn. The women wear a white chemise; over that a very small corselet, and over that a red jacket with blue and black velvet facings. The skirt is brown above and red below, with a blue band between the two colours; it is accordion-pleated. Two identical skirts are often worn, one above the other. The unmarried girls wear white kerchiefs, the married women black. A little to the N. of Fonni, by the high-road, stood the Roman station of Sorabile, mentioned in the *Antonine Itinerary* as situated 87 m. from Carales on the road to Olbia. Excavations made in 1879 and 1880 led to the discovery of the remains of this station, arranged round three sides of a courtyard some 100 ft. square, including traces of baths and other buildings, and a massive embanking wall above them, some 150 ft. in length, to protect them from landslips (F. Vivanet, in *Notizie degli scavi*, 1879, 350; 1881, 31), while a discharge certificate (*tabula honestae missionis*) of sailors who had served in the *classis Ravennas* was found in some ruins here or hereabouts (*id. ib.*, 1882, 440; T. Mommsen, *Corp. inscr. Lat.* x. 8325). Near Fonni, too, are several "menhirs" (called *pietre celtiche* in the district) and other prehistoric remains.

(T. As.)

FONSAGRADA, a town of north-western Spain, in the province of Lugo; 25 m. E.N.E. of Lugo by road. Pop. (1900) 17,302. Fonsagrada is situated 3166 ft. above the sea, on the watershed between the rivers Rodil and Suarna. It is an important market for all kinds of agricultural produce, and manufactures linen and frieze; but its trade is mainly local, owing to the mountainous character of the neighbourhood, and the lack of a railway or navigable waterway, which prevent the development of any considerable export trade.

FONSECA, MANOEL DEODORO DA (1827-1892), first president of the united states of Brazil, was born at Alagoas on the 5th of August 1827, being the third son of Lieut.-Colonel Manoel Mendes da Fonseca (d. 1859). He was educated at the military school of Rio de Janeiro, and had attained the rank of captain in the Brazilian army when war broke out in 1864 against Montevideo, and afterwards against Solano Lopez, dictator of Paraguay. His courage gained him distinction, and before the close of the war in 1870 he reached the rank of colonel, and some years later that of general of division. After holding several military commands, he was appointed in 1886 governor of the province of Rio Grande do Sul. In this position he threw himself heartily into politics, espoused the republican opinions then becoming prevalent, and sheltered their exponents with his authority. After a fruitless remonstrance, the government at the close of the year removed him from his post, and recalled him to the capital as director of the service of army material. Finding that even in that post he still continued to encourage insubordination, the minister of war, Alfredo Chaves, dismissed him from office. On 14th of May 1887, in conjunction with the viscount de Pelotas, Fonseca issued a manifesto in defence of the military officers' political rights. From that time his influence was supreme in the army. In December 1888, when the Conservative Correa d'Oliveira became prime minister, Fonseca was appointed to command an army corps on the frontier of Matto Grosso. In June 1889 the ministry was overthrown, and on a dissolution an overwhelming Liberal majority was returned to the chamber of deputies. Fonseca returned to the capital in September. Divisions of opinion soon arose within the Liberal party on the question of provincial autonomy. The more extreme desired the inauguration of a complete federal system. Amongst the most vehement was Ruy Barbosa, the journalist and orator, and after some difficulty he persuaded Fonseca to head an armed movement against the government. The insurrection broke out on the 15th of November 1889. The government commander, Almeida Barreto, hastened to place himself under Fonseca's orders, and the soldiers and sailors made common cause with the insurgents. The affair was almost bloodless, the minister of marine, baron de Ladario, being the only person wounded. Fonseca had only intended to overturn the ministry, but he yielded to the insistency of the republican, leaders and proclaimed a republic. A provisional government was constituted by the army and navy in the name of the nation, with Fonseca at its head. The council was abolished, and both the senate and the chamber of deputies were dissolved. The emperor was requested to leave the territory of Brazil within twenty-four hours, and on the 17th of November was embarked on a cruiser for Lisbon. On the 20th of December a decree of banishment was pronounced against the imperial family. So universal was the republican sentiment that there was no attempt at armed resistance. The provisional government exercised dictatorial powers for a year, and on the 25th of February 1891 Fonseca was elected president of the republic. He was, however, no politician, and possessed indeed little ability beyond the art of acquiring popularity. His tenure of office was short. In May he became involved in an altercation with congress, and in November pronounced its dissolution, a measure beyond his constitutional power. After a few days of arbitrary rule insurrection broke out in Rio Grande do Sul, and before the close of November Fonseca, finding himself forsaken, resigned his office. From that time he lived in retirement. He died at Rio de Janeiro on the 23rd of August 1892.

FONSECA, Amapala or Conchagua, **BAY OF,** an inlet of the Pacific Ocean in the volcanic region between the Central American republics of Honduras, Salvador and Nicaragua. The bay is unsurpassed in extent and security by any other harbour on the Pacific. It is upwards of 50 m. in greatest length, by about 30 m. in average width, with an entrance from the sea about 18 m. wide, between the great volcanoes of Conchagua (3800 ft.) and Coseguina (3000 ft.). The lofty islands of Conchaguita and Mianguiri, with a collection of rocks called "Los Farellones," divide the entrance into four distinct channels, each of sufficient depth for the largest vessels. A channel called "El Estero Real" extends from the extreme southern point of the bay into Nicaragua for about 50 m., reaching within 20 or 25 m. of Lake Managua. The principal islands in the bay are Sacate Grande, Tigre, Gueguensi and Esposescion belonging to Honduras, and Martin Perez, Punta Sacate, Conchaguita and Mianguiri belonging to Salvador. Of these Sacate Grande is the largest, being about 7 m. long by

4 broad. The island of Tigre from its position is the most important in the bay, being about 20 m. in circumference, and rising in a cone to the height of 2500 ft. On the southern and eastern shores of the island the lava forms black rocky barriers to the waves, varying in height from 10 to 80 ft.; but on the northward and eastward are a number of *playas* or smooth, sandy beaches. Facing one of the most considerable of these is the port of Amapala (*q.v.*). Fonseca Bay was discovered in 1522 by Gil Gonzalez de Avila, and named by him after his patron, Archbishop Juan Fonseca, the implacable enemy of Columbus.

FONT (Lat. *fons*, "fountain" or "spring," Ital. *fonte*, Fr. *les fonts*), the vessel used in churches to hold the water for Christian baptism. In the apostolic period baptism was administered at rivers or natural springs (cf. Acts viii. 36), and no doubt the primitive form of the rite was by *immersion* in the water. *Infusion*—pouring water on the head of the neophyte—was early introduced into the west and north of Europe on account of the inconvenience of immersion, as well as its occasional danger; this form has never been countenanced in the Oriental churches. *Aspersion*, or sprinkling, was also admitted as valid, but recorded early examples of its use are rare (see Baptism). These different modes of administering baptism have caused corresponding changes in the receptacles for the water. After the cessation of persecution, when ritual and ornament began to develop openly, special buildings were erected for administering the rite of baptism. This was obviously necessary, for a large *piscina* (basin or tank) in which candidates could be immersed would occupy too much space of the church floor itself. These baptisteries consisted of tanks entered by steps (an ascent of three, and descent of four, to the water was the normal but not the invariable number) and covered with a domed chamber (see Baptistery).

By the 9th century, however, the use of separate baptisteries had generally given place to that of fonts. The material of which these were made was stone, often decorative marble; as early as 524, however, the council of Lerida enacted that if a stone font were not procurable the presbyter was to provide a suitable vessel, to be used for the sacrament exclusively, which might be of any material. In the Eastern Church the font never became an important decorative article of church furniture: "The font, κολυμβήθρα (says Neale, *Eastern Church*, i. 214), in the Eastern Church is a far less conspicuous object than it is in the West. Baptism by immersion has been retained; but the font seldom or never possesses any beauty. The material is usually either metal or wood. In Russia the *columbethra* is movable and only brought out when wanted."

One of the most elaborate of early fonts is that described by Anastasius in the Lateran church at Rome, and said to have been presented thereto by Constantine the Great. It was of porphyry, overlaid with silver inside and out. In the middle were two porphyry pillars carrying a golden dish, on which burnt the Paschal lamp (having an asbestos wick and fed with balsam). On the rim of the bowl was a golden lamb, with silver statues of Christ and St. John the Baptist. Seven silver stags poured out water. This elaborate vessel was of course exceptional; the majority of early fonts were certainly much simpler. A fine early Byzantine stone example exists, or till recently existed, at Beer-Sheba.

Few if any fonts survive older than the 11th century. These are all of stone, except a few of lead; much less common are fonts of cast bronze (a fine example, dated 1112, exists at the Church of St Barthélemy, Liége). The most ancient are plain cylindrical bowls, with a circular—sometimes cruciform or quatrefoil—outline to the basin, either without support or with a single central pillar; occasionally there is more than one pillar. The basins are usually lined with lead to prevent absorption by the stone. The church of Efenechtyd, Denbigh, possesses an ancient font made of a single block of oak. Though the circular form is the commonest, early Romanesque fonts are not infrequently square; and sometimes an inverted truncated cone is found. Octagonal fonts are also known, though uncommon; hexagons are even less common, and pentagons very rare. There is a pentagonal font of this period at Cabourg, dept. Calvados, N. France.

Fonts early began to be decorated with sculpture and relief. Arcading and interlacing work are common; so are symbol and pictorial representation. A very remarkable leaden font is preserved at Strassburg, bearing reliefs representing scenes in the life of Christ. At Pont-à-Mousson on the Moselle are bas-reliefs of St John the Baptist preaching, and baptizing Christ. Caryatides sometimes take the place of the pillars, and sculptured animals and grotesques of strange design not infrequently form the base. More remarkable is the occasional persistence of pagan symbolism; an interesting example is the very ancient font from Ottrava, Sweden, which, among a series of Christian symbols and figures on its panels, bears a representation of Thor (see G. Stephens' brochure, *Thunor the Thunderer*).

In the 13th century octagonal fonts became commoner. A very remarkable example exists at the cathedral of Hildesheim in Hanover, resting on four kneeling figures, each bearing a vase from which water is running (typical of the rivers of Paradise). Above is an inscription explaining the connexion of these rivers with the virtues of temperance, courage, justice and prudence. On the sides of the cup are representations of the passage of the Jordan, of the Red Sea, the Baptism of Christ, and the Virgin and Child. The font has a conical lid, also ornamented with bas-reliefs. A cast of this font is to be seen in the Victoria and Albert Museum at South Kensington. A leaden font, with figures of Our Lord, the Virgin Mary, St Martin, and the twelve Apostles, exists at Mainz; it is dated 1328 by a set of four leonine hexameters inscribed upon it. In the 14th and succeeding centuries octagonal fonts became the rule. They are delicately ornamented with mouldings and similar decorations, in the contemporary style of Gothic architectural art. Though the basin is usually circular in 15th-century fonts, examples are not infrequently found in which the outline of the basin follows the octagonal shape of the outer surface of the vessel. Examples of this type are to be found at Strassburg, Freiburg and Basel.

In England no fonts can certainly be said to date before the Norman conquest, although it is possible that a few very rude examples, such as those of Washaway, Cornwall, and Denton, Sussex, are actually of Saxon times; of course we cannot count as "Saxon fonts" those adapted from pre-Norman sculptured stones originally designed for other purposes, such as that at Dolton, Devonshire. On the other hand, Norman fonts are very common, and are often the sole surviving relics of the Norman parish church. They are circular or square, sometimes plain, but generally covered with carving of arcades, figures, foliage, &c. Among good examples that might be instanced of this period are Alphington, Devon (inverted cone, without foot); Stoke Cannon, Devon (supported on caryatides); Ilam, Staffs (cup-shaped); Fincham, Burnham Deepdale, Sculthorpe, Toftrees, and Shernborne in Norfolk (all, especially the last, remarkable for elaborate carving); Youlgrave, Derby (with a projecting stoup in the side for the chrism—a unique detail); besides others in Lincoln cathedral; Iffley, Oxon; Newenden, Kent; Coleshill, Warwick; East Meon, Hants; Castle Frome, Herefordshire. Some of the best examples of "Norman" fonts in England (such as the notable specimen in Winchester cathedral) were probably imported from Belgium. In the Transitional period we may mention a remarkable octagonal font at Belton, Lincolnshire; in this period fall most of the leaden fonts that remain in England, of which thirty are known (7 in Gloucestershire, 4 in Berkshire and Kent, 3 in Norfolk, Oxford and Sussex, 1 in Derby, Dorset, Lincoln, Somerset, Surrey and Wiltshire); perhaps the finest examples are at Ashover, Derbyshire, and Walton, Surrey. Early English fonts are comparatively rare. They bear the moulding, foliage and tooth ornament in the usual style of the period. A good example of an Early English font is at All Saints, Leicester; others may be seen at St Giles', Oxford, and at Lackford, Suffolk. Fonts of the Decorated period are commoner, but not so frequent as those of the preceding Norman or subsequent Perpendicular periods. Fonts of the Perpendicular period are very common, and are generally raised upon steps and a lofty stem, which, together with 606 the body of the font, are frequently richly ornamented with panelling. It was also the custom during this period to ornament the font with shields and coats of arms and other heraldic insignia, as at Herne, Kent. The fonts of this period, however, are as a rule devoid of interest, and, like most Perpendicular work, are stiff and monotonous. There is, however, a remarkable font, with sculptured figures, belonging to the late 14th century, at West Drayton in Middlesex.

In Holyrood chapel there was a brazen font in which the royal children of Scotland were baptized. It was carried off in 1544 by Sir R. Lea, and given by him to the church at St Albans, but was afterwards destroyed by the Puritans. A silver font existed at Canterbury, which was sometimes brought to Westminster on the occasion of a royal baptism. At Chobham, Surrey, there is a leaden font covered with oaken panels of the 16th century. The only existing structure at all recalling the ancient baptisteries in English churches is found at Luton in Bedfordshire. The font at Luton belongs to the Decorated style, and is enclosed in an octagonal structure of freestone, consisting of eight pillars about 25 ft. in height, supporting a canopy. The space around the font is large enough to hold twelve adults comfortably. At the top of the canopy is a vessel for containing the consecrated water, which when required was let down into the font by means of a pipe.

In 1236 it was ordered by Edmund, archbishop of Canterbury, that baptismal fonts should be kept under lock and key, as a precaution against sorcery:—"Fontes baptismales sub sera clausi teneantur propter sortilegia." The lids appear at first to have been quite simple and flat. They gradually, however, partook of the ornamentation of the font itself, and are often of pyramidal and conical forms, highly decorated with finials, crockets, mouldings and grotesques. Sometimes these covers are very heavy and are suspended by chains to enable them to be raised at will. Very rich font covers may be seen at Ewelme, Oxon; St Gregory, Sudbury; North Walsingham, Norfolk; Worlingworth, Suffolk. The ordinary position of the font in the church was and is near the entrance, usually to the left of the south door.

See Arcisse de Caumont, *Cours d'antiquités monumentales* (Paris, 1830-1843); Francis Simpson, *A Series of Antient Baptismal Fonts* (London, 1828); Paley, Ancient Fonts; E.E. Viollet-le-Duc, *Dict. raisonné de l'architecture* (1858-1868), vol. v.; J.H. Parker's *Glossary of Architecture*; Francis Bond, *Fonts and Font-Covers* (London, 1908). A large number of fine illustrations of fonts, principally of the earlier periods, will be found in the volumes of the *Reliquary* and *Illustrated Archaeologist*.

(R. A. S. M.)

FONTAINE, PIERRE FRANÇOIS LÉONARD (1762-1853), French architect, was born at Pontoise on the 20th of September 1762. He came of a family several of whose members had distinguished themselves as architects. Leaving the college of Pontoise at the age of sixteen he was sent to L'Isle-Adam to assist in hydraulic works undertaken by the architect André. To facilitate his improvement André allowed him to have access to his plans and to copy his designs. In October 1779 he was sent to Paris to study in the school of Peyre the younger, and there began his acquaintance with Percier, which ripened into a life-long friendship. After six years of study he competed for a prize at the Academy, and, winning the second for the plan of an underground chapel, he received a pension and was sent to Rome (1785). Percier accompanied him. The Revolution breaking out soon after his return to France, he took refuge in England; but after the establishment of the consulate he was employed by Bonaparte, to whom he had been introduced by the painter, David, to restore the palace of Malmaison. Henceforth he was fully engaged in the principal architectural works executed in Paris as architect successively to Napoleon I., Louis XVIII. and Louis Philippe. In conjunction with Percier (till his death) he was employed on the arch of the Carrousel, the restoration of the Palais-Royal, the grand staircase of the Louvre, and the works projected for the union of the Louvre and the Tuileries. In 1812 he was admitted a member of the Academy of Fine Arts, and in 1813 was named first architect to the emperor. With Percier he published the following works—*Palais, maisons, et autres édifices de Rome moderne* (1802); *Descriptions de cérémonies et de fêtes* (1807 and 1810); *Recueil de décorations intérieures* (1812); *Choix des plus célèbres maisons de plaisance de Rome et des environs* (1809-1813); *Résidences des souverains, Parallèle* (1833). *L'histoire du Palais-Royal* was published by Fontaine alone, who lost Percier, his friend and associate, in 1838, and himself died in Paris on the 10th of October 1853.

FONTAINEBLEAU, a town of northern France, capital of an arrondissement in the department of Seine-et-Marne, 37 m. S.E. of Paris on the railway to Lyons. Pop. (1906) 11,108. Fontainebleau, a town of clean, wide and well-built streets, stands in the midst of the forest of Fontainebleau, nearly 2 m. from the left bank of the Seine. Of its old houses, the Tambour mansion, and a portion of that which belonged to the cardinal of Ferrara, both of the 16th century, are still preserved; apart from the palace, the public buildings are without interest. A statue of General Damesme (d. 1848) stands in the principal square, and a monument to President Carnot was erected in 1895. Fontainebleau is the seat of a subprefect and has a tribunal of first instance and a communal college. The school of practical artillery and engineering was transferred to Fontainebleau from Metz by a decree of 1871, and now occupies the part of the palace surrounding the cour des offices.

Fontainebleau has quarries of sand and sandstone, saw-mills, and manufactories of porcelain and gloves. Fine grapes are grown in the vicinity. The town is a fashionable summer resort, and during the season the president of the Republic frequently resides in the palace. This famous building, one of the largest, and in the interior one of the most sumptuous, of the royal residences of France, lies immediately to the south-east of the town. It consists of a series of courts surrounded by buildings, extending from W. to E.N.E.; they comprise the Cour du Cheval Blanc or des Adieux (thus named in memory of the parting scene between Napoleon and the Old Guard in 1814), the Cour de la Fontaine, the Cour Ovale, built on the site of a more ancient château, and the Cour d' Henri IV.: the smaller Cour des Princes adjoins the northern wing of the Cour Ovale. The exact origin of the palace and of its name (Lat. *Fons Bleaudi*) are equally unknown, but the older château was used in the latter part of the 12th century by Louis VII., who caused Thomas Becket to consecrate the Chapelle St Saturnin, and it continued a favourite residence of Philip Augustus and Louis IX. The creator of the present edifice was Francis I., under whom the architect Gilles le Breton erected most of the buildings of the Cour Ovale, including the Porte Dorée, its southern entrance, and the Salle des Fêtes, which, in the reign of Henry II., was decorated by the Italians, Francesco Primaticcio and Nicolo dell' Abbate, and is perhaps the finest Renaissance chamber in France. The Galerie de François I. and the lower storey of the left wing of the Cour de la Fontaine are the work of the same architect, who also rebuilt the two-storeyed Chapelle St Saturnin. In the same reign the Cour du Cheval Blanc, including the Chapelle de la Ste Trinité and the Galerie d'Ulysse, destroyed and rebuilt under Louis XV., was constructed by Pierre Chambiges. After Francis I., Fontainebleau owes most to Henry IV., to whom are due the Cour d' Henri IV., the Cour des Princes, with the adjoining Galerie de Diane, and Galerie des Cerfs, used as a library. Louis XIII. built the graceful horseshoe staircase in the Cour du Cheval Blanc; Napoleon I. spent 12,000,000 francs on works of restoration, and Louis XVIII., Louis Philippe and Napoleon III. devoted considerable sums to the same end. The palace is surrounded by gardens and ornamental waters—to the north the Jardin de l'Orangerie, to the south the Jardin Anglais and the Parterre, between which extends the lake known as the Bassin des Carpes, containing carp in large numbers. A space of over 200 acres to the east of the palace is covered by the park, which is traversed by a canal dating from the reign of Henry IV. On the north the park is bordered by a vinery producing fine white grapes.

Forest of Fontainebleau.—The forest of Fontainebleau is one of the most beautiful wooded tracts in France, and for generations it has been the chosen haunt of French landscape painters. Among the most celebrated spots are the Vallée de la Solle, the Gorge aux Loups, the Gorges de Franchard and d'Apremont, and the Fort l'Empereur. The whole area extends to 42,200 acres, with a circumference of 56 m. Nearly a quarter of this area is of a rocky nature, and the quarries of sandstone supplied a large part of the paving of Paris. The oak, pine, beech, hornbeam and birch are the chief varieties of trees.

It is impossible to do more than mention a few of the historical events which have taken place at Fontainebleau. Philip the Fair, Henry III. and Louis XIII. were all born in the palace, and the first of these kings died there. James V. of Scotland was there received by his intended bride; and Charles V. of Germany was entertained there in 1539. Christina of Sweden lived there for years, and the gallery is still to be seen where in 1657 she caused her secretary Monaldeschi to be put to death. In 1685 Fontainebleau saw the signing of the revocation of the edict of Nantes, and in the following year the death of the great Condé. In the 18th century it had two illustrious guests in Peter the Great of Russia and Christian VII. of Denmark; and in the early part of the 19th century it was twice the residence of Pius VII.,—in 1804 when he came to consecrate the emperor Napoleon, and in 1812-1814, when he was his prisoner.

