Táshefín. Before it was more than a hundred years old it is said to have had 700,000 inhabitants, but at present the total number probably does not exceed 50,000 or 60,000.

See Leo Africanus; Lambert's detailed description in *Bul. de la Soc. de géogr.*, Paris, 1865; and Dr Leared's *rifacimento* of Lambert. Lambert's plan of Morocco is reproduced with some additions by Dr Leared; and another may be found in Gatell. (H. A. W.)

MORON, or MORON DE LA FRONTERA, a town of Spain, in the province of Seville, about 32 miles to the south-east of that city, occupies an irregular site upon broken chalk hillocks at a distance of a mile and a half from the right bank of the Guadaira. It is connected by rail with Utrera on the Cadiz and Seville line. On the highest elevation to the eastward are the ruins of the ancient castle, of considerable importance during the Moorish period, and afterwards used as a palace by the counts of Ureña. In 1810-11 it was fortified by the French, but blown up by them in the following year. The chief public building of Moron is the large parish church, which dates from the 16th century, but presents no noteworthy features. The fine district between Moron and the Serrania de Ronda is largely occupied by olive plantations, and the trade in oil and other agricultural produce forms the chief industry of the town. Moron is also famous throughout Spain for its chalk (cal de Moron), from which the white-wash extensively used in the Peninsula is derived. The population of the town was 14,879 in 1878.

MORONI, GIAMBATTISTA (*c.* 1510-1578), an eminent portrait-painter of the Venetian school, was born at Albino near Bergamo about 1510, and became a pupil of Bonvicino named Il Moretto. Beyond the record of his works very few particulars regarding him have reached us. Titian, under whom also Moroni, while still very young, is said to have studied (but this appears hardly probable), had at any rate a high opinion of his powers; he said that Moroni made his portraits "living" or "actual" (*veri*). And if the magnates of Bergamo came to the great Venetian for their likenesses he advised them to go to their own countryman. In truthful and animated portraiture Moroni ranks near Titian himself. His portraits do not indeed attain to a majestic monumental character; but they are full of straightforward life and individuality, with genuine unforced choice of attitude, and excellent texture and arrangement of draperies. There is a certain tendency to a violet tint in the flesh, and the drawing and action of the hands are not first-rate. As leading samples of his portraits may be mentioned—in the Uffizi Gallery, Florence, the Nobleman pointing to a Flame, inscribed "Et quid volo nisi ut ardeat?"; in the National Gallery, London, the portraits of a Tailor, a member of the Fenaroli family, Canon Ludovico de' Terzi, and others; in the Berlin Gallery, his own portrait; and in Stafford House, the seated half-figure of the Jesuit Ercole Tasso, currently termed "Titian's Schoolmaster"—not as indicating any real connexion between the sitter and Titian, but only the consummate excellence of the work. Besides his portraits, Moroni painted, from youth to his latest days, the ordinary round of sacred compositions; but in these he falls below his master Il Moretto, and his design, which partakes more of the Lombard or Milanese style than of the Venetian, has at times some of the dryness of the quattrocento. One of the best is the Coronation of the Virgin in S. Alessandro della Croce, Bergamo; also in the Cathedral of Verona, Sts Peter and Paul, and in the Brera of Milan, the Assumption of the Virgin. Moroni was engaged upon a Last Judgment in the church of Corlago when he died on 5th February 1578.

MOROSINI, the name of a noble Venetian family. According to the best authorities, Cappellari and Barbaro, there would seem to have been two families of that name, distinguishing themselves by the variation of their shield. The one came from Mantua at the time of Attila's invasion, and bore or, a fess azure. The other came from Illyria in the 7th century; they bore or, a bend azure. However that may be, nothing authentic is known of the Morosini till we find them settled as one family in Venice during the 8th century. The Morosini belong to the Case Vecchie, or twenty-four families of Venetian nobility who were descended from the tribunes of the confederate islands before Venice became united in one centre at Rialto. The 10th century was a period of danger for the family. They became involved in a blood feud with another noble house, the Caloprini, who were Ghibelline in politics, and relied upon the emperor Otto for support. The Morosini, however, proved the stronger, thanks to their popularity; and the year 991 saw them victorious through the deposition of the doge Memo, who had favoured their enemies. The Morosini engaged in commerce with the East, and in the 14th century two brothers of the family, Alban and Marco, founded a house at Aleppo with branches in Damascus, Beyrút, and elsewhere in Syria. The wealth and importance of the family may be gathered from the fact that in 1379 no less than fifty-nine Morosini subscribed towards the fund for carrying on the war of Chioggia. The house of Morosini gave four doges to Venice, and numbered among its honours two royal marriages, two cardinals, twenty-four procurators of St Mark, besides numerous generals of the republic. The Morosini continued to flourish till the opening of the last century, when the family began to decline; it is now represented by one surviving member.