See Pfnor, *Monographie de Fontainebleau*, with text by Champollion Figeac (Paris, 1866); *Guide artistique et historique au palais de Fontainebleau* (Paris, 1889); E. Bourges, *Recherches sur Fontainebleau* (Fontainebleau, 1896).

FONTAN, LOUIS MARIE (1801-1839), French man of letters, was born at Lorient on the 4th of November 1801. He began his career as a clerk in a government office, but was dismissed for taking part in a political banquet. At the age of nineteen he went to Paris and began to contribute to the *Tablettes* and the *Album*. He was brought to trial for political articles written for the latter paper, but defended himself so energetically that he secured the indefinite postponement of his case. The offending paper was suppressed for a time, and Fontan produced a collection of political poems, *Odes et épîtres*, and a number of plays, of which *Perkins Warbec* (1828), written in collaboration with MM. Halévy and Drouineau, was the most successful. In 1828 the *Album* was revived, and in it Fontan published a virulent but witty attack on Charles X., entitled *Le Mouton enragé* (20th June 1829). To escape the inevitable prosecution Fontan fled over the frontier, but, finding no safe asylum, he returned to Paris to give himself up to the authorities, and was sentenced to five years' imprisonment and a heavy fine. He was liberated by the revolution of 1830, and his *Jeanne la folle*, performed in the same year, gained a success due perhaps more to sympathy with the author's political principles than to the merits of the piece itself, a somewhat crude and violent picture of Breton history. A drama representing the trial of Marshal Ney, which he wrote in collaboration with Charles Dupenty, *Le Procès d'un maréchal de France* (printed 1831), was suppressed on the night of its production. Fontan died in Paris on the 10th of October 1839.

A sympathetic portrait of Fontan as a prisoner, and an analysis of his principal works, are to be found in Jules Janin's *Histoire de la littérature dramatique*, vol. i.

FONTANA, DOMENICO (1543-1607), Italian architect and mechanician, was born at Mili, a village on the Lake of Como, in 1543. After a good training in mathematics, he went in 1563 to join his elder brother, then studying architecture at Rome. He made rapid progress, and was taken into the service of Cardinal Montalto, for whom he erected a chapel in the church of Santa Maria Maggiore and the villa Negroni. When the cardinal's pension was stopped by the pope, Gregory XIII., Fontana volunteered to complete the works in hand at his own expense. The cardinal being soon after elected pope, under the name of Sixtus V., he immediately appointed Fontana his chief architect. Amongst the works executed by him were the Lateran palace, the palace of Monte Cavallo (the Quirinal), the Vatican library, &c. But the undertaking which brought Fontana the highest repute was the removal of the great Egyptian obelisk, which had been brought to Rome in the reign of Caligula, from the place where it lay in the circus of the Vatican. Its erection in front of St Peter's he accomplished in 1586. After the death of Sixtus V., charges were brought against Fontana of misappropriation of public moneys, and Clement VIII. dismissed him from his post (1592). This appears to have been just in time to save the Colosseum from being converted by Fontana into a huge cloth factory, according to a project of Sixtus V. Fontana was then called to Naples, and accepted the appointment of architect to the viceroy, the count of Miranda. At Naples he built the royal palace, constructed several canals and projected a new harbour and bridge, which he did not live to execute. The only literary work left by him is his account of the removal of the obelisk (Rome, 1590). He died at Naples in 1607, and was honoured with a public funeral in the church of Santa Anna. His plan for a new harbour at Naples was carried out only after his death. His son Giulio Cesare succeeded him as royal architect in Naples, the university of that town being his best-known building.

FONTANA, LAVINIA (1552-1614), Italian portrait-painter, was the daughter of Prospero Fontana (*q.v.*). She was greatly employed by the ladies of Bologna, and, going thence to Rome, painted the likenesses of many illustrious personages, being under the particular patronage of the family (Buoncampagni) of Pope Gregory XIII., who died in 1585. The Roman ladies, from the days of this pontiff to those of Paul V., elected in 1605, showed no less favour to Lavinia than their Bolognese sisters had done; and Paul V. was himself among her sitters. Some of her portraits, often lavishly paid for, have been attributed to Guido. In works of a different kind also she united care and delicacy with boldness. Among the chief of these are a Venus in the Berlin museum; the "Virgin lifting a veil from the sleeping infant Christ," in the Escorial; and the "Queen of Sheba visiting Solomon." Her own portrait in youth—she was accounted very beautiful—was perhaps her masterpiece; it belongs to the counts Zappi of Imola, the family into which Lavinia married. Her husband, whose name is given as Paolo Zappi or Paolo Foppa, painted the draperies in many of Lavinia’s pictures. She is deemed on the whole a better painter than her father; from him naturally came her first instruction, but she gradually adopted the Caraccesque style, with strong quasi-Venetian colouring. She was elected into the Academy of Rome, and died in that city in 1614.

FONTANA, PROSPERO (1512-1597), Italian painter, was born in Bologna, and became a pupil of Innocenzo da Imola. He afterwards worked for Vasari and Perino del Vaga. It was probably from Vasari that Fontana acquired a practice of offhand, self-displaying work. He undertook a multitude of commissions, and was so rapid, that he painted, it is said, in a few weeks an entire hall in the Vitelli palace at Città di Castello. Along with daring, he had fertility of combination, and in works of parade he attained a certain measure of success, although his drawing was incorrect and his mannerism palpable. He belongs to the degenerate period of the Bolognese school, under the influence chiefly of the imitators of Raphael—Sabbatini, Sammachini and Passerotti being three of his principal colleagues. His soundest successes were in portraiture, in which branch of art he stood so high that towards 1550 Michelangelo introduced him to Pope Julius III. as a portrait-painter; and he was pensioned by this pope, and remained at the pontifical court with the three successors of Julius. Here he lived on a grand scale, and figured as a sort of arbiter and oracle among his professional brethren. 608 Returning to Bologna, after doing some work in Fontainebleau and in Genoa, he opened a school of art, in which he became the preceptor of Lodovico and Agostino Caracci; but these pupils, standing forth as reformers and innovators, finally extinguished the academy and the vogue of Fontana. His subjects were in the way of sacred and profane history and of fable. He has left a large quantity of work in Bologna,—the picture of the “Adoration of the Magi,” in the church of S. Maria delle Grazie, being considered his masterpiece—not unlike the style of Paul Veronese. He died in Rome in 1597.

FONTANE, THEODOR (1819-1898), German poet and novelist, was born at Neu-Ruppin on the 30th of December 1819. At the age of sixteen he was apprenticed to a chemist, and after qualifying as an apothecary, he found employment in Leipzig and Dresden. In 1844 he travelled in England, and settling in Berlin devoted himself from 1849 to literature. He made repeated journeys to England, interesting himself in old English ballads, and as the first fruits of his tours published *Ein Sommer in London* (1854); *Aus England, Studien und Briefe* (1860) and *Jenseit des Tweed, Bilder und Briefe aus Schottland* (1860). Fontane was particularly attached to the Mark of Brandenburg, in which his home lay; he was proud of its past achievements, and delighted in the growth of the capital city, Berlin. The fascination which the country of his birth had for him may be seen in his delightfully picturesque *Wanderungen durch die Mark Brandenburg* (1862-1882, 4 vols.). He also described the wars of Prussia in *Der schleswig-holsteinische Krieg im Jahre 1864* (1866) and *Der deutsche Krieg von 1866* (1869). He proceeded to the theatre of war in 1870, and, being taken prisoner at Vaucouleurs, remained three months in captivity. His experiences he narrates in *Kriegsgefangen. Erlebtes 1870* (1871), and he published the result of his observations of the campaign in *Der Krieg gegen Frankreich 1870-71* (1874-1876). Like most of his contemporaries, he at first sought inspiration for his poetry in the heroes of other countries. His *Gedichte* (1851) and ballads *Manner und Helden* (1860) tell of England’s glories in bygone days. Then the achievements of his own countrymen entered into rivalry, and these, as an ardent patriot, he immortalized in poem and narrative. It is, however, as a novelist that Fontane is best known. His fine historical romance *Vor dem Sturm* (1878) was followed by a series of novels of modern life: *L’Adultera* (1882); *Schach von Wuthenow* (1883); *Irrungen, Wirrungen* (1888); *Stine* (1890); *Unwiederbringlich* (1891); *Effi Briest* (1895); *Der Stechlin* (1899), in which with fine literary tact Fontane adapted the realistic methods and social criticism of contemporary French fiction to the conditions of Prussian life. He died on the 20th of September 1898 at Berlin.

Fontane’s *Gesammelte Romane und Erzählungen* were published in 12 vols. (1890-1891; 2nd ed., 1905). For his life see the autobiographical works *Meine Kinderjahre* (1894) and *Von zwanzig bis dreissig* (1898), also *Briefe an seine Familie* (1905); also F. Servaes, *Theodor Fontane* (1900).

FONTANES, LOUIS, Marquis de (1757-1821), French poet and politician, was born at Niort (Deux Sèvres) on the 6th of March 1757. He belonged to a noble Protestant family of Languedoc which had been reduced to poverty by the revocation of the edict of Nantes. His father and grandfather remained Protestant, but he was himself brought up as a Catholic. His parents died in 1774-1775, and in 1777 Fontanes went to Paris, where he found a friend in the dramatist J.F. Ducis. His first published poems, some of which were inspired by English models, appeared in the *Almanack des Muses*; “Le Cri de mon cœur,” describing his own sad childhood, in 1778; and “La Forêt de Navarre” in 1780. His translation from Alexander Pope, *L’Essai sur l’homme*, was published with an elaborate preface in 1783, and *La Chartreuse* and *Le Jour des morts* in the same year, *Le Verger* in 1788 and his *Épître sur l’édit en faveur des non-catholiques*, and the *Essai sur l’astronomie* in 1789. Fontanes was a moderate reformer, and in 1790 he became joint-editor of the *Modérateur*. He married at Lyons in 1792, and his wife’s first child was born during their flight from the siege of that town. Fontanes was in hiding in Paris when the four citizens of Lyons were sent to the Convention to protest against the cruelties of Collot d’Herbois. The petition was drawn up by Fontanes, and the authorship being discovered, he fled from Paris and found shelter at Sevran, near Livry, and afterwards at Andelys. On the fall of Robespierre he was made professor of literature in the École Centrale des Quatre-Nations, and he was one of the original members of the Institute. In the *Mémorial*, a journal edited by La Harpe, he discreetly advocated reaction to the monarchical principle. He was exiled by the Directory and made his way to London, where he was closely associated with Chateaubriand. He soon returned to France, and his admiration for Napoleon, who commissioned him to write an *éloge* on Washington, secured his return to the Institute and his political promotion. In 1802 he was elected to the legislative chamber, of which he was president from 1804 to 1810. Other honours and titles followed. He has been accused of servility to Napoleon, but he had the courage to remonstrate with him on the judicial murder of the due d’Enghien, and as grand master of the university of Paris (1808-1815) he consistently supported religious and monarchical principles. He acquiesced in the Bourbon restoration, and was made a marquis in 1817. He died on the 17th of March 1821 in Paris, leaving eight cantos of an unfinished epic poem entitled *La Grèce sauvée*.

The verse of Fontanes is polished and musical in the style of the 18th century. It was not collected until 1839, when

Sainte-Beuve edited the *Œuvres* (2 vols.) of Fontanes, with a sympathetic critical study of the author and his career. But by that time the Romantic movement was in the ascendant and Fontanes met with small appreciation.

FONTENAY-LE-COMTE, a town of western France, capital of an arrondissement in the department of Vendée 30 m. N.E. of La Rochelle on the State railway between that town and Saumur. Pop. (1906) town, 7639; commune, 10,326. Fontenay, an ancient and straggling town, is situated a few miles south of the forest of Vouvant and on both banks of the Vendée, at the point where it becomes navigable. The church of Notre-Dame (15th to 18th centuries), which has a fine spire and a richly sculptured western entrance, and the church of St Jean (16th and 17th centuries) are the chief religious buildings. The town has several houses of the 16th and 17th centuries. The most remarkable of these is the Hôtel de Terre Neuve (1595-1600), which contains much rich decoration together with collections of furniture and tapestry. Fontenay was the birthplace of many prominent men during the 15th and 16th centuries, and the Fontaine des Quatre-Tias, a fountain in the Renaissance style, given to the town by King Francis I., commemorates the fact. The chief square is named after François Viète, the great mathematician, who was born at Fontenay in 1540. The public institutions of the town include a tribunal of first instance and a communal college. Among its industries are the manufacture of felt hats, oil and soap and timber-sawing, flour-milling and tanning. There is trade in horses, mules, timber, grain, fruit, &c.

Fontenay was in existence as early as the time of the Gauls. The affix of "comte" is said to have been applied to it when it was taken by King Louis IX. from the family of Lusignan and given to his brother Alphonse, count of Poitou, under whom it became capital of Bas-Poitou. Ceded to the English by the treaty of Brétigny in 1360 it was retaken in 1372 by Duguesclin. It suffered repeated capture during the Religious Wars of the 16th century, was dismantled in 1621 and was occupied both by the republicans and the Vendeans in the war of 1793. From 1790 to 1806 it was capital of the department of Vendée.

FONTENELLE, BERNARD LE BOVIER DE (1657-1757), French author, was born at Rouen, on the 11th of February 1657. He died in Paris, on the 9th of January 1757, having thus very nearly attained the age of 100 years. His father was an advocate settled in Rouen, his mother a sister of the two Corneille. He was educated at the college of the Jesuits in his native city, and distinguished himself by the extraordinary precocity and versatility of his talents. His teachers, who readily appreciated these, were anxious for him to join their order, but his father had designed him for the bar, and an advocate accordingly he became; but, having lost the first cause which was entrusted to him, he soon abandoned law and gave himself wholly to literary pursuits. His attention was first directed to poetry; and more than once he competed for prizes of the French Academy, but never with success. He visited Paris from time to time and established intimate relations with the abbé de Saint Pierre, the abbé Vertot and the mathematician Pierre Varignon. He witnessed, in 1680, the total failure of his tragedy *Aspar*. Fontenelle afterwards acknowledged the justice of the public verdict by burning his unfortunate drama. His opera of *Thétis et Pélée*, 1689, though highly praised by Voltaire, cannot be said to rise much above the others; and it may be regarded as significant that of all his dramatic works not one has kept the stage. His *Poésies pastorales* (1688) have no greater claim to permanent repute, being characterized by stiffness and affectation; and the utmost that can be said for his poetry in general is that it displays much of the *limae labor*, great purity of diction and occasional felicity of expression. 609

His *Lettres galantes du chevalier d'Her* ..., published anonymously in 1685, was an amusing collection of stories that immediately made its mark. In 1686 his famous allegory of Rome and Geneva, slightly disguised as the rival princesses Mreo and Eenegu, in the *Relation de l'île de Bornéo*, gave proof of his daring in religious matters. But it was by his *Nouveaux Dialogues des morts* (1683) that Fontenelle established a genuine claim to high literary rank; and that claim was enhanced three years later by the appearance of the *Entretiens sur la pluralité des mondes* (1686), a work which was among the very first to illustrate the possibility of being scientific without being either uninteresting or unintelligible to the ordinary reader. His object was to popularize among his countrymen the astronomical theories of Descartes; and it may well be doubted if that philosopher ever ranked a more ingenious or successful expositor among his disciples.

Hitherto Fontenelle had made his home in Rouen, but in 1687 he removed to Paris; and in the same year he published his *Histoire des oracles*, a book which made a considerable stir in theological and philosophical circles. It consisted of two essays, the first of which was designed to prove that oracles were not given by the supernatural agency of demons, and the second that they did not cease with the birth of Christ. It excited the suspicion of the Church, and a Jesuit, by name Baltus, published a ponderous refutation of it; but the peace-loving disposition of its author impelled him to leave his opponent unanswered. To the following year (1688) belongs his *Digression sur les anciens et les modernes*, in which he took the modern side in the controversy then raging; his *Doutes sur le système physique des causes occasionnelles* (against Malebranche) appeared shortly afterwards.

In 1691 he was received into the French Academy in spite of the determined efforts of the partisans of the ancients in this quarrel, especially of Racine and Boileau, who on four previous occasions had secured his rejection. He consequently was admitted a member both of the Academy of Inscriptions and of the Academy of Sciences; and in 1697 he became perpetual secretary to the latter body. This office he actually held for the long period of forty-two years; and it was in this official capacity that he wrote the *Histoire du renouvellement de l'Académie des Sciences* (Paris, 3 vols., 1708, 1717, 1722) containing extracts and analyses of the proceedings, and also the *éloges* of the members, written with great simplicity and delicacy. Perhaps the best known of his *éloges*, of which there are sixty-nine in all, is that of his uncle Pierre Corneille. This was first printed in the *Nouvelles de la république des lettres* (January 1685) and, as *Vie de Corneille*, was included in all the editions of Fontenelle's *Œuvres*. The other important works of Fontenelle are his *Élements de la géometrie de l'infini* (1727) and his *Apologie des tourbillons* (1752). Fontenelle forms a link between two very widely different periods of French literature, that of Corneille, Racine and Boileau on the one hand, and that of Voltaire, D'Alembert and Diderot on the other. It is not in virtue of his great age alone that this can be said of him; he actually had much in common with the *beaux esprits* of the 17th century, as well as with the *philosophes* of the 18th. But it is to the latter rather than to the former period that he properly belongs.

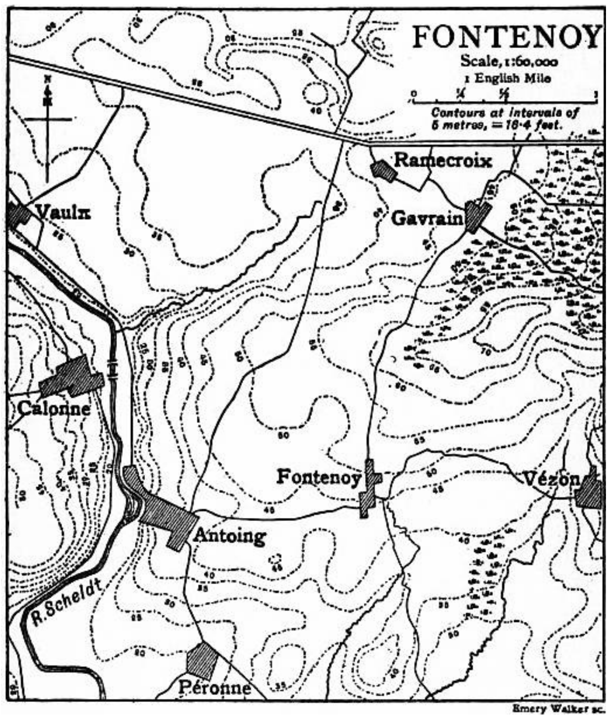
He has no claim to be regarded as a genius; but, as Sainte-Beuve has said, he well deserves a place "*dans la classe des esprits infiniment distingués*"—distinguished, however, it ought to be added by intelligence rather than by intellect, and less by the power of saying much than by the power of saying a little well. In personal character he has sometimes been described as having been revoltingly heartless; and it is abundantly plain that he was singularly incapable of feeling strongly the more generous emotions—a misfortune, or a fault, which revealed itself in many ways. "*Il faut avoir de l'âme* *pour avoir du goût.*" But the cynical expressions of such a man are not to be taken too literally; and the mere fact that he lived and died in the esteem of many friends suffices to show that the theoretical selfishness which he sometimes professed cannot have been consistently and at all times carried into practice.

There have been several collective editions of Fontenelle's works, the first being printed in 3 vols. at the Hague in 1728-1729. The best is that of Paris, in 8 vols. 8vo, 1790. Some of his separate works have been very frequently reprinted and also translated. The *Pluralité des mondes* was translated into modern Greek in 1794. Sainte-Beuve has an interesting essay on Fontenelle, with several useful references, in the *Causeries du lundi*, vol. iii. See also Villemain, *Tableau de la littérature française au XVIII[e] siècle*; the abbé Trublet, *Mémoires pour servir à l'histoire de la vie et des ouvrages de M. de Fontenelle* (1759); A. Laborde-Milaà, *Fontenelle* (1905), in the "Grands écrivains français" series; and L. Maigron, *Fontenelle, l'homme, l'œuvre, l'influence* (Paris, 1906).

FONTENOY, a village of Belgium, in the province of Hennegau, about 4 m. S.E. of Tournai, famous as the scene of the battle of Fontenoy, in which on the 11th of May 1745 the French army under Marshal Saxe defeated the Anglo-Allied army under the duke of Cumberland. The object of the French (see also Austrian Succession, War of the) was to cover the siege of the then important fortress of Tournai, that of the Allies, who slowly advanced from the east, to relieve it. Informed of the impending attack, Louis XV., with the dauphin, came with all speed to witness the operations, and by his presence to give Saxe, who was in bad health and beset with private enemies, the support necessary to enable him to command effectively. Under Cumberland served the Austrian field-marshal Königsegg, and, at the head of the Dutch contingent, the prince of Waldeck.

The right of the French position (see map) rested on the river at Antoing, which village was fortified and garrisoned, between Antoing and Fontenoy three square redoubts were constructed, and Fontenoy itself was put in a complete state of defence. On the left rear of this line, and separated from Fontenoy by some furlongs of open ground, another redoubt was made at the corner of the wood of Barry and a fifth towards Gavrain. The infantry was arrayed in deployed lines behind the Antoing-Fontenoy redoubts and the low ridge between Fontenoy and the wood; behind them was the cavalry. The approaches to Gavrain were guarded by a mounted volunteer corps called *Grassins*. At Calonne the marshal had constructed three military bridges against the contingency of a forced retreat. The force of the French was about 60,000 of all arms, not including 22,000 left in the lines before Tournai. Marshal Saxe himself, who was suffering from dropsy to such an extent that he was unable to mount his horse, slept in a wicker chariot in the midst of the troops. At early dawn of the 11th of May, the Anglo-Hanoverian army with the Austrian contingent formed up in front of Vézon, facing towards Fontenoy and the wood, while the Dutch on their left extended the general line to Péronne. The total force was 46,000, against about 52,000 whom Saxe could actually put into the line of battle.

The plan of attack arranged by Cumberland, Königsegg and Waldeck on the 10th grew out of circumstances. A preliminary skirmish had cleared the broken ground immediately about Vézon and revealed a part of the defender's dispositions. It was resolved that the Dutch should attack the front Antoing-Fontenoy, while Cumberland should deliver a 610
flank attack against Fontenoy and all in rear of it, by way of the open ground between Fontenoy and the wood. A great cavalry attack round the wood was projected but had to be given up, as in the late evening of the 10th the Allies' light cavalry drew fire from its southern edge. Cumberland then ordered his cavalry commander to form a screen facing Fontenoy, so as to cover the formation of the infantry. On the morning of the 11th another and most important modification had to be made. The advance was beginning when the redoubt at the corner of the wood became visible. Cumberland hastily told off Brigadier James Ingoldsby (major and brevet-colonel 1st Guards), with four regiments and an artillery detachment, to storm this redoubt which, crossing its fire with that of Fontenoy, seemed absolutely to inhibit the development of the flank attack. At 6 A.M. the brigade moved off, but it was irresolutely handled and halted time after time; and after waiting as long as possible, the British and Hanoverian cavalry under Sir James Campbell rode forward and extended in the plain, becoming at once the target for a furious cannonade which killed their leader and drove them back. Thereupon Sir John (Lord) Ligonier, whose deployment the squadrons were to have covered, let them pass to the rear, and, hearing the guns of the Dutch towards Antoing, pushed the British infantry forward through the lanes, each unit on reaching open ground covering the exit and deployment of the one in rear, all under the French cannonade. This went on for two hours, and save that it showed the magnificent discipline of the British and Hanoverian regiments, was a bad prelude to the real attack. Cumberland's own exertions brought a few small guns to the front of the Guards' Brigade, and one of the first shots from these killed Antoine Louis, duc de Gramont, colonel of the Gardes Françaises, and another Henri du Baraillon du Brocard, Saxe's artillery commander.



It was now 9 a.m., and while the guns from the wood redoubt battered the upright ranks of the Allies, Ingoldsby's brigade was huddled together, motionless, on the right. Cumberland himself galloped thither, and under his reproaches Ingoldsby lost the last remnants of self-possession. To Sir John Ligonier's aide-de-camp, who delivered soon afterwards a bitterly formal order to advance, Ingoldsby sullenly replied that the duke's orders were for him to advance in line with Ligonier's main body. By now, too, the Dutch advance against Antoing-Fontenoy had collapsed.

But on the right the cannonade and the blunders together had roused a stern and almost blind anger in the leaders and the men they led. Ingoldsby was wounded, and his successor, the Hanoverian general Zastrow, gave up the right attack and brought his battalions into the main body. A second halfhearted attack on Fontenoy itself, delivered by some Dutch troops, was almost made successful by the valour of two of these battalions (one of them being the then newly raised Highland regiment, the Black Watch) which came thither of their own accord. Meantime the young duke and the old Austrian field-marshal had agreed to take all risks and to storm through between Fontenoy and the wood redoubt, and had launched the great attack, one of the most celebrated in the history of war. The English infantry was in two lines. The Hanoverians on their left, owing to want of space, were compelled to file into third line behind the redcoats, and on their outer flanks were the battalions that had been with Ingoldsby. A few guns, man-drawn, accompanied the assaulting mass, and the cavalry followed. The column may have numbered 14,000 infantry. All the infantry battalions closed on their centre, the normal three ranks becoming six. If the proper distances between lines were preserved, the mass must have formed an oblong about 500 yds × 600 yds (excluding the cavalry).

The duke of Cumberland placed himself at the head of the front line and gave the signal to advance. Slowly and in parade order, drums beating and colours flying, the mass advanced, straight up the gentle slope, which was swept everywhere by the flanking artillery of the defence. Then, when the first line reached the low crest on the ends of which stood the French artillery, the fire, hitherto convergent, became a full enfilade from both sides, and at the same moment the enemy's horse and foot became visible beyond. A brief pause ensued, and the front gradually contracted as regiments shouldered inwards to avoid the fire. Then the French advanced, and the Guards Brigade and the Gardes Françaises met face to face. Captain Lord Charles Hay (d. 1760), lieutenant of the First (Grenadier) Guards, suddenly ran in front of the line, took off his hat to the enemy and drank to them from a pocket flask, shouting a taunt, "We hope you will stand till we come up to you, and not swim the river as you did at Dettingen," then, turning to his own men, he called for three cheers. The astonished French officers returned the salute and gave a ragged counter-cheer. Whether or not the French, as legend states, were asked and refused to fire first, the whole British line fired one tremendous series of volleys by companies. 50 officers and 760 men of the three foremost French regiments fell at once, and at so appalling a loss the remnant broke and fled. Three hundred paces farther on stood the second line of the French, and slowly the mass advanced, firing regular volleys. It was now well inside the French position, and no longer felt the enfilade fire that swept the crest it had passed over. By now, as the rear lines closed up, the assailants were practically in square and repelled various partial attacks coming from all sides. The Régiment du Roi lost 33 officers and 345 men at the hands of the Second (Coldstream) Guards. But these counter-attacks gained a few precious minutes for the French. It was the crisis of the battle. The king, though the court meditated flight, stood steady with the dauphin at his side,—Fontenoy was the one great day of Louis XV.'s life,—and Saxe, ill as he was, mounted his horse to collect his cavalry for a charge. The British and Hanoverians were now at a standstill. More and heavier counter-strokes were repulsed, but no progress was made; their cavalry was unable to get to the front, and Saxe was by now thinking of victory. Captain Isnard of the Touraine regiment suggested artillery to batter the face of the square, preparatory to a final charge. General Löwendahl galloped up to Saxe, crying, "This is a great day for the king; they will never escape!" The nearest guns were planted in front of the assailants, and used with effect. The infantry, led by Löwendahl, fastened itself on the sides of the square, the regiments of Normandy and Vaisseaux and the Irish Brigade conspicuous above the rest. On the front, waiting for the cannon to do 611
its work, were the Maison du Roi, the Gendarmerie and all the light cavalry, under Saxe himself, the duke of Richelieu and count d'Estrées. The left wing of the Allies was still inactive, and troops were brought up from Antoing and Fontenoy to support the final blow. About 2 p.m. it was delivered, and in eight minutes the square was broken. As the infantry retired across the plain in small stubborn groups the French fire still made havoc in their ranks, but all attempts to close with them were repulsed by the terrible volleys, and they regained the broken ground about Vézon, whence they had come. Cumberland himself and all the senior generals remained with the rearguard.

The losses at Fontenoy were, as might be expected, somewhat less than normally heavy when distributed over the whole of both armies, but exceedingly severe in the units really engaged. Eight out of nineteen regiments of British infantry lost over 200 men, two of these more than 300. A tribute to the loyalty and discipline of the British, as compared with the generality of armies in those days, may be found in the fact that the three Guards' regiments had no "missing" men whatever. The 23rd (Royal Welsh Fusiliers) had 322 casualties. Böschlanger's Hanoverian regiment suffered even more heavily, and four others of that nation had 200 or more casualties. The total loss was about 7500, that of the French 7200. The French "Royal" regiment lost 30 officers and 645 men; some other regimental casualties have been mentioned above. The Dutch lost a bare 7% of their strength.

Fontenoy was in the 18th century what the attack of the Prussian Guards at St Privat is to-day, *a locus classicus* for military theorists. But the technical features of the battle are completely overshadowed by its epic interest, and above all it illustrates the permanent and unchangeable military characteristics of the British and French nations.

FONTEVRAULT, or Fontevraud (Lat. *Fons Ebraldi*), a town of western France, in the department of Maine-et-Loire, 10 m. S.E. of Saumur by road and 2½ m. from the confluence of the Loire and Vienne. Pop. (1906) 1279. It is situated in the midst of the forest of Fontevrault. The interest of the place centres in its abbey, which since 1804 has been utilized and abused as a central house of detention for convicts. The church (12th century), of which only the choir and apse are appropriated to divine service, has a beautiful nave formerly covered by four cupolas destroyed in 1816. There is a fifth cupola above the crossing. In a chapel in the south transept are the effigies of Henry II. of England, of his wife Eleanor of Guienne, of Richard I. of England and of Isabella of Angoulême, wife of John of England—Eleanor's being of oak and the rest of stone. The cloister, refectory and chapter-house date from the 16th century. The second court of the abbey contains a remarkable building, the Tour d'Évrault (12th century), which long went under the misnomer of *chapelle funéraire*, but was in reality the old kitchen. Details and diagrams will be found in Viollet-le-Duc's *Dictionnaire de l'architecture*. There are three stories, the whole being surmounted by a pyramidal structure.

The *Order of Fontevrault* was founded about 1100 by Robert of Arbrissel, who was born in the village of Arbrissel or Arbresec, in the diocese of Rennes, and attained great fame as a preacher and ascetic. The establishment was a double monastery, containing a nunnery of 300 nuns and a monastery of 200 monks, separated completely so that no communication was allowed except in the church, where the services were carried on in common; there were, moreover, a hospital for 120 lepers and other sick, and a penitentiary for fallen women, both worked by the nuns. The basis of the life was the Benedictine rule, but the observance of abstinence and silence went beyond it in stringency. The special feature of the institute was that the abbess ruled the monks as well as the nuns. At the beginning the order had a great vogue, and at the time of Robert's death, 1117, there were several monasteries and 3000 nuns; afterwards the number of monasteries reached 57, all organized on the same plan. The institute never throve out of France; there were attempts to introduce it into Spain and England: in England there were three houses—at Ambresbury (Amesbury in Wiltshire), Nuneaton, and Westwood in Worcestershire. The nuns in England as in France were recruited from the highest families, and the abbess of Fontevrault, who was the superior-general of the whole order, was usually of the royal family of France.

See P. Hélyot, *Hist, des ordres religieuses* (1718), vi. cc. 12, 13; Max Heimbucher, *Orden und Kongregationen* (1907), i. 46; the arts. "Fontevrauld" in Wetzer and Welte, *Kirchenlexicon* (ed. 2), and in Herzog-Hauck, *Realencyklopädie* (ed. 3), supply full references to the literature. The most recent monograph is Édouard, *Fontevrault et ses monuments* (1875); for the later history see art. by Edmund Bishop in *Downside Review* (1886).

(E. C. B.)

FOOD (like the verb "to feed," from a Teutonic root, whence O. Eng. *foda*; cf. "fodder"; connected with Gr. πατεῖσθαι, to feed), the general term for what is eaten by man and other creatures for the sustenance of life. The scientific aspect of human food is dealt with under Nutrition and Dietetics.

Infancy.—The influence of a normal diet upon the health of man (we exclude here the question of diet in illness, which must depend on the abnormal conditions existing) begins at the earliest stage of his life. No food has as yet been found so suitable for the young of all animals as their mother's milk. This, however, has not been from want of seeking. Dr Brouzet (*Sur l'éducation médicinale des enfants*, i. p. 165) had such a bad opinion of human mothers, that he expressed a wish for the state to interfere and prevent them from suckling their children, lest they should communicate immorality and disease! A still more determined pessimist was the famous chemist Van Helmont, who thought life had been reduced to its present shortness by our inborn propensities, and proposed to substitute bread boiled in beer and honey for milk, which latter he calls "brute's food." Baron Justus von Liebig, as the result of his chemical researches, introduced a "food for infants," which in more modern days has been followed by a multiplication of patent foods. A close imitation of human milk may also be made by the addition to fresh cow's milk of half its bulk of soft water, in each pint of which has been mixed a heaped-up teaspoonful of powdered "sugar of milk" and a pinch of phosphate of lime. These artificial substitutes for the natural nutriment have their value where for any reason it is not available. The wholesomest food, however, for the first six months is certainly mother's milk alone. A vigorous baby can indeed bear with impunity much rough usage, and often appears none the worse for a certain quantity of farinaceous food; but the majority do not get habituated to it without an exhibition of dislike which indicates rebellion of the bowels. It is only when the teeth are on their way to the front, as shown by dribbling, that the parotid glands secrete an active saliva capable of digesting bread stuffs. Till then anything but milk must be given tentatively, and considered in the light of a means of education for its future mode of nutrition.

The time for weaning should be fixed partly by the child's age, partly by the growth of the teeth. The first group of teeth nine times out of ten consists of the lower central front teeth, which may appear any time during the sixth and seventh month. The mother may then begin to diminish the number of suckling times; and by a month she can have reduced them to twice a day, so as to be ready when the second group makes its way through the upper front gums to cut off the supply altogether. The third group, the lateral incisors and first grinders, usually after the first anniversary of birth, give notice that solid food can be chewed. But it is prudent to let dairy milk form a considerable portion of the fare till the eye-teeth are cut, which seldom happens till the eighteenth or twentieth month.

Childhood and Youth.—At this stage of life the diet must obviously be the best which is a transition from that of infancy to that of adult age. Growth is not completed, but yet entire surrender of every consideration to the claim of growth is not possible, nor indeed desirable. Moreover, that abundance of adipose tissue, or reserve new growth, which a baby can bear is an impediment to the due education of the muscles of the boy or girl. The supply of nutriment need not be so continuous as before, but at the same time should be more frequent than for the adult. Up to at least fourteen or fifteen years of age the rule should be four meals a day, varied indeed, but nearly equal in nutritive power and in quantity, that is to say, all moderate, all sufficient. The maturity the body then reaches involves a hardening and enlargement of the bones and cartilages, and a strengthening of the digestive organs, which in healthy young persons enables us to dispense with some of the watchful care bestowed upon their diet. Three full meals a day are generally sufficient, and the requirements of mental training may be allowed to a certain extent to modify the attention to nutrition which has hitherto been paramount.

Adults.—It is only necessary here to refer to the article on Dietetics (see also Vegetarianism) for a discussion of the food of normal adults; and to such headings as Dietary (for fixed allowances) or Cookery. Different staple articles of food are dealt with under their own headings. For animals other than man see the respective articles on them.

Among numerous books on the subject, in addition to those enumerated under Dietetics, see Sir Henry Thompson's *Foods and Feeding* (1894); Hart's *Diet in Sickness and Health* (1896); Knight, *Food and its Functions* (1895).

FOOD PRESERVATION. The preservation of food material beyond the short term during which it naturally keeps sound and eatable has engaged human thought from the earliest dawn of civilization. Necessity compelled man to store the plenitude of one season or place against the need of another. The hunter dried, smoked and salted meat and fish, pastoral man preserved milk in the form of cheese and butter, or fermented grape-juice into wine. With the separation of country from town, the development of manufacturing nation as distinct from agricultural and food-producing people, the spreading of civilized man from torrid to arctic zones, the needs of travellers on land and sea and of armies on the march, the problem of the prevention of the natural decomposition to which nearly all food substances are liable became increasingly urgent, and forms to-day, next to the production of food, the most important problem in connexion with the feeding and the trade of nations. As long as the reasons of decomposition were unknown, all attempts at preservation were necessarily empirical, and of the numberless processes which have during modern times been proposed and attempted comparatively few have stood the test of experience. In the light of modern knowledge, however, the guiding principles appear to be very simple.

Very few organic materials undergo decomposition, as it were, of their own accord. They may lose water by evaporation, and fatty substances may alter by the absorption of oxygen from the air. They are otherwise quite stable and unchangeable while not attacked and eaten up by living organisms, or while the life with which they may be endowed is in a state of suspense. An apple is alive and in breathing undergoes its ripening change; a grain of wheat is dormant and does not alter. A substance, in order to be a food material, must be decomposable under the attack of a living organism; the energy stored in it must be available to that stream of energy which we call life, whether the life be in the form of the human consumer or of any lower organism. All decomposition of food is due to the development within the food of living organisms. Under conditions under which living organisms cannot enter or cannot develop food keeps undecomposed for an indefinite length of time. The problem of food preservation resolves itself, therefore, into that of keeping out or killing off all living things that might feed upon and thus alter the food, and as these organisms mainly belong to the family of moulds, yeasts and bacteria, modern food preservation is strictly a subject for the bacteriologist.

The changes which food undergoes on keeping are easily intelligible when once their biological origin is recognized. Yeasts cause the decomposition of saccharine substances into alcohol and carbon dioxide, acetic and lactic ferments produce from sugar or from alcohol the organic acids causing the souring of food, moulds as a rule cause oxidation and complete destruction of organic matter, nitrogenous or saccharine, while most bacteria act mainly upon the nitrogenous constituents, producing albumoses and peptones and breaking up the complex albumen-molecule into numerous smaller molecules often allied to alkaloids, generally with the production of evil-smelling gases. These processes may go on simultaneously, but more frequently take place successively in the decomposition of food, one set of organisms taking up the work of destruction as the conditions become favourable to its development and unfavourable to its predecessor. The organisms may come from the air, the soil or from animal sources. The air teems with organisms which settle and may develop when brought upon a favourable nidus; the organic matter of the soil largely consists of fungoid life; while the intestinal canal and other mucous membranes of all animals harbour bacteria, sarcinae and other organisms in countless millions. Whenever, therefore, food material is exposed to the air, or touched by the soil or by animals or man, it becomes infected with living cells, which by their development lead to its decomposition and destruction.

Fungoid organisms may be killed by heat or by chemicals; or their development may be arrested by cold, removal of water, or by the presence of agents inhibiting their growth though not destroying their life. All successful processes of food preservation depend upon one or other of these circumstances.

Preservation by Heat.—At the boiling-point of water all living cells perish, but some spores of bacteria may survive for about three hours. Few adult bacteria can live beyond 75° C. (167° F.) in the presence of water, though dry heat only kills with certainty at 140° C. (284° F.). Destruction of life takes place more rapidly in solutions showing an acid than a feebly alkaline reaction; hence acid fruit is more easily preserved than milk, which, when quite fresh, is alkaline. By cooking, therefore, food becomes temporarily sterile, until a fresh crop of organisms finds access from the air. By repeated cooking all food can be indefinitely preserved. One of the most important functions of cookery is sterilization. Civilized man unwittingly revolts against the consumption of non-sterile food, and the use of certain fungus-infected material is an inheritance from barbarous ages; few materials of animal origin are eaten raw, and in vegetables some sort of sterilizing process is attempted by washing (of salads) or removal of the outer skin (of fruits). All preparation of food for the table, cooking being the most important, tends towards preservation, but is effectual only for a few hours or days at most, unless special means are adopted to prevent reinfection. The housewife covering the jam with a thin paper soaked in brandy, or the potted meat with a thin layer of lard, attempts unconsciously to bar the road to bacteria and other minute organisms. To preserve food in a permanent manner and on a commercial scale it has to be cooked in a receptacle which must be sufficiently strong for transport, cheap, light and unattacked by the material in contact with it. None of the receptacles at present in use quite fulfils the whole of these conditions: glass and china are heavy and fragile, and their carriage is expensive; tinned iron, so-called tin-plate, is rarely quite unaffected by food materials, but owing to its strength, tenacity and cheapness, it is used on an ever-increasing scale. The sheet iron, which formerly was made of soft wrought iron, now generally consists of steel containing but very little carbon; it is cleaned by immersion in acid and covered with a very thin layer of pure tin, all excess of tin being removed by hot rollers and brushes. The layer of tin, which formerly constituted from 3 to 5% of the total weight of the plate, has, owing to the increased price of tin and the improvement in machinery, gradually become so thin that its weight is only from 1 to 3%. Not rarely, therefore, the tin-surface is imperfect, perforated or pin-holed. Tin itself is slightly attacked by all acid juices of vegetable or animal substances. With the exception of milk, all human food is slightly acid, and consequently all food that has been preserved in tin canisters contains variable traces of dissolved tin. Happily, salts of tin have but little physiological action. Nevertheless, the employment cf tin-plate for very acid materials, like tomatoes, peaches, &c., is very objectionable.

The process of preservation in canisters is carried out as follows:—The canister, which has been made either by the use of solder or by folding machinery only, is packed with the material to be preserved, and a little water having been added to fill the interstices the lid is secured by soldering or folding, generally the former. Sterilization is effected by placing the tins in pressure chambers, which are heated by steam to 120° C. or more. The tins are exposed to that temperature for such time as experience has shown to be necessary to heat the contents throughout to at least 100° C. The temperature is then allowed to fall slowly to below the boiling-point of water, when the tins can be taken out of the pressure chamber, or they are placed in pans filled with water or a solution of calcium chloride and are therein heated till thoroughly cooked. Sometimes a small aperture is pierced through the lid, to allow of the escape of the expanding air, such holes before cooling closed by means of a drop of solder. This process, which was originally introduced by François Appert early in the 19th century, is employed on an enormous scale, especially in America. The use of lacquered tins, having the inner surface of the tin covered with a heat-resisting varnish, is gradually extending. Imperfect sterilization shows itself in many cases by gas development within the tin, which causes the ends to become convex and drummy. More frequently than not the contents of the larger tins, containing meat or other animal products, are not absolutely sterile, but the conditions are mostly such that the organisms which have survived the cooking process cannot develop. When they can develop without formation of gas dangerous products of decomposition may be produced without showing themselves to taste or smell. Numerous cases of so-called ptomaine poisoning have thus occurred; these are more frequently associated with preserved fish and lobster than with meats, although no class of preserved animal food is free from liability of ptomaine formation. The formation of poisonous substances has never been traced to preserved fruit or other material poor in nitrogen. The mode of preserving food in china or glass is quite similar, but the losses by breakage are not inconsiderable. Food which has been preserved in tins is sometimes transferred to glass and re-sterilized, the feeling against "tinned" food caused by the "Chicago scandals" not having entirely subsided. Were it not for the facts that sterilization is rarely quite perfect, and that the food attacks the tin, the contents of tin canisters ought to keep for an indefinite length of time. Under existing circumstances, however, there is a distinct limit to the age of soundness of canned food.