Among the more distinguished members of the house must be mentioned:—Giovanni, who in 982 founded the monastic establishment on S. Giorgio Maggiore after the order of St Benedict; Domenico, doge 1148-1156—in the third year of his reign Pola and Istria, which had rebelled, were reconquered; Marino, doge 1249-1252, during whose reign the Inquisition, in a modified form and under the surveillance of Venetian officers, was introduced into Venice for the first time. In this same century (1290) Tommasina Morosini, the sister of Albertino il Grande, married Stephen, prince of Hungary. Their son Andrew succeeded to the throne, and was directed in his government by his uncle Albertino, on whom he conferred the dukedom of Slavonia and the county of Morlacchia. A cousin of Tommasina, Costanza, married Ladislaus, king of Servia. In 1382 Michele Morosini was elected doge. He had acquired a large fortune and a reputation for astuteness by buying Venetian property while the Genoese were still in Chioggia; and much was expected of him in the restoration of his country's finance when that war came to an end. But he died the year of his election. Andrea Morosini the historian was born in 1558. He studied at Padua, and on coming of age embarked on public life. He passed through the various offices of state, till in 1618 he was a candidate for the dogeship, but failed to secure it, and died the same year. On the death of the official historian Paolo Paruta, in 1598, Andrea was commissioned by the Council of Ten to continue his work, and received authority to consult the state papers down to 1594. He wrote his history in Latin. It covers from 1521 to 1615, and was first published in Venice, 1623.

Andrea's other works, of which only the first has been edited, are:—(1) *L'imprese ed espeditioni di Terra Santa e l'acquisto fatto dell' Imperio di Costantinopoli dalla Serenissima Republica di Venetia*, Venice, 1627; (2) *De iis quæ Veneta Respublica ad Istriæ oras gessit adversus Othonem Federici Imperatoris filium*, in the Corner-Duodo collection of MSS.; (3) *De forma reipublicæ Venetæ*, in the National Library, Paris; (4) *Raccolta delle Leggi del Cons. X.*, in the Archivio Generale at the Frari, Venice; (5) *De rebus gestis ac nece Francisci Carmanioles*, in the Corner-Duodo collection. The life of Andrea has been written by Luigi Lollin, bishop of Belluno (1623), by Niccolo Crasso (1621), and by Antonio Palazzoli (1620).

The most distinguished member of the house of Morosini was Francesco, the captain-general of the republic against the Turks and conqueror of the Morea. He was born in 1618. In 1666 he was in command during an unfortunate campaign in Candia. In 1687 he conquered Patras, and so opened the Morea to the Venetian arms. In the following year he was elected doge. After his return to Venice the republic suffered severely in Candia, and though now an old man Francesco took the field again in 1693, but died the next year at Nauplia, seventy-six years of age. A more detailed account of his exploits will be found in the article VENICE.

Authorities.—Barbaro, *Genealogie delle Famiglie Patrizie Venete*, MS., clas. vii. cod. dccccxxvii., in the Marcian Library, Venice; Cappellari, *Campidoglio Veneto*, MS., clas. vii. cod. xvii., in the same library; Romanin, *Storia documentata di Venezia*: Freschot, *La Nobiltà Veneta*; Cicogna, *Iscrizione Veneziane*.

MORPETH, a municipal and parliamentary borough of Northumberland, England, is situated in a fine valley on the Wansbeck, and on the North-Eastern Railway, 50 miles south of Berwick and 16 north of Newcastle. The Wansbeck, which is crossed by a stone and two wooden bridges, winds round the town on the west, south, and east, and a small rivulet, the Cottingburn, bounds it on the north. Morpeth is irregularly built, but possesses a number of good shops. The parish church of the Blessed Virgin, a plain building of the 14th century, is situated on Kirk Hill, a short distance from the town. Among the other public buildings are the Edward VI.'s grammar school, reopened in 1857 after a Chancery suit lasting 150 years; the town-hall, erected in 1870 to supersede a building of 1714 by Vanbrugh; and the county-hall and former gaol, in the baronial style, built in 1814. Nothing remains of the old castle except the gateway. Morpeth had at one time one of the largest cattle-markets in England. The industries of the town include tanning, brewing, malting, iron and brass founding, and the manufacture of flannels, agricultural implements, and bricks and tiles. The population of the municipal borough (231 acres) in 1871 was 4517, and in 1881 it was 4556. The population of the parliamentary borough (17,085 acres) in the same years was 30,239 and 33,459.