Preservation by Chemicals.—Salt is the oldest chemical preservative and, either alone or in conjunction with saltpetre and with wood-smoke, has been used for many centuries, mainly as a meat preservative. It is used either dry in layers strewn on the surface of the meat or fish to be preserved, or in the form of brine in which the meat is submerged or which is injected into the carcasses. The preserving power of salt is but moderate. It has the great advantage that in ordinary doses it is non-injurious, that an excess at once betrays itself in the taste, and that it can be readily removed by soaking in water. When aided by wood-smoke, which depends for its preservative power upon traces of creosote and formaldehyde, it is, however, quite efficient. The addition of saltpetre is principally for the purpose of giving to the meat a bright pink tint. The strongly saline taste of pickled meat or salted butter appears gradually to have become repugnant to a large part of mankind, and other preservatives have come into use, possessing greater bactericidal power and less taste. The serious objection attaching to them is discussed in the article Adulteration. At the present time the use of borax or boracic acid is almost universal in England. Meat which has been exposed to the vapours of formaldehyde, and has thus been superficially sterilized, is also coming into commerce in increasing quantities. Formaldehyde in itself is distinctly poisonous, and has the property of combining with albuminoids and rendering them completely insoluble in the digestive secretions. Salicylic and benzoic acids are not infrequently used to stop fermentation of saccharine beverages or deterioration of so-called "potted meats," which are supposed to last fresh and sweet on the consumer's table for a considerable length of time. Sulphurous acid and sulphites are chiefly used in the preservation of thin ales, wine and fruit, and sodium fluoride has been found in butter. The whole of these substances possess decided and injurious physiological properties. Alcohol now rarely forms a preservative of food material, its employment being confined to small fruit. The use of sugar as a preservative depends upon the fact that, although in a dilute solution it is highly prone to fermentation and other decomposition, it possesses bactericidal properties when in the form of a concentrated syrup. A sugar solution containing 30% of water or less does not undergo any biological change; in the presence of organic acids, like those contained in fruit, growth of organisms is inhibited when the percentage of water is somewhat greater. Upon this fact depends the use of sugar in the manufacture of jams, marmalades and jellies. Moulds may grow on the surface of such saccharine preparations, but the interior remains unaffected and unaltered.

Preservation by Drying.—Food materials in which the percentage of moisture is small (not exceeding about 8%) are but little liable to bacterial growths, at most to the attacks of innocent *Penicillium*. Nature preserves the germs in seeds and nuts, which are laden with otherwise decomposable food material, by the simple expedient of water removal. The life of cereal grains and many seeds appears to be unlimited. By the removal of water the most perishable materials, like meat or eggs, can be rendered unchangeable, except so far as the inevitable oxidation of the fatty substances contained in them is concerned and which is independent of life-action. The drying of meat, upon which a generation ago inventors bestowed a great deal of attention, has become almost obsolete, excepting for comparatively small articles or animals, like ox tongues or tails and fish. It has been superseded even among less civilized communities by the spread of canned food. Fruit, however, is very largely preserved in the dried state. Grapes are sun-dried and thus form currants, raisins and sultanas, the last variety being often bleached by the addition of sulphites. Plums, apples and pears are artificially dried in ovens on wooden battens or on wire sieves; from the latter they are apt to become contaminated with notable quantities of zinc. Excellent preparations of dried vegetables, including potatoes, carrots, onions, French beans and cabbages, are also manufactured.

The utilization of meat in the form of meat extract belongs to some extent to this class of preserved foods. Its origin is due to J. von Liebig and Max von Pettenkofer, and dates from the middle of the 19th century. The soluble material is extracted mainly from beef, in Australia to some extent from mutton, by means of warm water; the albumen is coagulated by heat and removed, and the broths thus obtained are evaporated *in vacuo* until the extract contains no more than about 20% of water. One pound of extract is obtained from about 25 ℔ of lean beef.

Preservation by Refrigeration.—At or below the freezing-point of water fungoid organisms are incapable of growth and multiplication. Although it has been asserted that many of them perish when kept for some time in the frozen condition, it is certain that the vast majority of bacteria and their germs remain merely dormant. Even so highly organized structures as cereal seeds do not suffer in vitality on being kept for a considerable length of time at the far lower temperature of liquid air. Biological change is, therefore, arrested at freezing-point, and as long as that temperature is maintained food material remains unaltered, except for physical changes depending upon the evaporation of water and of volatile flavouring matters, or chemical alterations due to oxidation.

Refrigeration, therefore, affords the means of keeping for a reasonably long time, and without the addition of any preservative substance, food in a raw condition. It is the only process of preservation which from a sanitary point of view is entirely unobjectionable as ordinarily and properly employed. Its introduction on a commercial scale has more powerfully affected the economic conditions of England and, to a less degree, of the United States than any other 614
scientific advance since the establishment of railways and steamboats. Enormous quantities of frozen carcasses, butter, fruit, vegetables and fish are introduced in the fresh condition into Great Britain and stored until required. Extreme fluctuations of supply or of price have become almost impossible, and the abundance of Australian and New Zealand ranches, and of West Indian orchards, has been made readily accessible to the British consumer. For household purposes cooling in ice-chests or ice-chambers suffices to preserve food on a comparatively small scale. The ice used for the purpose comes, to a small extent, from natural sources, stored from the winter or imported from northern countries; a far larger quantity is artificially produced by the methods described in the article on Refrigerating, which also contains an account of the means by which low temperatures are produced for industrial purposes of importation and storage. Fleets

of steamships fitted with refrigerating machinery and insulated cold-rooms are employed in carrying the food materials, which are deposited in cold-stores at docks, warehouses, markets and hotels. The first cargo of frozen meat was shipped in July 1873 from Melbourne, but arrived in October in an unsatisfactory state. In 1875-1876 sound frozen meat came from America. The first cargo of frozen meat was successfully brought to the United Kingdom in 1880 from Australia in the "Strathleven," fitted with a Bell-Coleman air machine. The temperature in the cold-storage rooms is generally kept near 34° F., whilst in the chilling chambers a somewhat lower, and in the freezing room or chambers a much lower temperature (between 0° and 10° F.) is maintained. The carcasses to be frozen should be cooled slowly at first to ensure even freezing throughout and to prevent damage by the unequal expansion of the outer layer of ice. The carcasses when freezing must be hung separated from each other, but for storage or transportation they are packed tightly together. Fish such as salmon is washed, thoroughly cleansed, and frozen on trays. Butter should be cooled as rapidly as possible to about 10° F.; its composition as regards proportion of volatile fatty-acids, &c., remains absolutely unaltered for years. Cheese should only be cold-stored when nearly ripe and should not be frozen. Eggs must be carefully selected, each one being inspected by candle-light. They are placed in cases holding about three hundred, which are taken first to a room in which they are slowly cooled to about 33° F., and are then kept in store just below freezing-point. Particular attention must be paid to the relative humidity of the air in egg stores. Fruit should be quite fresh; grapes may be chilled to 26° F., while lemons cannot safely be kept at a lower temperature than 36°. The time during which soft fruit can be kept even in cold-store is limited, and does not exceed about six weeks.

In the early days of the chilled-meat trade considerable prejudice existed against stored meat. While in many cases the flavour of fresh meat is rather superior, the food value is in no way altered by cold-storage.[1]

Preservation by Pickling other than Salt.—For the preservation of vegetables, vinegar or other solution of acetic acid is used to a limited extent. Eggs are submerged in lime-water or a dilute solution of sodium silicate (soluble glass). During the storage of eggs the more aqueous white of egg yields by endosmosis a portion of its water to the more concentrated yolk, which thereby expands and renders its thin containing-membrane liable to rupture. Fish, such as sardines, sprats and salmon, is preserved by packing in olive or other oil.

The preservation of the most important dairy product, namely, milk, deserves a separate notice. It has already been stated that alkaline liquids, like milk, are more difficult to sterilize by heat than acid materials. In consequence of the alteration in flavour which milk undergoes by long continued boiling, and of the fact that milk forms perhaps the best medium for the growth and propagation of bacterial organisms, there is exceptional difficulty in its sterilization. As secreted by a healthy cow it is a perfectly sterile fluid, and, as shown by Sir J. Lister, when drawn under aseptic conditions and kept under such, it remains definitely fresh and sweet. Bacterial and other pollution at the time of milking arises from the animal, the stable, the milker and the vessels. In animals suffering from tuberculosis and other bacterial affections the milk may be infected within the udder. Milk as it reaches the consumer rarely contains less than 50,000 bacteria and often many millions per cubic centimetre. In fresh country cream 100 millions per cubic centimetre are not unusual. These bacteria are of many kinds, some of them spore-bearing. The spores are more difficult to kill than the adult organism. The first step towards preservation is the removal of the dirt unavoidably present, to the particles of which a considerable proportion of the bacteria adhere. Filtration through cloths or, better, the passing of the milk through centrifugals effects that removal. Subsequent treatment is preferably preceded by a breaking-up of the larger fat-globules by the projection of a jet of the milk under high pressures against a steel or agate plate, a process known as homogenizing. From homogenized milk the cream separates slowly, and does not form the coherent layer thrown up by ordinary milk. Heating is then effected either after bottling or by passing the milk continuously through pipes in which it is heated to from 160° to 170° F. By a repetition of the heating process on two or more succeeding days, complete sterilization may be effected, although a single treatment is sufficient to render the milk stable for a few days. Many forms of pasteurizing apparatus for milk are in use. Since the general introduction of pasteurization of the skim-milk used in Denmark for the feeding of calves and pigs, tuberculosis in these animals has practically disappeared. On the continent of Europe the use of sterilized milk is now very general. In England it has found little favour in households, but is making rapid progress on board ship.

Milk which has been condensed has for many years found a most extensive sale. The first efforts to condense and thus preserve milk date from 1835, when an English patent was granted to Newton. In 1849 C.N. Horsford prepared condensed milk with the addition of lactose. Commercially successful milk condensation began in 1856. The milk is heated to about 180° F. and filled into large copper vacuum pans, after having been mixed with from 10 to 12 parts of sugar per 100 parts of milk. Evaporation takes place in the pans at about 122° F., and is carried on till the milk is boiled down to such concentration that 100 parts of the condensed milk, including the sugar, contain the solids of 300 parts of milk. Sweetened condensed milk, although rarely quite sterile, keeps indefinitely, and is invariably brought into commerce in tin canisters. The preparation of sweetened condensed milk forms one of the most important branches of manufacture in Switzerland and is steadily increasing in England. Although milk can quite well be preserved in the form of condensed unsweetened milk, which dietetically possesses immense advantages over the sweetened milk in which the balance between carbohydrates and albuminoids is very unfavourable, such unsweetened milk has found little or no favour. Milk powder is manufactured under various patents, the most successful of which depends upon the addition of sodium bicarbonate and the subsequent rapid evaporation of the milk on steam-heated revolving iron cylinders. Milk powder made from skim-milk keeps well for considerable periods, but full-cream milk develops rancid or tallowy flavours by the oxidation of the finely divided butter-fat. It is largely employed in the preparation of so-called milk chocolates.

(O. H.*)

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1 *Per contra*, see the article by Mary E. Pennington in the *Year-book for 1907* (1908) of the U.S. Dept. of Agriculture, pp. 197-206, with illustrations of chickens kept in cold storage for two and three years. The results there shown cast considerable doubt on the efficiency of even refrigeration so far as an "indefinite" period is concerned; and it is suggested that the consumption of frozen meat may really account for various modern diseases.

FOOL (O. Fr. *fol*, modern *fou*, foolish, from a Late Latin use of *follis*, bellows, a ball filled with air, for a stupid person, a jester, a wind-bag), a buffoon or jester.

The class of professional fools or jesters, which reached its culminating point of influence and recognized place and function in the social organism during the middle ages, appears to have existed in all times and countries. Not only have there always been individuals naturally inclined and endowed to amuse others; there has been besides in most communities a definite class, the members of which have used their powers or weaknesses in this direction as a regular means of getting a livelihood. Savage jugglers, medicine-men, and even priests, have certainly much in common with the jester by profession. There existed in ancient Greece a distinct class of professed fools whose habits were not essentially different from those of the jesters of the middle ages. Of the behaviour of one of these, named Philip, Xenophon has given 615 a picturesque account in the *Banquet*. Philip of Macedon is said to have possessed a court fool, and certainly these (as well as court poets and court philosophers, with whom they have sometimes been not unreasonably confounded) were common in a number of the petty courts at that era of civilization. *Scurrae* and *moriones* were the Roman parallels of the medieval witty fool; and during the empire the manufacture of human monstrosities was a regular practice, slaves of this kind being much in request to relieve the languid hours. The jester again has from time immemorial existed at eastern courts. Witty stories are told of Bahalul (see D’Herbelot, s.v.) the jester of Harun al-Reshid, which have long had a place in Western fiction. On the conquest of Mexico court fools and deformed human creatures of all kinds were found at the court of Montezuma. But that monarch no doubt hit upon one great cause of the favour of monarchs for this class when he said that “more instruction was to be gathered from them than from wiser men, for they dared to tell the truth.” Douce, in his essay *On the Clowns and Fools of Shakespeare*, has made a ninefold division of English fools, according to quality and place of employment, as the domestic fool, the city or corporation fool, the tavern fool, the fool of the mysteries and moralities. The last is generally called the “vice,” and is the original of the stage clowns so common among the dramatists of the time of Elizabeth, and who embody so much of the wit of Shakespeare. A very palpable classification is that which distinguishes between such creatures as were chosen to excite to laughter from some deformity of mind or body, and such as were so chosen for a certain (to all appearance generally very shallow) alertness of mind and power of repartee,—or briefly, butts and wits. The dress of the regular court fool of the middle ages was not altogether a rigid uniform. To judge from the prints and illuminations which are the sources of our knowledge on this matter, it seems to have changed considerably from time to time. The head was shaved, the coat was motley, and the breeches tight, with generally one leg different in colour from the other. The head was covered with a garment resembling a monk’s cowl, which fell over the breast and shoulders, and often bore asses’ ears, and was crested with a cockscomb, while bells hung from various parts of the attire. The fool’s bauble was a short staff bearing a ridiculous head, to which was sometimes attached an inflated bladder, by means of which sham castigations were effected. A long petticoat was also occasionally worn, but seems to have belonged rather to the idiots than to the wits.

The fool’s business was to amuse his master, to excite him to laughter by sharp contrast, to prevent the over-oppression of state affairs, and, in harmony with a well-known physiological precept, by his liveliness at meals to assist his lord’s digestion. The names and the witticisms of many of the official jesters at the courts of Europe have been preserved by popular or state records. In England the list is long between Hitard, the fool of Edmund Ironside, and Muckle John, the fool of Charles I., and probably the last official royal fool of England. Many are remembered from some connexion with general or literary history. Scogan was attached to Edward IV., and later was published a collection of poor jests ascribed to him, to which Andrew Boorde’s name was attached, but without authority.

Will Sommers, of the time of Henry VIII., seems to have been a kind-hearted as well as a witty man, and occasionally used his influence with the king for good and charitable purposes. Armin, who, in his *Nest of Ninnies*, gives a full description of Sommers, and introduces many popular fools, says of him—

“Only this much, he was a poor man’s friend.
And helpt the widow often in her end.
The king would ever grant what he would crave.
For well he knew Will no exacting knave.”

The literature of the period immediately succeeding his death is full of allusions to Will Sommers.

Richard Tarleton, famous as a comic actor, cannot be omitted from any list of jesters. A book of Tarleton’s Jests was published in 1611, and, together with his *News out of Purgatory*, was reprinted by Halliwell Phillips for the Shakespeare Society in 1844. Archie Armstrong, for a too free use of wit and tongue against Laud, lost his office and was banished the court. The conduct of the archbishop against the poor fool is not the least item of the evidence which convicts him of a certain narrow-mindedness and pettiness. In French history, too, the figure of the court-jester flits across the gay or sombre scene at times with fantastic effect. Caillette and Triboulet are well-known characters of the times of Francis I. Triboulet appears in Rabelais’s romance, and is the hero of Victor Hugo’s *Le Roi s’amuse*, and, with some changes, of Verdi’s opera *Rigoletto*; while Chicot, the lithe and acute Gascon, who was so close a friend of Henry III., is portrayed with considerable justness by Dumas in his *Dame de Monsoreau*. In Germany Rudolph of Habsburg had his Pfaff Cappadox, Maximilian I. his Kunz von der Rosen (whose features, as well as those of Will Sommers, have been preserved by the pencil of Holbein), and many a petty court its jester after jester.

Late in the 16th century appeared *Le Sottilissime Astuzie di Bertoldo*, which is one of the most remarkable books ever written about a jester. It is by Giulio Cesare Croce, a street musician of Bologna, and is a comic romance giving an account of the appearance at the court of Alboin king of the Lombards of a peasant wonderful in ugliness, good sense and wit. The book was for a time the most popular in Italy. A great number of editions and translations appeared, and it was even versified. Though fiction, both the character and the career of Bertoldo are typical of the jester. That the private fool existed as late as the 18th century is proved by Swift’s epitaph on Dicky Pearce, the earl of Suffolk’s jester.

See Flögel, Geschichte der Hofnarren (Leipzig, 1789); Doran, The History of Court Fools (1858).

(W. He.)

FOOLS, FEAST OF (Lat. *festum stultorum*, *fatuorum*, *follorum*, Fr. *fête des fous*), the name for certain burlesque quasi-religious festivals which, during the middle ages, were the ecclesiastical counterpart of the secular revelries of the Lord of Misrule. The celebrations are directly traceable to the pagan Saturnalia of ancient Rome, which in spite of the conversion of the Empire to Christianity, and of the denunciation of bishops and ecclesiastical councils, continued to be celebrated by the people on the Kalends of January with all their old licence. The custom, indeed, so far from dying out, was adopted by the barbarian conquerors and spread among the Christian Goths in Spain, Franks in Gaul, Alemanni in Germany, and Anglo-Saxons in Britain. So late as the 11th century Bishop Burchard of Worms thought it necessary to fulminate against the excesses connected with it (*Decretum*, xix. c. 5, Migne, *Patrologia lat*. 140, p. 965). Then, just as it appears to have been sinking into oblivion among the people, the clergy themselves gave it the character of a specific religious festival. Certain days seem early to have been set apart as special festivals for different orders of the clergy: the feast of St Stephen (December 26) for the deacons, St John’s day (December 27) for the priests, Holy Innocents’ Day for the boys, and for the sub-deacons Circumcision, the Epiphany, or the 11th of January. The Feast of Holy Innocents became a regular festival of children, in which a boy, elected by his fellows of the choir school, functioned solemnly as bishop or archbishop, surrounded by the elder choir-boys as his clergy, while the canons and other clergy took the humbler seats. At first there is no evidence to prove that these celebrations were characterized by any specially indecorous behaviour; but in the 12th century such behaviour had become the rule. In 1180 Jean Beleth, of the diocese of Amiens, calls the festival of the sub-deacons *festum stultorum* (Migne, *Patrol. lat*. 202, p. 79). The burlesque ritual which characterized the Feast of Fools throughout the middle ages was now at its height. A young sub-deacon was elected bishop, vested in the episcopal *insignia* (except the mitre) and conducted by his fellows to the sanctuary. A mock mass was begun, during which the lections were read *cum farsia*, obscene songs were sung and dances performed, cakes and sausages eaten at the altar, and cards and dice played upon it.

This burlesquing of things universally held sacred, though condemned by serious-minded theologians, conveyed to the child-like popular mind of the middle ages no suggestion of contempt, though when belief in the doctrines and rites of the medieval Church was shaken it became a ready instrument in the hands of those who sought to destroy them. Of this kind of retribution Scott in *The Abbot* gives a vivid picture, the Protestants interrupting the mass celebrated by the trembling remnant of the monks in the ruined abbey church, and insisting on substituting the traditional Feast of Fools.

This naive temper of the middle ages is nowhere more conspicuously displayed than in the Feast of the Ass, which under various forms was celebrated in a large number of churches throughout the West. The ass had been introduced into the ritual of the church in the 9th century, representing either Balaam's ass, that which stood with the ox beside the manger at Bethlehem, that which carried the Holy Family into Egypt, or that on which Christ rode in triumph into Jerusalem. Often the ass was a mere incident in the Feast of Fools; but sometimes he was the occasion of a special festival, ridiculous enough to modern notions, but by no means intended in an irreverent spirit. The three most notable celebrations of the Feast of the Ass were at Rouen, Beauvais and Sens. At Rouen the feast was celebrated on Christmas Day, and was intended to represent the times before the coming of Christ. The service opened with a procession of Old Testament characters, prophets, patriarchs and kings, together with heathen prophets, including Virgil, the chief figure being Balaam on his ass. The ass was a hollow wooden effigy, within which a priest capered and uttered prophecies. The procession was followed, inside the church, by a curious combination of ritual office and mystery play, the text of which, according to the *Ordo processionis asinorum secundum Rothomagensem usum*, is given in Du Cange.

Far more singular was the celebration at Beauvais, which was held on the 14th of January, and represented the flight into Egypt. A richly caparisoned ass, on which was seated the prettiest girl in the town holding in her arms a baby or a large doll, was escorted with much pomp from the cathedral to the church of St Étienne. There the procession was received by the priests, who led the ass and its burden to the sanctuary. Mass was then sung; but instead of the ordinary responses to the *Introit*, *Kyrie*, *Gloria*, &c., the congregation chanted "Hinham" (Hee-haw) three times. The rubric of the mass for this feast actually runs: *In fine Missae Sacerdos versus ad populum vice, Ite missa est, Hinhannabit: populus vero vice, Deo Gratias, ter respondebit Hinham, Hinham, Hinham* (At the close of the mass the priest turning to the people instead of saying, *Ite missa est*, shall bray thrice: the people, instead of *Deo gratias*, shall thrice respond Hee-haw, Hee-haw, Hee-haw).

At Sens the Feast of the Ass was associated with the Feast of Fools, celebrated at Vespers on the Feast of Circumcision. The clergy went in procession to the west door of the church, where two canons received the ass, amid joyous chants, and led it to the precentor's table. Bizarre vespers followed, sung falsetto and consisting of a medley of extracts from all the vespers of the year. Between the lessons the ass was solemnly fed, and at the conclusion of the service was led by the precentor out into the square before the church (*conductus ad ludos*); water was poured on the precentor's head, and the ass became the centre of burlesque ceremonies, dancing and buffoonery being carried on far into the night, while the clergy and the serious-minded retired to matins and bed.

Various efforts were made during the middle ages to abolish the Feast of Fools. Thus in 1198 the chapter of Paris suppressed its more obvious indecencies; in 1210 Pope Innocent III. forbade the feasts of priests, deacons and sub-deacons altogether; and in 1246 Innocent IV. threatened those who disobeyed this prohibition with excommunication. How little effect this had, however, is shown by the fact that in 1265 Odo, archbishop of Sens, could do no more than prohibit the obscene excesses of the feast, without abolishing the feast itself; that in 1444 the university of Paris, at the request of certain bishops, addressed a letter condemning it to all cathedral chapters; and that King Charles VII. found it necessary to order all masters in theology to forbid it in collegiate churches. The festival was, in fact, too popular to succumb to these efforts, and it survived throughout Europe till the Reformation, and even later in France; for in 1645 Mathurin de Neuré complains in a letter to Pierre Gassendi of the monstrous fooleries which yearly on Innocents' Day took place in the monastery of the Cordeliers at Antibes. "Never did pagans," he writes, "solemnize with such extravagance their superstitious festivals as do they.... The lay-brothers, the cabbage-cutters, those who work in the kitchen ... occupy the places of the clergy in the church. They don the sacerdotal garments, reverse side out. They hold in their hands books turned upside down, and pretend to read through spectacles in which for glass have been substituted bits of orange-peel."

See B. Picart, *Cérémonies et coutumes religieuses de tous les peuples* (1723); du Tilliot, *Mémoires pour servir à l'histoire de la fête des Fous* (Lausanne, 1741); Aimé Cherest, *Nouvelles recherches sur la fête des Innocents et la fête des Fous dans plusieurs églises et notamment dans celle de Sens* (Paris, 1853); Schneegans in Müller's *Zeitschrift für deutsche Kulturgeschichte* (1858); H. Böhmer, art. "Narrenfest" in Herzog-Hauck, *Realencyklop*. (ed. 1903); Du Cange, *Glossarium* (ed. 1884), *s.v.* "Festum Asinorum."

FOOLSCAP, the cap, usually of conical shape, with a cockscomb running up the centre of the back, and with bells attached, worn by jesters and fools (see Fool); also a conical cap worn by dunces. The name is given to a size of writing or printing paper, varying in size from 12 × 15 in. to 17 × 13-1/2 in. (see Paper). The name is derived from the use of a "fool's cap" as a watermark. A German example of the watermark dating from 1479 was exhibited in the Caxton Exhibition (1877). The *New English Dictionary* finds no trustworthy evidence for the introduction of the watermark by a German, Sir John Spielmann, at his paper-mill at Dartford in 1580, and states that there is no truth in the familiar story that the Rump Parliament substituted a fool's cap for the royal arms as a watermark on the paper used for the journals of parliament.

FOOL'S PARSLEY, in botany, the popular name for *Aethusa Cynapium*, a member of the family *Umbelliferae*, and a common weed in cultivated ground. It is an annual herb, with a fusiform root and a smooth hollow branched stem 1 to 2 ft. high, with much divided (ternately pinnate) smooth leaves and small compound umbels of small irregular white flowers. The plant has a nauseous smell, and, like other members of the order (*e.g.* hemlock, water-drop wort), is poisonous.

FOOT, the lower part of the leg, in vertebrate animals consisting of tarsus, metatarsus and phalanges, on which the body rests when in an upright position, standing or moving (see Anatomy: *Superficial and Artistic*; and Skeleton: *Appendicular*). The word is also applied to such parts of invertebrate animals as serve as a foot, either for movement or attachment to a surface. "Foot" is a word common in various forms to Indo-European languages, Dutch, *voet*, Ger. *Fuss*, Dan. *fod*, &c. The Aryan root is *pod-*, which appears in Sans. *pūd*, Gr. ποῦς, ποδός and Lat. *pes*, *pedis*. From the resemblance to the foot, in regard to its position, as the base of anything, or as the lowest member of the body, or in regard to its function of movement, the word is applied to the lowest part of a hill or mountain, the plate of a sewing-machine which holds the material in position, to the part of an organ pipe below the mouth, and the like. In printing the bottom of a type is divided by a groove into two portions known as "feet." Probably referring to the beating of the rhythm with the foot in dancing, the Gr. ποῦς and Lat. *pes* were applied in prosody to a grouping of syllables, one of which is stressed, forming the division of a verse. "Foot," *i.e.* foot-soldier, was formerly, with an ordinal number prefixed, the name 617
of the infantry regiments of the British army. It is now superseded by territorial designations, but it still is used in the four regiments of the infantry of the Household, the Foot Guards. As a lineal measure of length the "foot" is of great antiquity, estimated originally by the length of a man's foot (see Weights and Measures). For the ceremonial washing of feet, see Maundy Thursday.

FOOT-AND-MOUTH DISEASE (Aphthous Fever, Epizootic Aphtha, Eczema Epizootica), a virulent contagious and inoculable malady of animals, characterized by initial fever, followed by the formation of vesicles or blisters on the tongue, palate and lips, sometimes in the nostrils, fourth stomach and intestine of cattle, and on parts of the body where the skin is thin, as on the udder and teats, between the claws, on the heels, coronet and pastern. The disease begins suddenly and spreads very rapidly. A rise of temperature precedes the vesicular eruption, which is accompanied by salivation and a peculiar "smacking" of the lips. The vesicles gradually enlarge and eventually break, exposing a red raw patch, which is very sensitive. The animal cannot feed so well as usual, suffers much pain and inconvenience, loses condition, and, if a milk-yielding creature, gives less milk, or, if pregnant, may abort. More or less lameness is a constant symptom, and sometimes the feet become very much diseased and the animal is so crippled that it has to be destroyed. It is often fatal to young animals. It is transmitted by the saliva and the discharges from the vesicles, though all the secretions and excretions are doubtless infective, as well as all articles and places soiled by them. This disease can be produced by injecting the saliva, or the lymph of the vesicles, into the blood or the peritoneal cavity.

If we were to judge by the somewhat vague descriptions of different disorders by Greek and Roman writers, this disease has been a European malady for more than 2000 years. But no reliance can be placed on this evidence, and it is not until we reach the 17th and 18th centuries that we find trustworthy proof of its presence, when it was reported as frequently prevailing extensively in Germany, Italy and France. During the 19th century, owing to the vastly extended commercial relations between civilized countries, it has, like the lung-plague, become widely diffused. In the Old World its effects are now experienced from the Caspian Sea to the Atlantic Ocean. Hungary, Lower Austria, Bohemia, Saxony and Prussia were invaded in 1834. Cattle in the Vosges and in Switzerland were attacked in 1837, and the disease extending to France, Belgium and Holland, reached England in 1839, and quickly spread over the three kingdoms (see also under Agriculture). At this time the importation of foreign animals into England was prohibited, and it was supposed that the infection must have been introduced by surplus ships' stores, probably sheep, which had not been consumed during the voyage. This invasion was followed at intervals by eleven distinct outbreaks, and since 1902 Great Britain has been free of foot-and-mouth disease. From the observations of the best authorities it would appear to be an altogether exotic malady in the west of Europe, always invading it from the east; at least, this has been the course noted in all the principal invasions. It was introduced into Denmark in 1841; and into the United States of America in 1870, from Canada, where it had been carried by diseased cattle from England. It rapidly extended through cattle traffic from the state first invaded to adjoining states, but was eventually extinguished, and does not now appear to be known in North America. It was twice introduced into Australia in 1872, but was stamped out on each occasion. It appears to be well known in India, Ceylon, Burma and the Straits Settlements. In 1870 it was introduced into the Andaman Islands by cattle imported from Calcutta, where it was then prevailing, and in the same year it appeared in South America. In South Africa it is frequently epizootic, causing great inconvenience, owing to the bullocks used for draught purposes becoming unfit for work. These cattle also spread the contagion. It is not improbable that it also prevails in central Africa, as Schweinfurth alludes to the cattle of the Dinkas suffering from a disease of the kind.

Though not usually a fatal malady, except in very young animals, or when malignant, yet it is a most serious scourge. In one year (1892) in Germany, it attacked 150,929 farms, with an estimated loss to the owners of £7,500,000 sterling. It is transmissible to nearly all the domestic animals, but its ravages are most severe among cattle, sheep, goats and swine. Human beings are also liable to infection.

The treatment of affected animals comprises a laxative diet, with salines, and the application of antiseptics and astringents to the sores. The preventive measures recommended are, isolation of the diseased animals, boiling the milk before use, and thorough disinfection of all places and substances which are capable of conveying the infection.

FOOTBALL, a game between two opposing sides played with a large inflated ball, which is propelled either by the feet alone or by both feet and hands.

Pastimes of the kind were known to many nations of antiquity, and their existence among savage tribes, such as the Maoris, Faroe Islanders, Philippine Islanders, Polynesians and Eskimos, points to their primitive nature. In Greece the ἐπίσκυρος seems to have borne a resemblance to the modern game. Of this we read in Smith's *Dictionary of Antiquities*—"It was the game at football, played in much the same way as with us, by a great number of persons divided into two parties opposed to one another." Amongst the Romans the *harpastum*, derived from the Greek verb ἁρπάζω, I seize, thus showing that carrying the ball was permissible, bore a certain resemblance. Basil Kennett, in his *Romae antiquae notitia*, terms this missile a "larger kind of ball, which they played with, dividing into two companies and striving to throw it into one another's goals, which was the conquering cast." The *harpastum* was a gymnastic game and probably played for the most part indoors. The real Roman football was played with the inflated *follis*, which was kicked from side to side over boundaries, and thus must have closely resembled the modern Association game. Tradition ascribes its introduction in northern Europe to the Roman legions. It has been played in Tuscany under the name of *Calcio* from the middle ages down to modern times.

Regarding the origin of the game in Great Britain the Roman tradition has been generally accepted, although Irish antiquarians assert that a variety of football has been played in Ireland for over 2000 years. In early times the great football festival of the year was Shrove Tuesday, though the connexion of the game with this particular date is lost in obscurity. William Fitzstephen, in his *History of London* (about 1175), speaks of the young men of the city annually going into the fields after dinner to play at the well-known game of ball on the day *quae dicitur Carnilevaria*. As far as is known this is the first distinct mention of football in England. It was forbidden by Edward II. (1314) in consequence of "the great noise in the city caused by hustling over large balls (*rageries de grosses pelotes*)." A clear reference is made "ad pilam ... pedinam" in the Rotuli Clausarum, 39 Edward III. (1365), memb. 23, as one of the pastimes to be prohibited on account of the decadence of archery, and the same thing occurs in 12 Richard II. c. 6 (1388). Both Henry VIII. and Elizabeth enacted laws against football, which, both then and under the Stuarts and the Georges, seems to have been violent to the point of brutality, a fact often referred to by prominent writers. Thus Sir Thomas Elyot, in his *Boke named the Governour* (1531), speaks of football as being "nothyng but beastely fury and extreme violence, whereof proceedeth hurte and consequently rancour and malice to remayne with thym that be wounded, wherefore it is to be put in perpetual silence." In Stubbes' *Anatomie of Abuses* (1583) it is referred to as "a develishe pastime ... and hereof groweth envy, rancour and malice, and sometimes brawling, murther, homicide, and great effusion of blood, as experience daily teacheth." Fifty years later (1634) Davenant is quoted (in Hone's *Table-Book*) as remarking, "I would now make a safe retreat, but methinks I am stopped by one of your heroic games called football; which I conceive (under your favour) not very conveniently civil in the streets, especially in such irregular and narrow roads as Crooked Lane. Yet it argues your courage, much like your 618
military pastime of throwing at cocks, since you have long allowed these two valiant exercises in the streets."

An evidence of its old popularity in Ireland is that the statutes of Galway in 1527 forbade every other sport save archery, excepting "onely the great foot balle." In the time of Charles II. football was popular at Cambridge, particularly at Magdalene College, as is evidenced by the following extract from the register book of that institution under the date 1679:—

> "That no schollers give or receive at any time any treat or collation upon account of ye football play, on or about Michaelmas Day, further than Colledge beere or ale in ye open halle to quench their thirsts. And particularly that that most vile custom of drinking and spending money—Sophisters and Freshmen together—upon ye account of making or not making a speech at that football time be utterly left off and extinguished."

It nevertheless remained for the most part a game for the masses, and never took root, except in educational institutions, among the upper classes until the 19th century. No clubs or code of rules had been formed, and the sole aim seems to have been to drive the ball through the opposing side's goal by fair means or foul. So rough did the game become that James I. forbade the heir apparent to play it, and describes the exercise in his *Basilikon Doron* as "meeter for laming than making able the users thereof." Both sexes and all ages seem to have taken part in it on Shrove Tuesday; shutters had to be put up and houses closed in order to prevent damage; and it is not to be wondered that the game fell into bad repute. Accidents, sometimes fatal, occurred; and Shrove Tuesday "football-day" gradually died out about 1830, though a relic of the custom still remained in a few places. For some thirty years football was only practised at the great English public schools, many of which possessed special games, which in practically all cases arose from the nature of the individual ground. Thus the rough, open game, with its charging, tackling and throwing, which were features of football when it was taken up by the great public schools, would have been extremely dangerous if played in the flagged and walled courts of some schools, as, for example, the old Charterhouse. Hence at such institutions the dribbling style of play, in which Mr Montague Shearman (*Football*, in the "Badminton Library") sees the origin of the Association game, came into existence. Only at Rugby (later at some other schools), which from the first possessed an extensive grass field, was the old game preserved and developed, including even its roughness, for actual "hacking" (*i.e.* intentional kicking of an opponent's legs) was not expressly abolished at Rugby until 1877. The description of the old school game at Rugby contained in *Tom Brown's School Days* has become classic.

1. *Rugby Union.*—We have seen that from early times a rudimentary game of football had been a popular form of sport in many parts of Great Britain, and that in the old-established schools football had been a regular game among the boys. In different schools there arose various developments of the original game; or rather, what, at first, must have been a somewhat rough form of horse-play with a ball began to take shape as a definite game, with a definite object and definite rules. Rugby school had developed such a game, and from football played according to Rugby rules has arisen Rugby football. It was about the middle of the 19th century that football—up till that time a regular game only among schoolboys—took its place as a regular sport among men. To begin with, men who had played the game as schoolboys formed clubs to enable them to continue playing their favourite school game, and others were induced to join them; while in other cases, clubs were formed by men who had not had the experience of playing the game at school, but who had the energy and the will to follow the example of those who had had this experience. In this way football was established as a regular game, no longer confined to schoolboys. When football was thus first started, the game was little developed or organized. Rules were very few, and often there was great doubt as to what the rules were. But, almost from the first, clubs were formed to play football according to Rugby rules—that is, according to the rules of the game as played at Rugby school. But even the Rugby rules of that date were few and vague, and indeed almost unintelligible to those who had not been at Rugby school. Still, the fact that play was according to Rugby rules produced a certain uniformity; but it was not till the establishment of the English Union, and the commencement of international matches, that a really definite code of rules was drawn up.

It is an interesting question to ask why it was that the game of Rugby school became so popular in preference to the games of other schools, such as Eton, Winchester or Harrow. It was probably very largely due to the reputation and success of Rugby school under Dr Arnold, and this also led most probably to its adoption by other schools; for in 1860 many schools besides Rugby played football according to Rugby rules. The rapidity with which the game spread after the middle of the 19th century was remarkable. The Blackheath club, the senior club of the London district, was established in 1860, and Richmond, its great rival, shortly afterwards. Before 1870, football clubs had been started in Lancashire and Yorkshire; indeed the Sheffield football club dates back to 1855. Likewise, in the universities of Oxford and Cambridge, Rugby football clubs had been formed before 1870, and by that date the game had been implanted both in Ireland and South Wales; while in Scotland, before 1860, football had taken a hold. Thus by 1870 the game had been established throughout the United Kingdom, and in many districts had been regularly played for a number of years. Rapid as, in some ways, had been the spread of the game between the years 1850 and 1870, it was as nothing to what happened in the following twenty years; for by 1890 Rugby football, together with Association football, had become the great winter amusement of the people, and roused universal interest; while to-day on any fine Saturday afternoon in winter there are tens of thousands of people playing football, while those who watch the game can be counted by the hundred thousand. The causes that led to this great increase in the game and interest taken in it were, undoubtedly, the establishment of the various national Unions and the international matches; and, of course, the local rivalry of various clubs, together with cup or other competitions prevalent in certain districts, was a leading factor. The establishment of the English Union led to a codification of the rules without which development was impossible.

In the year 1871 the English Rugby Union was founded in London. This Union was an association of some clubs and schools which joined together and appointed a committee and officials to draw up a code of rules of the game. From this beginning the English Rugby Union has become the governing body of Rugby football in England, and has been joined by

practically all the Rugby clubs in England, and deals with all matters connected with Rugby football, notably the choosing of the international teams. In 1873 the Scottish Football Union was founded in Edinburgh on the same lines, and with the same objects, while in 1880 the Welsh Football Union, and in 1881 the Irish Rugby Football Union, were established as the national Unions of Wales and Ireland, though in both countries there had been previously Unions not thoroughly representative of the country. All these Unions became the chief governing body within their own country, and one of their functions was to make the rules and laws of the game; but as this had been done to start with by the English Union, the others adopted the English rules, with amendments to them from time to time. This state of affairs had one element of weakness—viz. that since all the Unions made their own rules, if ever a dispute should arise between any of them, a deadlock was almost certain to ensue. Such a dispute did occur in 1884 between the English and Scottish Unions. This dispute eventually turned on the question of the right of the English Union to make and interpret the rules of the game, and to be the paramount authority in the game, and superior to the other Unions. Scotland, Ireland and Wales resisted this claim, and finally, in 1889, Lord Kingsburgh and Major Marindin were appointed as a commission to settle the dispute. The result was the establishment of the International Board, which consists of representatives from each Union—six from England, two from each of the others—whose duties were to settle any question that might arise between the different 619
Unions, and to settle the rules under which international matches were to be played, these rules being invariably adopted by the various Unions as the rules of the game.

With the establishment of the International Board the organization of the game was complete. Still harmony did not prevail, and in 1895 occurred a definite disruption. A number of leading clubs in Yorkshire and Lancashire broke off from the English Union and formed the Northern Union, which since that date has had many accessions, and has become the leading body in the north of England. The question in dispute was the payment of players. Football was originally played by men for the sheer love of the game, and by men who were comparatively well-to-do, and who could give the time to play it; but with the increasing popularity of the game it became the pastime of all classes of the people, and clubs began to grow rich by "drawing big gates,"—that is, large numbers of spectators, frequently many thousands in number, paid for the privilege of witnessing the match. In these circumstances the temptation arose to reimburse the player for any out-of-pocket expenses he might be put to for playing the game, and thus it became universally recognized as legitimate to pay a player's expenses to and from a match. But in the case of working men it often meant that they lost part of their weekly wage when they had to go a distance to play a match, or to go on tour with their club—that is, go off for a few days and play one or two matches in different parts of the country—and consequently the claim was made on their behalf to recoup them for their loss of wage; while at the same time rich clubs began to be willing to offer inducements to good players to join their club, and these inducements were generally most acceptable in the form of money. In Association football (see below) professionalism—*i.e.* the hiring and paying of a player for his services—had been openly recognized. A large section of the English Union—the amateur party—would not tolerate anything that savoured of professionalism, and regarded payments made to a player for broken time as illegitimate. The result was the formation of the Northern Union, which allowed such payments, and has practically recognized professionalism. This body has also somewhat altered the laws of the game, and reduced the number of players constituting a team from fifteen to thirteen. In Scotland and Ireland Rugby footballers are strongly amateur; but wherever Rugby football is the popular game of the artisan the professional element is strong.

Besides legislation, one of the functions of the Unions is to select international teams. On the 27th of March 1871 the first international match was played between England and Scotland in Edinburgh. This was a match between teams picked from English and Scottish players. These matches from the first roused widespread interest, and were a great stimulus to the development of the game. With the exception of a few years, when there were disputes between their respective Unions, all the countries of the United Kingdom have annually played one another—England having played Scotland since 1871, Ireland since 1875 and Wales since 1880. Scotland commenced playing Ireland in 1877 and Wales in 1883, while Ireland and Wales met first in 1882 and then in 1884, and since 1887 have played annually. The qualifications of a player for any country were at first vaguely considered to be birth; but they were never definitely settled, and there has been a case of a player playing for two countries. In 1894, however, the International Board decided that no player was to play for more than one country, and this has been the only pronouncement on the question; and though birth is still looked upon as the main qualification, it is not essential. Though international matches excite interest throughout the United Kingdom, the matches between two rival clubs arouse just as much excitement in their district, particularly when the clubs may be taken as representatives of two neighbouring rival towns. But when to this rivalry there is added the inducement to play for a cup, or prize, the excitement is much more intense. Among Rugby players cup competitions have never been so popular as among Association, but the competition for the Yorkshire Cup was very keen in the days before the establishment of the Northern Union, and this undoubtedly was the main cause of the popularity of the game in that county. Similarly the competition for the South Wales Cup from 1878 to 1887 did a great deal to establish the game in that country. The method of carrying on these competitions is, that all the clubs entered are drawn by lot, in pairs, to play together in the first round; the winners of these ties are then similarly drawn in pairs for the next round, until for the final round there is only one pair left, the winner of which takes the cup. An elaboration of this competition is the "League system" of the Association game. This, likewise, has not been popular with Rugby players. Still it exists in some districts, especially where clubs are anxious to draw big gates. In the League system a certain number of clubs form a league to play one another twice each season; two points are counted for a win and one for a draw. The club which at the end of the season comes out with most points wins the competition. The advantage of this system over a cup competition is, that interest is kept up during the whole season, and one defeat does not debar a club from eventually coming out first.

It is said that wherever Britons go they take their games with them, and this has certainly been the case with Rugby football, especially in New Zealand, South Africa and Australia. An interchange of football visits between these colonies and the motherland is now an important feature in the game. These tours date from 1888, when an English team visited Australia and New Zealand. In the following season, 1889, a team of New Zealanders, some of whom were native Maories, came over to England, and by their play even then indicated how well the grammar of the game had been studied in that colony. Subsequently several British teams visited at intervals New Zealand and Australia, and in 1905 New Zealand sent home a team which eclipsed anything previously accomplished. They played altogether thirty-three matches, including fixtures with England, Ireland, Scotland and Wales, and only sustained one defeat, viz. by a try in their match with Wales, a record which speaks for itself. In 1908 a combined team of English and Welsh players toured in New Zealand and Australia, and also visited Canada on their way home. The team was not so strong as could have been wished, and though they did fairly well in Australia, they lost all three "test matches" against New Zealand. In South Africa the game is followed with equal enthusiasm, and the play is hardly inferior, if at all, to that of the New Zealanders. The first British team to visit the Cape went in 1891 through the generosity of Cecil Rhodes, who guaranteed the undertaking against loss. Teams were also sent out in 1896 and 1903; the result of matches played in each visit showing the steady improvement of the colonists. In 1906 the South Africans paid their first visit to England, and the result of their tour proved them to be equally formidable with the New Zealanders. England managed to draw with them, but Scotland was the only one of the home Unions to gain a victory. The success of these colonial visits, more especially financially, created a development very foreign to the intentions of their organizers. The Northern Union as a professional body had drifted into a somewhat parlous state, through suffering on the one hand from a lack of international matches, and on the other from the competition of Association professional teams. The great financial success resulting from the New Zealand tour of 1905 roused the attention of the Northern Union authorities, and they quickly entered into negotiations with New Zealand players to collect a team who would come over and play the Northern Union clubs, the visiting players themselves taking a share of the gate-money. For this purpose a team of New Zealanders toured the north of England in 1907, and their action caused the introduction of professional or Northern Union football in both New Zealand and Australia.

The spread of the game has not, however, been confined to English-speaking races. In France it has found fruitful soil, and numerous clubs exist in that country. Since 1906 international matches have been played between France and England, and the energy of French players, coupled with their national *élan*, makes them formidable opponents. The 620
Rugby code has also obtained a firm footing in Canada, India, Ceylon and the Argentine.

The game itself is essentially a winter pastime, as two requisite conditions for its enjoyment are a cool atmosphere and a soft though firm turf. The field of play is an oblong, not more than 110 yds. long nor more than 75 yds. broad, and it usually approximates to these dimensions. The boundaries are marked by lines, called touch-lines, down the sides, and goal-lines along the ends. The touch-lines are continued beyond the goal-lines for a distance of not more than 25 yds.; and parallel to the goal-line and behind it, at a distance of not more than 25 yds., is drawn a line called the dead-ball line, joining the ends of the touch-lines produced. On each goal-line, at an equal distance from the touch-lines, are erected two posts, termed goal-posts, exceeding 11 ft. in height, and generally much more—averaging perhaps from 20 to 30 ft. from the ground, and placed 18 ft. 6 in. apart. At a height of 10 ft. from the ground they are joined by a cross-bar; and the object of the game is to kick the ball over the cross-bar between the upright posts, and so obtain a goal. The ball is egg-shaped (strictly an oblate spheroid), and the official dimensions are—length, 11 to 11¼ in.; length circumference, 30 to 31 in.; width circumference, 25½ to 26 in.; weight, 13 to 14½ oz. It is made of india-rubber inflated, and covered with a leather case. Halfway between the two goal-lines there is generally drawn the half-way line, but sometimes it is marked by flags on the touch-line; and 25 yds. from each goal-line there is similarly marked the 25-yds. line. In the original game the side that had gained the majority of goals won the match, and if no goal had been scored, or an equal number, the game was said to be left drawn; but a modification was adopted before long. A goal can be kicked from the field in the ordinary course of play; but from the very first a try goal could be obtained by that side one of whose players either carried the ball across his opponents' goal-line and then touched it down (*i.e.* on the ground), or touched it down after it had been kicked across the goal-line, before any of his opponents. The "try" is then proceeded with as follows: the ball is taken out by a member of the side obtaining the try in a straight line from the spot where it was "touched down," and is deposited in a selected position on the ground in the field of play, the defending side being all confined behind their own goal-line until the moment the ball is so placed on the ground, when another member of the attacking side endeavours to kick it from the ground (a "place kick") over the bar and between the goal-posts. Frequently a goal is kicked; very often not. The modification first allowed was to count that side the winner which had gained the majority of tries, provided no goal or an equal number of goals had been scored; but a majority of one goal took precedence of any number of tries. But this, too, was afterwards abolished, and a system of points instituted by which the side with the majority of points wins. The numerical value, however, of goals and tries has undergone several changes, the system in 1908 being as follows:—A try counts 3 points. A goal from a try (in which case the try shall not count) 5 points. A dropped goal (except from a mark or a penalty kick) 4 points; a dropped goal being a goal obtained by a player who drops the ball from his hands and kicks it the moment it rises off the ground, as in the "half-volley" at cricket or tennis. A goal from a mark or penalty kick 3 points. Under the Northern Union code any sort of goal counts 2 points, a try 3 points; but if a try be converted into a goal, both try and goal count, *i.e.* 5 points are scored.

In the game itself not only may the ball be kicked in the direction of the opponents' goal, but it may also be carried; but it must not be thrown forward or knocked on—that is, in the direction of the opponents' goal—though it may be thrown back. Thus the game is really a combination of football and handball. The main principle is that any one who is not "offside" is in play. A player is offside if he gets in front of the ball—that is, on the opponents' side of the ball, nearer than a colleague in possession of the ball to the opponents' goal-line; when in this position he must not interfere with an opponent or touch the ball under penalty. The leading feature of the game is the "scrummage." In old days at Rugby school there was practically no limit to the numbers of players on each side, and not infrequently there would be a hundred or more players on one side. This was never prevalent in club football; twenty a-side was the usual number to start with, reduced in 1877 to fifteen a-side, the number still maintained. In the old Rugby big sides the ball got settled amidst a mass of players, and each side attempted to drive it through this mass by shoving, kicking, and otherwise forcing their way through with the ball in front of them. This was the origin of the scrummage.

The game is played usually for one hour, or one hour and ten minutes, sometimes for one hour and a half. Each side defends each goal in turn for half the time of play. Of the fifteen players who compose a side, the usual arrangement is that eight are called "forwards," and form the scrummage; two "half-backs" are posted outside the scrummage; and four "three-quarter-backs," a little behind the halves, stretch in a line across the field, their duties being mainly to run and kick and pass the ball to other members of their own side, and to prevent their opponents from doing the same. In recent years, owing to the development of "passing," the field position of the half-backs has undergone a change. One stands fairly close to the scrummage and is known as the "scrum-half," the other takes a position between the latter and the three-quarters, and is termed the "stand-off-half." Behind the three-quarters comes the "full-back" or "back," a single individual to maintain the last line of defence; his duties are entirely defensive, either to "tackle" an opponent who has managed to get through, or, more usually, to catch and return long kicks. Play is started by one side kicking the ball off from the centre of the field in the direction of the opponents' goal. The ball is then caught by one of the other side, who either kicks it or runs with it. In running he goes on until he is "tackled," or caught, by one of his opponents, unless he should choose to "pass" or throw it to another of his own side, who, provided he be not offside, may either kick, or run, or pass as he chooses. The ball in this way is kept moving until it crosses the touch-line, or goal-line, or is tackled. If the ball crosses the touch-line both sides line up at right angles to the point where it crossed the line, and the ball is thrown in straight either by one of the same side whose player carried the ball across the touch-line, or, if the ball was kicked or thrown out, by one of the opposite side. If the ball crosses the goal-line either a try is gained, as explained above, or if the defending side touch it down first, the other side retire to the line 25 yds. from the goal-line, and the defending side kick it up the field. If the ball is tackled the player carrying the ball gets up from the ground as soon as possible, and the forwards at once form the scrummage by putting down their heads and getting ready to shove against one another. They shove as soon as the ball is put down between the two front rows. In the scrummage the object is, by shoving the opponents back or otherwise breaking away with the ball in front, to carry the ball in the direction of the opponents' goal-line by a series of short kicks in which the players run after the ball as fast as possible, while their opponents lie in wait to get the ball, and either by a kick or other device stop the rush. Instead, however, of the forwards breaking away with the ball, sometimes they let the ball come out of the scrummage to their half-backs, who either kick or run with it, or pass it to the three-quarter-backs, and so the game proceeds until the ball is once more "dead"—that is, brought to a standstill. The scrummage appears to be an uninteresting manœuvre, and a strange relic of bygone times; but it is not merely a manœuvre in which weight and strength alone tell—it also needs a lot of dexterity in moving the ball with the feet, applying the weight to best advantage, and also in outflanking the opposing side, as it were—usually termed wheeling—directing all the force to one side of the scrummage and thus breaking away. As a rule the game is a lively one, for the players are rarely at rest; if there is much scrummaging it is called a slow game, but, if much running and passing, a fast or an open game. The spectator, unless he be an expert, prefers the open game; but in any case the game is always a hard 621
and exciting struggle, frequently with the balance of fortune swaying very rapidly from one side to the other, so that it is a matter of no surprise to find the British public so ardently attached to it.

(C. J. N. F.; C. J. B. M.)

2. *Association.*—It is generally supposed that the English game of Association football is the outcome of the game of football as played at Cambridge University about the middle of the 19th century. In October 1863 a committee, consisting of representatives of the schools of Eton, Harrow, Rugby, Marlborough, Shrewsbury and Westminster, drew up a code of laws which settled the fundamental principle of the "Association" game, as distinguished from other forms of the game which permitted of handling and carrying the ball. In Association football the use of the hands or arms, either for the purpose of playing the ball or impeding or holding an opponent, is absolutely prohibited; "dribbling" or kicking the ball with the feet, and propelling it by the head or body, are the methods to be adopted. The Cambridge laws specially provided for "kicking" the ball. Laws 13 and 14 provided that "the ball, when in play, may be stopped by any part of the body, but may not be held or hit by the hands, arms or shoulders. All charging is fair, but holding, pushing with the hands, tripping up and shinning are forbidden."

The laws of Association football first took practical shape as the outcome of a meeting held on the 26th of October 1863 at the Freemasons' Tavern, London. The clubs which sent delegates were representative of all classes of football then played. The meeting was a momentous one, for not only was the foundation laid of the Football Association, the national association which has since then controlled the game in England, but as the outcome of the differences of opinion which existed as to "hacking" being permissible under the laws, the representatives who favoured the inclusion of the practice, which is now so roundly condemned in both the Association and Rugby games, withdrew and formed the Rugby Union.

The Cambridge laws were considered by the committee of the Football Association at their meeting on the 24th of November 1863. They took the view that those laws "embraced the true principles of the game with the greatest simplicity"; the laws were "officially" passed on the 1st of December 1863, and the first publication was made in *Bell's Life* four days later. These laws have from time to time been modified, but the principles as laid down in 1863 have been adhered to; and the Association game itself has altered very little since 1880. The usual dimensions for a ground are 120 yds. long by 80 yds. wide, and the goals are 8 yds. in width with a cross-bar from post to post 8 ft. from the ground. The ball is about 14 oz. in weight, and must be a perfect sphere from 27 to 28 in. in circumference, as distinguished from the elliptical or egg-shaped Rugby ball. A rectangular space extending to 18 yds. in front of the goals, and marked with lines on the ground, constitutes the "penalty area"; within which, at a distance of 12 yds. opposite the centre of the goal, is the "penalty kick mark." The boundary lines at the sides of the field are called the "touch-lines"; those at the ends (in the centre of which are the goals) being the "goal-lines." The game is started by a place kick from the centre of the field of play, and none of the opposite side is allowed to approach within 10 yds. of the ball when it is kicked off. When the ball passes over the touch line it has to be thrown in by one of the opposite side, and can be returned into the field of play in any direction. If it passes over the goal-line at any time without touching one of the defending side, it has to be kicked out by the goalkeeper or one of the backs from a line marked in front of goal, the spot selected being in front of the post nearest the point where the ball left the field of play. But should it touch one of the defending side in its transit over the goal-line the attacking side has the privilege of a free kick from the corner flag (a "corner kick"). This is often a great advantage, but such free kick does not produce a goal unless the ball touches one of the other players on its way to the post. Ordinarily a goal is scored when the ball goes between the goal-posts and under the cross-bar, not being thrown, knocked on or carried. The regulation duration of a game is an hour and a half, and ends are changed at forty-five minutes. The side winning the toss has the choice of ends or kick-off, and the one obtaining the majority of goals wins. A goal cannot be scored from a free kick except when the free kick has been allowed by the referee as a penalty for certain infringements of the rules by the opposite side; and if such infringement take place within the penalty area on the part of a player on the side then defending the goal, and in the judgment of the referee be intentional, a "penalty kick" is awarded to the attacking side. The penalty kick is a free kick from the penalty kick mark, all the players of the defending side being excluded from the penalty area, except the goalkeeper, who is confined to the goal-line; the result, therefore, being an almost certain goal.

A player is always in play as long as there are three of the opposite side between him and the opposite goal *at the time the ball is kicked*. This "offside" rule gives much trouble to the young player, though why it should do so it is not easy to say. The rule is simple if the words in italics are remembered. The ball must not be carried, knocked or wilfully handled under any pretence whatever, save by the goalkeeper, who is allowed to use his hands in defence of his goal, either by knocking on or throwing, within his own half of the field of play. Thus far he is entitled to go in maintaining his goal, but if he carry the ball the penalty is a free kick. There are other infringements of the rules which also involve the penalty of a free kick, among them the serious offences of tripping, hacking and jumping at a player. Players are not allowed to wear nails in their boots (except such as have their heads driven in flush with the leather), or metal plates or gutta-percha, and any player discovered infringing this rule is liable to be prohibited from taking further part in a match.

In the early 'sixties of the 19th century there were probably not more than twenty-five organized clubs playing Association football in the United Kingdom, and these were chiefly confined in the south of England to the universities and public schools. But whilst the game was being established in the south it was making steady progress in the north, particularly in Yorkshire, where the Sheffield Club had been formed as early as 1854. In 1867 the game had become so well established that it was decided to play an inter-county match. The match, which was played "in the wilds of Battersea Park," terminated in a draw, neither side having obtained a goal; and it did much to stimulate the growing popularity of the game. During the season 1870-1871, only three years later, two matches of an international character were played between Englishmen and Scotsmen in membership with the Football Association; they were not, however, recognized as "international" matches. The first real international match, England v. Scotland, was played on the 30th of November 1872 at Partick, Glasgow; the first international match between England and Wales was played at Kennington Oval in 1879; and that between England and Ireland at Belfast in 1882. In 1896 amateur international matches were inaugurated with Germany, Austria and Bohemia; and games are now annually played with Scotland, Wales, Ireland, France, Belgium, Germany, Holland, Austria and other continental countries. As the outcome of the international relations with Scotland, Wales and Ireland, an International Football Association Board was formed in 1882, when a universal code of laws was agreed upon. Two representatives from each of the four national associations constitute the board, whose laws are accepted and observed not only by the clubs and players of the United Kingdom but in all countries where the Association game is played. At a meeting held at Paris on the 21st of May 1904 the "International Federation of Association Football" was instituted. It consists of the recognized national associations in the respective countries: and its objects are to develop and control Association international football. The countries in federation are: Austria, Belgium, Denmark, England, Finland, France, Germany, Hungary, Italy, Netherlands, Norway, Sweden and Switzerland.

622

The small number of clubs taking part in the game in the early days becomes of interest when compared with the magnitude of the game in the 20th century. Association football has become one of the most popular of all national sports in the United Kingdom. It is slowly but surely taking a similar position on the continent of Europe and is making progress even in the Far East, Japan being one of its latest adherents. In the season of 1871-1872 the Football Association inaugurated its popular challenge cup competition which is now competed for by both amateur and professional clubs. In the first year fifteen clubs entered, all of which were from the south of England. The first winners of the cup were the Wanderers, who defeated the Royal Engineers in the final tie by one goal to nothing. For the first ten years the competition was mostly limited to the southern clubs, but in the season of 1881-1882 the Blackburn Rovers were only defeated in the final tie by the Old Etonians by one goal to nothing. Professionalism was then unknown in the game, and comparatively little interest was taken in it except by the players themselves. In the following season of 1882-1883 the cup was for the first time taken north by the Blackburn Olympic Club, and it remained in the north for the next nineteen years, until in the season of 1900-1901 it was again brought south by the Tottenham Hotspur Club, who defeated the Sheffield United Club at Bolton by three goals to one. In the following season the cup was again taken north by the Bury Club. In the early days of the competition a few hundred people only attended the final tie, which for many years was played at Kennington Oval in London. In the course of time, however, the interest of the public so largely increased that it became necessary to seek a ground of greater capacity; accordingly in 1893 the final was played at Fallowfield, Manchester, where it was watched by forty thousand people; in 1894 it was played at Everton and in 1895 at the Crystal Palace. The attendance during the following ten years averaged 80,000 people. The record attendance was in the season of 1900-1901, when the south were contesting with the north, the spectators then being upwards of 113,000. In the season of 1908-1909 356 clubs entered the competition; in 1910-11 the number had increased to 404.

The great development of the game necessitated many changes in the system of control. About the year 1880 (although contrary to the rules) a practice of making payment to players crept into the game in the north of England and slowly developed. After some years of debate as to the best method of dealing with this development the Football Association decided in 1885 to legalize and control the payment of players. The rules define a professional player as one who receives remuneration of any sort above his necessary hotel and travelling expenses actually paid, or is registered as a professional. They further provide that training expenses not paid by the players themselves will be considered as remuneration beyond necessary travelling and hotel expenses. Players competing for any money prizes in football contests are also considered professionals.

In 1888 the Football League, a combination of professional clubs of the north and midlands of England, was formed; and a new scheme was inaugurated for the playing of matches on what is known as the “League” principle, the essential advantage of which is that the clubs in membership of a league agree to play with each other “home and home” matches each season, and also bind themselves under certain penalties to play their best team in all league matches. Six years later the Southern League came into existence, primarily with the object of increasing the interest in the game in the south and west of England. The Football League and the Southern League very soon had their imitators, and in 1909 there were upwards of six hundred league competitions playing under the sanction and control of the Football Association. The league system also found favour in Scotland, Wales and Ireland, and has extended to most of the colonies where Association football is played. In the season of 1893-1894 the Amateur Cup Competition, restricted to amateur clubs in membership with the Football Association, was inaugurated. In the first season 32 clubs entered, and the growing popularity of the competition is shown by the fact that in the season of 1908-1909 there were 229 entries.

The Football Association, founded in 1863 with its eleven clubs, had in 1909 under its jurisdiction upwards of 10,000 amateur clubs and a quarter of a million of amateur players, and 400 professional clubs with 7000 professional players. It has also directly affiliated 52 county, district and colonial associations, and indirectly in membership a large number of minor associations which are affiliated through the county and district associations. The Army Association includes 316 army clubs in Great Britain and Ireland, together with clubs formed by the various battalions in India, South Africa, Gibraltar and other army stations; and the Royal Navy Football Association comprises all ships afloat having Association football clubs.

The regulations of the Football Association, which is the recognized administrative and legislative body for the game in England, make provision for the sanction and control of leagues and competitions; and its rules, regulations, principles and practices very largely prevail in all national associations. The king is the patron, and the council consists of 56 members, a president, 6 vice-presidents, a treasurer, 10 representatives elected by the clubs in the ten divisions into which the country is subdivided, together with representatives of the army, the navy and of county associations in England which have upwards of 50 clubs in membership, each representative being directly appointed by his association. In 1905 the Football Association became incorporated under the Joint Stock Companies Acts, and as a consequence the word “Limited” appears in its title. It is not, however, a trading body; the shareholders are not entitled to any dividend, bonus or profit, nor may the members of the council, who are the directors, receive any payment for their services. The Scottish Football Association is also an incorporated body with similar powers. Many of the leading clubs of the United Kingdom have also become incorporated, but under the regulations of the Football Association they may not pay a larger dividend to their shareholders than 5%, nor may any of the directors receive payment for their services.

The whole policy of legislation in Association football of late years has been naturally to make the game faster by bringing every one into full play. The great aim accordingly has been to encourage combination and to discourage purely individual efforts. In the early days, though there was a certain amount of cohesion, a player had to rely mainly on himself. Even up to the middle of the ’seventies dribbling was looked upon as the great desideratum; it was the essential for a forward, just as long kicks were the main object of a back. The development of the game was of course bound to change all that. The introduction of passing, long or short, but long in particular, placed the dribbler pure and simple at a discount, and necessitated methods with which he was mostly unacquainted. Combined play gradually came to be regarded as the keynote to success. Instead of one full back, as was originally the case, and one half-back, the defence gradually developed by the addition first of a second half, then of a second full back, and still later of a third half-back, until it came to show, in addition to the goalkeeper of course, two full backs and three half-backs. The eight forwards who used to constitute the attack in the earliest days of the Association have been reduced by degrees, as the science of the game became understood, until they now number only five. The effect of the transition has been to put the attack and defence on a more equal footing, and as a natural consequence to make the game more open and thereby generally more interesting and attractive. Association football is indeed, from the standpoint of the spectator, a much brighter game than it was in its infancy, the result of the new methods bringing every one of the eleven players into full relief throughout the game. The players who, as a rule, make or mar the success of a side in modern football are the centre forward and the centre half-back. They are the pivot on which the attack and the defence respectively turn. Instead of close dribbling and following up, the new formation makes for accuracy of passing among the forwards, with intelligent support from the half-backs. The net result is practically the effective combination of the whole side. To do his part as it ought to be done every member of an eleven must work in harmony with the rest, and on a definite system, in all cases subordinating his own 623
methods and personal interests to promote the general well-being of the side.

(C. W. A.; F. J. W.)

The literature of British football is very extensive, but the following works are among the best: *Football* in the “Badminton Library” (London, 1904), where the different games played at Eton, Harrow, Rugby, Winchester and other public schools are thoroughly described; Rev. F. Marshall, *Football; the Rugby Game* (London, Cassells); J.E. Vincent, *Football; its History for Five Centuries* (London, 1885); C.J.B. Marriott and C.W. Alcock, *Football* (“Oval Series”); “Football,” in the *Encyclopaedia of Sport*; *The Rugby Football Union Handbook*, Richardson, Greenwich, Official Annual; and *The Football Annual*, Merritt and Hatcher (Association Game), London.

United States.—In America the game of football has been elaborated far more than elsewhere, and involves more complications than in England. From colonial times until 1871 a kind of football generally resembling the English Association game was played on the village greens and by the students of colleges and academies. There was no running with the ball, but dribbling, called “babying,” was common. In 1871 a code of rules was drawn up, but they were unsatisfactory and not invariably observed. “Batting the ball,” *i.e.* striking the ball forward with the fists, was allowed.

There were two backs, sixteen rushers or forwards, and two rovers or “peanutters,” who lurked near the opponents’ goal. During this period the first international football game was played at Yale between the college team and one made up of old Etonians, the rules being a compromise between the American and the English.

English Rugby, introduced from Canada, was first played at Harvard University, and in 1875 a match under a compromise set of rules, taken partly from the Rugby Union and partly from the existing American game, was played with Yale. The following year Yale adopted the regular Rugby Union rules, and played Harvard under these. Later, several other colleges adopted these English rules. Absence of tradition necessitated expansion of these laws, and a convention of colleges was assembled. Thenceforward annual conventions were held, which from time to time altered and amplified the rules. A college association was formed, and the game grew in popularity. Public criticism of the roughness shown in the play early threatened its existence; indeed at one time the university authorities compelled Harvard to abstain from the annual game with Yale. Changes in the rules were introduced, and the game has been characterized by less roughness and by increased skill. It has become the most popular autumn game in the United States, the principal university matches often attracting crowds of 35,000 and even 40,000 spectators. The association subsequently disbanded, but a Rules Committee, invited by the University Athletic Club of New York, made the necessary changes in the rules from time to time, and these have been accepted by the country at large. In the West associations were formed; but the game in the East is played principally under separate agreements between the contesting universities, all using, however, one code of rules. Later this Rules Committee amalgamated with a new committee of wider representation. Amateur athletic clubs as well as public and private schools have also taken up the game. The American football season lasts from the middle of September to the first of December only, owing to the severity of the American winter. Professional football is not played in America.

The American Rugby game is played by teams of eleven men on a field of 330 ft. long and 160 ft. wide, divided by chalk lines into squares with sides 5 yds. long, leaving a strip 5 ft. wide on each side of the field. Until 1903 the field was divided by latitudinal lines only and was therefore popularly called the “gridiron”; subsequently it was called the “checkerboard.” The end lines are called “goal-lines,” the side “touch-lines.” The two lines 25 yds. from each goal-line, and the middle line, or 55 yard-line, are made broader than the rest. In the middle of each goal-line is a goal, consisting of two uprights exceeding 20 ft. in length, set 18 ft. 6 in. apart with a crossbar 10 ft. from the ground. The ball is in shape and material of the English Rugby type.

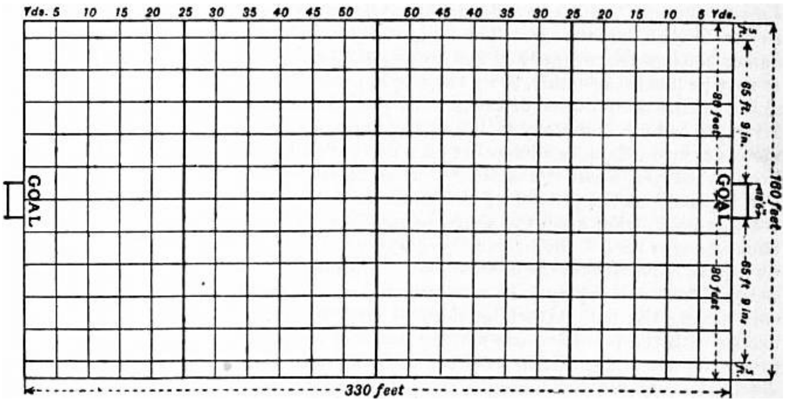

Diagram of Field

The football rules provide that when the ball is put in play in a scrimmage, the first man who receives the ball, commonly known as the quarter-back, may carry it forward beyond the line of scrimmage, provided in so doing he crosses such line at least 5 yds. from the point where the snapper-back put the ball in play, and furthermore, that a forward pass may be made provided the ball passes over the line of scrimmage at least 5 yds. from the point at which the ball is put in play. The field is marked off at intervals of 5 yds. with white lines parallel to the goal line, for convenience in penalizing fouls and for measuring the 10 yds. to be gained in three downs, and also at intervals of 5 yds. with white lines parallel to the side lines, in order to assist the referee in determining whether the quarter-back runs according to rule, or whether, in case of a forward pass, such pass is legally made. Thus the football field is changed from the gridiron as in 1902, to what now resembles a checkerboard, and the above diagram shows exactly how the field should be marked. As the width of the field does not divide evenly into 5 yd. spaces, it is wise to run the first line through the middle point of the field and then to mark off the 5 yds. on each side from that middle line. In order to save labour, it may be sufficient to omit the full completion of the longitudinal lines, as the object of these lines is accomplished if their points of intersection with the transverse lines are distinctly marked, for instance, by a line a foot long.

A match game consists of two periods (*halves*) of thirty-five minutes with an interval of fifteen minutes. Practice games usually have shorter halves. There are four officials: the *umpire*, whose duty it is to watch the conduct of the players and decide regarding fouls; the *referee*, who decides questions regarding the progress of the ball and of play; the *field judge* who assists the referee and keeps the time; and the *linesman*, who (with two assistants, one representing each eleven) marks the distance gained or lost in each play.

In scoring, a “touchdown” (the English Rugby “try”) counts 5 points, a goal from a touchdown 6 (or one added to the 5 for the touchdown), a “goal from the field,” whether from placement or drop-kick, 4, and a “safety” (the English Rugby “touchdown”) 2. *Mutatis mutandis*, these are made as in English Rugby. American Rugby differs from the English game, because in the scrimmage the men are lined up opposite each other, and, although separated by the length of the ball, are engaged in a constant man-to-man contest, and also in that a system of “interference” is allowed. Furthermore, a player in the American game is put “on side” when a kicked ball strikes the ground; and forward passing, *i.e.* throwing the ball toward the opponents’ goal, is permissible under certain restrictions. The costume usually consists of a close-fitting jersey with shoulders and elbows padded and reinforced with leather; short trousers with padded thighs and knees, heavy stockings and shoes with leather cleats. In the early period of the game caps were worn, but, as they were impossible to keep on, they were discarded in favour of the wearing of long hair, and the “chrysanthemum head” became the distinguishing mark of the football player. This, however, proved an inadequate protection, and some players now wear a “head harness” of soft padded leather. Substitutes are allowed in the places of injured players. 624

The object of the game is identical with that of English Rugby, and the rules in regard to fair catches, punting, drop-kicking, place-kicking, goal-kicking, passing and gentlemanly conduct are practically the same, except that, on a free kick after a fair catch, the opposing players in the American game may not come up to the mark but must keep 10 yds. in front of it. In the American game there is no scrummage in the English sense, nor is the ball thrown in at right angles after going into touch. The element of chance in both these methods of play was done away with by the enunciation of the principle of the "possession of the ball." In America, when the ball has gone out of bounds or a runner has been tackled and held and the ball downed, the ball is also put into play by an evolution called a scrimmage, usually called "line-up," which beyond the name bears no resemblance to the English scrummage. The ball, at every moment of the game, belongs theoretically either to one side or to the other. It may be lost by a fumble, or by the side in possession not being able to make the required distance of 10 yds. in three successive attempts or by a voluntary kick. In the line-up the seven linemen (*i.e.* forwards) face each other on a line parallel to the goal-lines on the spot where it was ordered down by the referee. The ball is placed on the ground by the centre-rush, also called the snapper-back, who, upon the signal being given by his quarter-back, "snaps back" the ball to this player, or to the full-back, by a quick movement of the hand or foot. The moment the ball is snapped-back it is in play. In every scrimmage it is a foul for the side having the ball (attacking side) to obstruct an opponent except with the body (no use may be made of hands or arms); or for the defending side to interfere with the snap-back. The defenders may use their hands and arms only to get their opponents out of the way in order to get at the man with the ball. Each member of the attacking side endeavours, of course, to prevent his opponents from breaking through and interfering with the quarter-back, who requires this protection from his line in order to have time to pass the ball to one of the backs, whom he has notified by a signal to be ready. In the United States a player may be obstructed by an off-side opponent so long as hands and arms are not used. In the line-up this is called "blocking-off" and "interference" when done to protect a friend running with the ball. Interference is one of the most important features of American football. As soon as the ball is passed to one of the half-backs for a run, for example, round one end of the line, his interference must form immediately. This means that one or more of his fellows must accompany and shield him as he runs, blocking off any opponent who tries to tackle him. The first duty of the defence against a hostile run is therefore to break up the interference, *i.e.* put these defenders out of the play, so that the runner may be reached and tackled.

The game begins by the captains tossing for choice of kick-off or goal. If the winner of the toss chooses the goal, on account of the direction of wind, the loser must kick off and send the ball at least 10 yds. into the opponents' territory from a place-kick from the 55 yds. line. The two ends of the kicking side, who are usually fast runners, get down the field after the ball as quickly as possible, in order to prevent the man who catches the kick-off from running back with the ball. When the kick-off is caught, the catcher with the aid of interference runs it back as far as possible, and as soon as he is tackled and held by his opponents the ball is down, and a line-up takes place, the ball being in the possession of the catcher's side, which now attacks. In order to prevent the so-called "block game," once prevalent, in which neither side made any appreciable progress, the rules provide that the side in possession of the ball must make *at least 10 yds. in three successive attempts*, or, failing to do so, must surrender the ball to the enemy, or, as it is called, "lose the ball on downs". This is infrequent in actual play, because if, after two unsuccessful attempts, or partly successful, it becomes evident that the chances of completing the obligatory 10-yd. gain on the remaining attempt are unfavourable, a forward pass or a kick is resorted to, rather than risk losing the ball on the spot. The kick, although resulting in the loss of the ball, nevertheless gives it to the enemy much nearer his goal. When the wind is strong the side favoured by it usually kicks often, as the other side, not being able to kick back on equal terms, is forced to play a rushing game, which is always exhausting. Again, the kicking game is often resorted to by the side that has the lead in the score, in order to save its men and yet retain the advantage. The only remaining way to advance the ball is on a free-kick after a fair catch, as in the English game. The free kick may be either a punt, a drop-kick or a kick from placement. Whenever the ball goes over the side line into touch it is brought back to the point where it crossed the line by the man who carried it over, or, if kicked or knocked over, by a man of the side which did not kick it out, and there put in play in one of two ways. Either it may be touched to the ground and then kicked at least 10 yds. towards the opponents' goal, or it may be taken into the field at right angles to the line a distance not less than 5 yds. nor more than 15, and there put down for a line-up, the player who takes it in first declaring how far he will go, so that the opposing team may not be caught napping.

Of the seven men in the line, the centre is chosen for his weight and ability to handle the ball cleanly in snapping back. He must also, in case the full-back is to make the next play, be able to throw the ball from between his legs accurately into the full-back's hands, thus saving the time that would be wasted if the quarter-back were used as an intermediary. The two "guards," who must also be heavy men, form with the centre the bulk of the line, protecting the backs in offence, and in defence blocking the enemy. The two "tackles" must be heavy yet active and aggressive men, as they must not only help the centre and guards in repelling assaults on the middle of the line, but also assist the ends in stopping runs round the line as well as those between tackle and end, a favourite point of attack. The "ends" are chosen for their activity, sure tackling, fast running and ability to follow up the ball after a kick. Of the four players behind the line, the full-back must be a sure catcher and tackler and a fast runner. The two half-backs must also be fast runners and good dodgers. One of them is often chosen for his ability to gain ground by "bucking the line," *i.e.* plunging through the opposing team's line. He must therefore be over the average weight, while the other half-back is called upon to gain by running round the opposing ends. The quarter-back is the commanding general and therefore the most important member of his side, as with him lies the choice of plays to be made when on the attack. Courage, coolness, promptness in decision and discrimination in the choice of plays are the qualities absolutely required for this position. As soon as his side obtains the ball, the quarter-back shouts out a signal, consisting of a series of numbers or letters, or both, which denotes a certain play that is to be carried through the moment the ball is snapped back. A good quarter-back thinks rapidly and shouts his signal for the next play as soon as a down has been called and while the scrimmage is forming, so that the plays are run off rapidly and the enemy is given as little time as possible to concentrate. The signals, which are secret and often changed to guard them from being solved by the enemy, are formed by designating every position and every space in the line, as well as kicks and other open plays, by a number or letter. Some signals are called sequence-signals, and indicate a prearranged series of plays for use in certain emergencies. Every manœuvre of the attacking side is carried out by every member of the team, the ideal being "every man in every play every time." As soon as a signal is given each man should know what part of the ensuing move will fall to him, in carrying the ball, interfering for the runner, or getting down the field under a punt. Every team has its own code.

About 1890 the system of interference led to momentum and mass plays (wedge-formations, tandems, &c.), *i.e.* to the grouping of bodies of men behind the line, and starting them before the ball was snapped back, so that they struck the line with an acquired momentum that was extremely severe, particularly when met by men equally determined. These plays caused frequent injuries and led to legislation against them, the most important law providing for a limitation to the number of men who could be dropped back of the line, and practically keeping seven men drawn up in the line. 625

Penalties are of three kinds: (1) forfeiture of the game, for refusing to play when directed to do so by the referee, and for repeated fouls made with the intention of delaying the game; (2) disqualification of players for unnecessary roughness or ungentlemanly conduct; and (3) for infringement of rules, for which certain distances are taken away from the previous gains of the side making the fouls.

The game resolves itself into a series of scrimmages interspersed with runs and kicks. The systematized development of plays places at the disposal of the quarter an infinite variety of attack, which he seeks to direct at the opposing line with bewildering rapidity and dash. During the preliminary games of the season "straight football" is generally played; that is, intricate attacks are avoided and kicks and simple plunges into the line are mainly relied upon. "Trick plays," which comprise all manœuvres of an intricate nature, are reserved for later and more important matches. Among these is the "fake (false) kick," in which the full-back takes position as if to receive the ball for a kick, but the ball is passed to a different player for a run. Another play of this kind is the "wing-shift," in which some or all of the players on one side of centre suddenly change to the other side, thus forming a mass and throwing the opponents' line out of balance. To this category belong also "double passes," "false passes," "delayed passes," "delayed runs" and "criss-crosses."

Training for football in America resembles that for other sports in regard to food and hygiene. The coaching systems at the universities differ, but there is generally a head coach, who is assisted by graduates, each of whom pays especial attention to one set of men, one to the men in the centre of the line, one to the backs, another to the ends, &c. Candidates for the teams are put through a severe course of practice in catching punts and hard-thrown passes, in quick starts, falling on the ball, tackling a mechanical dummy, in blocking, breaking through the line, and all kinds of kicking, although in matches the kicking is generally left to one or two men who have shown themselves particularly expert. Every player is taught to dive for the ball whenever he sees it on the ground, as possession is of cardinal importance in American football, and dribbling for this reason is unknown. When running with the ball the player is taught to take short steps, to follow his interference, that is, not isolate himself from his defenders, and neither to slow up nor shut his eyes when striking the opposing line. Tackling well below the waist is taught, but it is a foul to tackle below the knee. The general rule for defensive work of all kinds is "play low."

See Walter Camp, *How to play Football*, and the *Official Football Guide* (annual), both in Spalding's Athletic Library; his *Book of College Sports* (New York, 1893), his *American Football* (New York, 1894), and his *Football* (Boston, 1896)—the last in co-operation with L.F. Deland; R.H. Barbour, *The Book of School and College Sports* (New York, 1904); W.H. Lewis, *Primer of College Football* (Boston, 1896).

(E. B.; W. Ca.)

FOOTE, ANDREW HULL (1806-1863), American admiral, was born at New Haven, Connecticut, on the 12th of September 1806, his father, Samuel Augustus Foote (1780-1846), being a prominent lawyer and Whig politician, who as U.S. senator moved in 1829 "Foote's resolutions" on public lands, in the discussion of which Daniel Webster made his "reply to Hayne." He entered the U.S. navy in 1822, and was commissioned lieutenant in 1830. After cruising round the world (1837-1840) in the "John Adams," he was assigned to the Philadelphia Naval Asylum, and later (1846-1848) to the Boston Navy Yard. In 1849 he was made commander of the "Perry," and engaged for two years in suppressing the slave trade on the African coast. In 1856, as commander of the "Portsmouth," he served on the East India station, under Com. James Armstrong, and he captured the Barrier Forts near Canton. From October 1858 to the outbreak of the Civil War, he was in charge of the Brooklyn Navy Yard, becoming a full captain in 1861. In August 1861 he was assigned to the command "of the naval operations upon the Western waters." His exploit in capturing Fort Henry (on the right bank of the Tennessee river) from the Confederates, on the 6th of February 1862, without the co-operation of General Grant's land forces, who had not arrived in time, was a brilliant success; but their combined attack on Fort Donelson (12 m. off, on the left bank of the Cumberland river), whither most of the Fort Henry garrison had escaped, resulted, before its surrender (Feb. 16), in heavy losses to Foote's gunboats, Foote himself being severely wounded. In March-April he co-operated in the capture of New Madrid (*q.v.*) and Island No. 10. In June he retired from his command and in July was promoted rear-admiral, and became chief of the Bureau of Equipment and Recruiting. On the 26th of June 1863 he died at New York.

See the life (1874) by Professor James Mason Hoppin (1820-1906).

FOOTE, MARY HALLOCK (1847-   ), American author and illustrator, was born in Milton, New York, on the 19th of November 1847, of English Quaker ancestry. She was educated at the Poughkeepsie (N.Y.) Female Collegiate Seminary and at the Cooper Institute School of Design for women, in New York. In 1876 she married Arthur De Wint Foote, a mining engineer, and subsequently lived in the mining regions of California, Idaho, Colorado and Mexico. She is best known for her stories, in which, as in her drawings, she portrays vividly the rough picturesque life, especially the mining life, of the West. Some of her best drawings appear in her own books. Among her publications are *The Led-Horse Claim* (1883), *John Bodewin's Testimony* (1886), *The Chosen Valley* (1892), *Cœur d'Alene* (1894); *The Prodigal* (1900), a novelette; *The Desert and the Sown* (1902); and several collections of short stories, including *A Touch of Sun and other Stories* (1903).

FOOTE, SAMUEL (1720-1777), English dramatist and actor, was baptized at Truro on the 27th of January 1720. Of his attachment to his native Cornwall he gives no better proofs as an author than by making the country booby Timothy (in *The Knights*) sound the praises of that county and of its manly pastimes; but towards his family he showed a loyal and enduring affection. His father was a man of good family and position. His mother, Eleanor Goodere, whom he is said in person as well as in disposition to have strongly resembled, he liberally supported in the days of his prosperity, and after her death indignantly vindicated her character from the imputations recklessly cast upon it by the revengeful spite of the duchess of Kingston. About the time when Foote came of age, he inherited his first fortune through the murder of his uncle, Sir John Dinely Goodere, Bart., by his brother, Captain Samuel Goodere. Foote was educated at the collegiate school at Worcester, and at Worcester College, Oxford, distinguishing himself in both places by mimicry and audacious pleasantries of all kinds, and, although he left Oxford without taking his degree, acquiring a classical training which afterwards enabled him neatly to turn a classical quotation or allusion, and helped to give to his prose style a certain fluency and elegance.

Foote was "designed" for the law, but certainly not by nature. In his chambers at the Temple, and in the Grecian Coffee-house hard by, he learned to know something of lawyers if not of law, and was afterwards able to jest at the jargon and to mimic the mannerisms of the bar, and to satirize the Latitats of the other branch of the profession with particular success. The famous argument in Hobson v. Nobson, in *The Lame Lovers*, is almost as good of its kind as that in Bardell v. Pickwick. But a stronger attraction drew him to the Bedford Coffee-house in Covent Garden, and to the theatrical world of which it was the social centre. After he had run through two fortunes (the second of which he appears to have inherited at his father's death), and had then passed through severe straits, he made his first appearance on the actual stage in 1744. It is said that he had married a young lady in Worcestershire; but the traces of his wife (he affirmed himself that he was married to his washer-woman) are mysterious, and probably apocryphal.

Foote's first appearance as an actor was made little more than two years after that of Garrick, as to whose merits the 626
critics, including Foote himself, were now fiercely at war. His own first venture, as Othello, was a failure; and though he was fairly successful in genteel comedy parts, and was, after a favourable reception at Dublin, enrolled as one of the regular company at Drury Lane in the winter of 1745-1746, he had not as yet made any palpable hit. Finding that his talent lay neither in tragedy nor in genteel comedy, he had begun to wonder "where the devil it *did* lie," when his successful performance of the part of Bayes in *The Rehearsal* at last suggested to him the true outlet for his extraordinary gift of mimicry. Following the example of Garrick, he had introduced into this famous part imitations of actors, and had added a variety of other satirical comment in the way of "gag." Engaging a small company of actors, he now boldly announced for the 22nd of April 1747, at the theatre in the Haymarket "*gratis*," "a new entertainment called the *Diversions of the Morning*," to which were to be added a farce adapted from Congreve, and an epilogue "spoken by the B-d-d Coffee-house." Foote's success in these *Diversions* obtained for him the name of "the English Aristophanes," an absurd compliment, declined by Foote himself (see his letter in *The Minor*). The *Diversions* consisted of a series of imitations of actors and other well-known persons, whose various peculiarities of voice, gesture, manner or dress were brought directly before the spectators, while the epilogue introduced the wits of the Bedford engaged in ludicrous disputation, and specially "took off" an eminent physician (probably the munificent Sir William Browne, whom he afterwards caricatured in *The Devil on Two Sticks*), and a notorious quack oculist of the day. The actors ridiculed in this entertainment having at once procured the aid of the constables for preventing its repetition, Foote immediately advertised an invitation to his friends to drink a dish of tea with him at the Haymarket on the following day at noon—"and 'tis hoped there will be a great deal of comedy and some joyous spirits; he will endeavour to make the morning as diverting as possible. Tickets for this entertainment to be had at St George's coffee-house, Temple-Bar, without which no person will be admitted. N.B.—*Sir Dilbury Diddle will be there, and Lady Betty Frisk has absolutely promised.*" The device succeeded to perfection; further resistance was abandoned as futile by the actors, whom Foote mercilessly ridiculed in the "instructions to his pupils" which the entertainer pretended to impart (typifying them under characters embodying their several chief peculiarities or defects—the massive and sonorous James Quin as a watchman, the shrill-voiced Lacy Ryan as a razor-grinder, the charming Peg Woffington, whose tones had an occasional squeak in them, as an orange-woman crying her wares and the bill of the play); and Mr Foote's *Chocolate*, which was afterwards converted into an evening *Tea*, became an established favourite with the town.

In spite of this success, he seems to have contrived to spend a third fortune, and to have found it necessary to eke out his means by a speculation in small-beer, as is recorded in an amusing anecdote told of him by Johnson. But he could now command a considerable income; and when money came he seems to have freely expended it in both hospitality and charity. During his engagements at Covent Garden and at Drury Lane, of which he was joint-manager, and in professional trips to Scotland, and more especially to Ireland, he appeared both in comedies of other authors and more especially in his own. He played Hartop in his *Knights* (1749, printed 1754). *Taste* (1752), in which parts of the *Diversions* were incorporated, was followed by some eighteen pieces, the majority of which were produced at the Haymarket, the favourite home of Foote's entertainments. In 1760 he succeeded in obtaining for this theatre a licence from the lord chamberlain, afterwards (in 1766) converted into a licence for summer performances for life. The entertainments were a succession of variations on the original idea of the *Diversions* and the *Tea*. Now, it was an Auction of Pictures (1748), of part of which an idea may be formed from the second act of the comedy Taste; now, a lecture on *Orators* (1754), suggested by some bombastic discourses given by Macklin in his old age at the Piazza coffee-house in Covent Garden, where Foote had amused the audience and confounded the speaker by interposing his humorous comments. *The Orators* is preserved in the shape of a hybrid piece, which begins with a mock lecture on the art of oratory and its representatives in England, and ends with a diverting scene of a pot-house forum debate, to which Holberg's *Politician-Tinman* can hardly have been a stranger. At a later date (1773) a new device was introduced in a *Puppet-show*. The piece (unprinted) played in this by the puppets was called *Piety in Pattens*, and professed to show "by the moral how maidens of low degree might become rich from the mere effects of morality and virtue, and by the literature how thoughts of the most commonplace might be concealed under cover of words the most high flown." In other words, it was an attack upon sentimental comedy, which was still not altogether extinguished. An attack upon Garrick in connexion with the notorious Shakespeare jubilee was finally left out from the *Puppet-show*, and thus was avoided a recurrence of the quarrel which many years before had led to an interchange of epistolary thrusts, and an imitation by Woodward of the imitative Foote.

On the whole, the relations between the two public favourites became very friendly, and on Foote's part unmistakably affectionate, and they have not been always generously represented by Garrick's biographers. A comparison between the two as actors is of course out of the question; but, though Foote was a buffoon, and his tongue a scurrilous tongue, there is no authentic ground for the suggestion that his character was one of malicious heartlessness. Of Samuel Johnson's opinions of him many records remain in Boswell; when Johnson had at last found his way into Foote's company (he afterwards found it to Foote's own table) he was unable to "resist" him, and, on hearing of Foote's death, he thought the career just closed worthy of a lasting biographical record.

Meanwhile most of poor Foote's friendships in high life were probably those that are sworn across the table, and require "t'other bottle" to keep them up. It is not a pleasant picture—of Lord Mexborough and his royal guest the duke of York, and their companions, bantering Foote on his ignorance of horsemanship, and after he had weakly protested his skill, taking him out to hounds on a dangerous animal. He was thrown and broke his leg, which had to be amputated, the "patientee" (in which character he said he was now making his first appearance) consoling himself with the reflection that he would now be able to take off "old Faulkner" (a pompous Dublin alderman with a wooden leg, whom he had brought on the stage as Peter Paragraph in *The Orators*) "to the life." The duke of York made him the best reparation in his power by promising him a life-patent for the theatre in the Haymarket (1766); and Foote not only resumed his profession, as if, like Sir Luke Limp, he considered the leg he had lost "a redundancy, a mere nothing at all," but ingeniously turned his misfortune to account in two of his later pieces, *The Lame Lover* and *The Devil on Two Sticks*, while, with the true instinct of a public favourite, making constant reference to it in plays and prologues. Though the characters played by him in several of his later plays are comparatively short and light, he continued to retain his hold over the public, and about the year 1774 was beginning to think of withdrawing, at least for a time, to the continent, when he became involved in what proved a fatal personal quarrel. Neither in his entertainments nor in his comedies had he hitherto (except in Garrick's case, and it is said in Johnson's) put any visible restraint upon personal satire. *The Author*, in which, under the infinitely humorous character of Cadwallader, he had brought a Welsh gentleman of the name of Ap-Rice on the stage, had, indeed, been ultimately suppressed. But in general he had pursued his hazardous course, mercilessly exposing to public ridicule and contempt not only fribbles and pedants, quacks or supposed quacks in medicine (as in *The Devil on Two Sticks*), enthusiasts in religion, such as Dr Dodd (in *The Cozeners*) and George Whitefield and his connexion (in *The Minor*). He had not only dared the wrath of the whole Society of Antiquaries (in *The Nabob*), and been rewarded by the withdrawal, 627
from among the pundits who rationalized away Whittington's Cat, of Horace Walpole and other eminent members of the body, but had in the same play attacked a well-known representative of a very influential though detested element in English society,—the "Nabobs" themselves. But there was one species of cracked porcelain which he was not to try to hold up to contempt with impunity. The rumour of his intention to bring upon the stage, in the character of Lady Kitty Crocodile in *The Trip to Calais*, the notorious duchess of Kingston, whose trial for bigamy was then (1775) impending, roused his intended victim to the utmost fury; and the means and influence she had at her disposal enabled her, not only

to prevail upon the lord chamberlain to prohibit the performance of the piece (in which there is no hint as to the charge of bigamy itself), but to hire agents to vilify Foote's character in every way that hatred and malice could suggest. After he had withdrawn the piece, and letters had been exchanged between the duchess and him equally characteristic of their respective writers, Foote took his revenge upon the chief of the duchess's instruments, a "Reverend Doctor" Jackson, who belonged to the "reptile" society of the journalists of the day, so admirably satirized by Foote in his comedy of *The Bankrupt*. This man he gibbeted in the character of Viper in *The Capuchin*, under which name the altered *Trip to Calais* was performed in 1776. But the resources of his enemies were not yet at an end; and a discharged servant of Foote's was suborned by Jackson to bring a charge of assault and apply for a warrant against him. Though the attempt utterly broke down, and Foote's character was thus completely cleared, his health and spirits had given way in the struggle—as to which, though he seems to have had the firm support of the better part of the public, including such men as Burke and Reynolds, the very audiences of his own theatre had been, or had seemed to be, divided in opinion. He thus resolved to withdraw, at least for a time, from the effects of the storm, let his theatre to Colman, and after making his last appearance there in May 1777, set forth in October on a journey to France. But at Dover he fell sick on the day after his arrival there, and after a few hours died (October 21st). His epitaph in St Mary's church at Dover (written by his faithful treasurer William Jewell) records that he had a hand "open as day for melting charity." His resting-place in Westminster Abbey is without any memorial.

Foote's chief power as an actor lay in his extraordinary gift of mimicry, which extended to the mental and moral, as well as the mere outward and physical peculiarities of the personages whose likeness he assumed. He must have possessed a wonderful flexibility of voice, though his tones are said to have been harsh when his voice was not disguised, and an incomparable readiness for rapidly assuming characters, both in his entertainments and in his comedies, where he occasionally "doubled" parts. The excellent "patter" of some of his plays, such as *The Liar* and *The Cozeners*, must have greatly depended for its effect upon rapidity of delivery. In person he was rather short and stout, and coarse-featured; but his overflowing humour is said to have found full expression in the irresistible sparkle of his eyes.

As a dramatic author he can only be assigned a subordinate rank. He regarded comedy as "an exact representation of the peculiar manners of that people among whom it happens to be performed; a faithful imitation of singular absurdities, particular follies, which are openly produced, as criminals are publicly punished, for the correction of individuals and as an example to the whole community." This he regarded as the *utile*, or useful purpose, of comedy; the *dulce* he conceived to be "the fable, the construction, machinery, conduct, plot, and incidents of the piece." For part at least of this view (advanced by him in the spirited and scholarly "Letter" in which he replied, "to the Reverend Author of the 'Remarks, Critical and Christian,' on *The Minor*"), he rather loftily appealed to classical authority. But he overlooked the indispensableness of the *dulce* to the comic drama under its primary aspect as a species of art. His comic genius was particularly happy in discovering and reproducing characters deserving of ridicule; and the fact that he not only took them from real life, but closely modelled them on well-known living men and women, was not in himself an artistic sin. Nor indeed was the novelty of this process absolute, though probably no other comic dramatist has ever gone so far in this course, or has pursued it so persistently. The public delighted in his "d——d fine originals," because it recognized them as copies; and he was himself proud that he had taken them from real persons, instead of their being "vamped from antiquated plays, pilfered from the French farces, or the baseless beings of the poet's brain." But the real excellence of many of Foote's comic characters lies in the fact that, besides being incomparably ludicrous types of manners, they remain admirable comic types of general human nature. Sir Gregory Gazette, and his imbecile appetite for news; Lady Pentweazel, and her preposterous vanity in her superannuated charms; Mr Cadwallader, and his view of the advantages of public schools (where children may "make acquaintances that may hereafter be useful to them; for between you and I, as to what they learn there, does not signify twopence"); Major Sturgeon and Jerry Sneak; Sir Thomas Lofty, Sir Luke Limp, Mrs Mechlin, and a score or two of other characters, are excellent comic figures in themselves, whatever their origin; and many of the vices and weaknesses exposed by Foote's vigorous satire will remain the perennial subject of comic treatment so long as a stage exists. The real defect of his plays lies in the abnormal weakness of their construction, in the absolute contempt which the great majority of them show for the invention or conduct of a plot, and in the unwarrantable subordination of the interest of the action to the exhibition of particular characters. His characters are ready-made, and the action is only incidental to them. With the exception of *The Liar* (which Foote pretended to have taken from Lope de Vega, but which was really founded on Steele's adaptation of Corneille's *Le Menteur*), and perhaps of *The Bankrupt*, there is hardly one of Foote's "comedies" in which the conception and conduct of the action rise above the exigencies of the merest farce. Not that sentimental scenes and even sentimental characters are wanting, but these familiar ingredients are as incapable of exciting real interest as an ordinary farcical action is in itself unable to produce more than transitory amusement. In his earlier plays Foote constantly resorts to the most hackneyed device of farce—a disguise. Of course Foote must have been well aware of the shortcomings of his rapidly manufactured productions; he knew that if he might sneer at "genteel comedy" as suited to the dramatists of the servants' hall, and pronounce the arts of the drama at the great houses to be "directed by the genius of insipidity," he, like the little theatre where he held sway, was looked upon as "an eccentric, a mere summer fly."

At the same time, he was inexhaustible in the devising of comic scenes of genuine farce. An oration of "old masters," an election of a suburban mayor, an examination at the College of Physicians, a newspaper conclave where paragraphs are concocted and reputations massacred—all these and other equally happy situations are brought before the mere reader with unfailing vividness. And everywhere the comic dialogue is instinct with spirit and vigour, and the comic characters are true to themselves with a buoyancy which at once raises them above the level of mere theatrical conventionalism. Foote professed to despise the mere caricaturing of national peculiarities as such, and generally used dialect as a mere additional colouring; he was, however, too wide awake to the demands of his public not to treat France and Frenchmen as fair game, and coarsely to appeal to national prejudice. His satire against those everlasting victims of English comedy and farce, the Englishman in Paris and the Englishman returned from Paris, was doubtless well warranted; while at the same time he made fun of the fact that Englishmen are nowhere more addicted to the society of their countrymen than abroad. In general, the purposes of Foote's social satire are excellent, and the abuses against which it is directed are those which it required courage to attack. The tone of his morality is healthy, and his language, though not aiming at refinement, is remarkably free from intentional grossness. He made occasional mistakes; but he was on the right side in the warfare against the pretentiousness of Cant and the effrontery of Vice, the two master evils of the age and the society in which he lived.

The following is a list of Foote's farces or "comedies" as he calls them, mostly in three, some in two acts, which remain in print. The date of production, and the character originally performed by Foote, are added to the title of each:

The Knights (1748: Hartop, who assumes the character of Sir Penurious Trifle); Taste (1752), in which part of the *Diversions* is incorporated; *The Englishman in Paris* (1753: Young Buck); *The Englishman returned from Paris* (1756: Sir Charles Buck); *The Author* (1757: Cadwallader); *The Minor* (1760: Smirk and Mrs Cole); *The Liar* (1762); *The Orators* (1762: Lecturer); *The Mayor of Garratt* (1763: Major Sturgeon and Matthew Mug); *The Patron* (1764: Sir Thomas Lofty and Sir Peter Peppercorn); *The Commissary* (1765: Mr Zac. Fungus); *The Devil upon Two Sticks* (1768: Devil,—alias Dr Hercules Hellebore); *The Lame Lover* (1770: Sir Luke Limp); *The Maid of Bath* (1771: Mr Flint); *The Nabob* (1772: Sir Matthew Mite); *The Bankrupt* (1773: Sir Robert Riscounter); *The Cozeners* (1774: Mr Aircastle); *The Capuchin*, a second version of The Trip to Calais, forbidden by the censor (1776: O'Donovan). His dramatic works were collected in 1763-1768.

Bibliography.—Foote's biography may be read in W. ("Conversation") Cooke's *Memoirs of Samuel Foote* (3 vols., 1805), which contain, amidst other matter, a large collection of his good things and of anecdotes concerning him, besides two of

his previously unpublished occasional pieces (with the *Tragedy à la mode*, part of the *Diversions*, in which Foote appeared as Fustian). From this source seems to have been mainly taken the biographical information in the rather grandiloquent essay on Foote prefixed by "Jon Bee" (John Badcock, fl. 1816-1830, also known as "John Hunds") to his useful edition of Foote's Works (3 vols., 1830). Various particulars will be found in Tate Wilkinson's *Wandering Patentee* (York, 1795) and in other sources. There is an admirable essay on Foote, reprinted with additions, from the *Quarterly Review*, in John Forster's *Biographical Essays* (1858). A recent life of Foote is by Percy Fitzgerald (1910).

(A. W. W.)

FOOTMAN, a name given among articles of furniture to a metal stand, usually of polished steel or brass, and either oblong or oval in shape, for keeping plates and dishes hot before a dining-room fire. In the days before the general use of hot-water dishes the footman possessed definite utility, but although it is still in occasional use, it is now chiefly regarded as an ornament. It was especially common in the hardware counties of England, where it is still frequently seen; the simple conventionality of its form is not inelegant.

FOOTSCRAY, a city of Bourke county, Victoria, Australia, on the Saltwater river, 4 m. W. of and suburban to Melbourne. Pop. (1901) 18,301. The city has large bluestone quarries from which most of the building stones in Melbourne and the neighbourhood is obtained; it is also an important manufacturing centre, with numerous sugar-mills, jute factories, soap works, woollen-mills, foundries, chemical works and many other minor industries.

FOOT-STALL, a word supposed to be a literal translation of *pièdestal*, or pedestal, the lower part of a pier in architecture (see Base).

FOPPA, VINCENZO, Italian painter, was born near Brescia. The dates of his birth and death used to be given as 1400 and 1492; but there is now good reason for substituting 1427 and 1515. He settled in Pavia towards 1456, and was the head of a Lombard school of painting which subsisted up to the advent of Leonardo da Vinci. In 1489 he returned to Brescia. His contemporary reputation was very considerable, his merit in perspective and foreshortening being recognized especially. Among his noted works are a fresco in the Brera Gallery, Milan, the "Martyrdom of St Sebastian"; and a "Crucifixion" in the Carrara gallery, Bergamo, executed in 1455. He worked much in Milan and in Genoa, but many of his paintings are now lost.

See C.J. Ffoulkes and R. Maiocchi, *Vincenzo Foppa* (1910).

FORAGE, food for cattle or horses, chiefly the provender collected for the food of the horses of an army. In early usage the word was confined to the dried forage as opposed to grass. From this word comes "foray," an expedition in search of "forage," and hence a pillaging expedition, a raid. The word "forage," directly derived from the Fr. *fourrage*, comes from a common Teutonic origin, and appears in "fodder," food for cattle. The ultimate Indo-European root, *pat*, cf. Gr. πατεῖσθαι, Lat. *pascere*, to feed, gives "food," "feed," "foster"; and appears also in such Latin derivatives as "pastor," "pasture."

FORAIN, J. L. (1852-   ), French painter and illustrator, was born in 1852. He became one of the leading modern Parisian caricaturists, who in his merciless exposure of the weaknesses of the *bourgeoisie* continued the work which was begun by Daumier under the second Empire. The scathing bitterness of his satire is as clearly derived from Daumier as his pictorial style can be traced to Manet and Degas; but even in his painting he never suppresses the caustic spirit that drives him to caricature. He has, indeed, been rightly called "a Degas pushed on to caricature." In his pen-and-ink work he combines extraordinary economy of means with the utmost power of expression and suggestion. Forain's popularity dates from the publication of his *Comédie parisienne*, a series of two hundred and fifty sketches republished in book form. He has contributed many admirable, if sometimes over-daring, pages to the *Figaro*, *Le Rire*, *L'Assiette au beurre*, *Le Courrier français*, and *L'Indiscret*. His political drawings for the *Figaro* were republished in book form under the title of *Doux Pays*.

FORAKER, JOSEPH HENSON (1846-), American political leader, was born near Rainsboro, Highland county, Ohio, on the 5th of July 1846. He passed his early life on a farm, enlisted as a private in the 89th Ohio Volunteer Infantry in July 1862, served throughout the Civil War, for part of the time as an aide on the staff of General H.W. Slocum, and in 1865 received a captain's brevet for "efficient services during the campaigns in North Carolina and Georgia." After the war he spent two years at the Ohio Wesleyan University and two years at Cornell. In 1869 he was admitted to the Ohio bar and began practice in Cincinnati. He was a judge of the Cincinnati Superior Court from 1879 to 1882. In 1883 he was the Republican candidate for governor of Ohio, but was defeated; in 1885 and 1887, however, he was elected, but was again defeated in 1889. He then for eight years practised law with great success in Cincinnati. In 1896 he was elected United States senator to succeed Calvin S. Brice (1845-1898); in 1902 was re-elected and served until 1909. In the Senate he was one of the aggressive Republican leaders, strongly supporting the administration of President M'Kinley (whose name he presented to the Republican National Conventions of 1896 and 1900) in the debates preceding, during, and immediately following the Spanish-American War, and later, during the administration of President Roosevelt, was conspicuous among Republican leaders for his independence. He vigorously opposed various measures advocated by the president, and led the opposition to the president's summary discharge of certain negro troops after the Brownsville raid of the 13th of August 1906 (see Brownsville, Texas).