Morpeth (*Morepath*, *i.e.*, the path over the moor) had attained some size before the Norman Conquest, when it was granted to William de Merlay. From the De Merlays it passed through the Greystocks and Dacres to the Howards, earls of Carlisle. Soon after the Conquest it obtained the privilege of a market, and in 1552 arms were granted to it by Edward VI. It is a borough by prescription, and was incorporated by Charles II. By the Municipal Act of 1835 the government was placed in a mayor and burgesses, but there is a local board of health distinct from the corporation, having control over an area slightly larger than that of the municipal borough. From 1553 the borough sent two members to parliament, but since 1832 only one member has been returned, and in 1868 the area of the borough was increased.

MORPHEUS is a personification, apparently invented by Ovid (*Metam.*, xi. 635), of the power that calls up shapes before the fancy of a dreamer. The name (from μορφή) expresses this function; Ovid translates it *artifex simulatorque figuræ*. Morpheus is naturally represented as the son of Sleep (Somnus).

MORPHIA. See OPIUM.

MORPHOLOGY

THE term Morphology (*μορφή, form*), introduced by Goethe to denote the study of the unity of type in organic form (for which the Linnæan term METAMORPHOSIS (*q.v.*) had formerly been employed), now usually covers the entire science of organic form, and will be employed in this more comprehensive sense in the present article.

§ 1. *Historical Outline.*—If we disregard such vague likenesses as those expressed in the popular classifications of plants by size into herbs, shrubs, and trees, or of terrestrial animals by habit into beasts and creeping things, the history of morphology commences with Aristotle. Founder of comparative anatomy and taxonomy, he established eight great divisions (to which are appended certain minor groups)—*Viviparous Quadrupeds*, *Birds*, *Oviparous Quadrupeds and Apoda*, *Fishes*, *Malakia*, *Malacostraca*, *Entoma*, and *Ostracodermata*—distinguishing the first four groups as *Enaima* ("with blood") from the remaining four as *Anaima* ("bloodless"). In these two divisions we recognize the Vertebrata and Invertebrata of Lamarck, while the eight groups are identical with the Mammals, Birds, Reptiles, Fishes, the Cephalopods, Crustaceans, other Articulates, and Testaceans of recent zoology. Far, too, from committing the mistake often attributed to him of reckoning Bats as Birds, or Cetaceans as Fishes, he discerned the true affinities of both, and erected the latter into a special γένος beside the Viviparous Quadrupeds, far more on account of their absence of limbs than of their aquatic habit. Not only is his method inductive, and, as in modern systems, his groups natural, *i.e.*, founded on the aggregate of known characters, but he foreshadows such generalizations as those of the correlation of organs, and of the progress of development from a general to a special form, long afterwards established by Cuvier and Von Baer respectively. In the correspondence he suggests between the scales of Fishes and the feathers of Birds, or in that hinted at between the fins of Fishes and the limbs of Quadrupeds, the idea of homology too is nascent; and from the compilation of his disciple Nicolaus of Damascus, who regards leaves as imperfectly-developed fruits, he seems almost to have anticipated the idea of the metamorphosis of plants. In short, we find a knowledge of structural facts and a comparative freedom from the errors induced by physiological resemblance, of which his successors such as Theophrastus and Pliny, generally mere classifiers by habit, show little trace, and which the moderns have but slowly regained. Little indeed can be recorded until the 13th century, when the reappearance of Aristotle's works gave a new impulse to the study of organic nature. Of the works of this period that of Albertus Magnus is far the most important; but they are all no more than revivals of Aristotle, marking the reappearance of scientific method and the reawakening of interest in and sympathy with nature. Meanwhile leech and apothecary, alchemist and witch, were accumulating considerable knowledge of plants, which, after the invention of printing, became collected and extended in the descriptive and well-illustrated folios of Gesner and his successors, Fuchs, Lobel, and others, as well as by the establishment of botanic gardens and scientific academies, while, as Sachs expresses it, "in the sharpest contrast to the naive empiricism of the German fathers of botany came their Italian contemporary Cæsalpinus, as the thinker of the vegetable world." Both made systematic efforts,—the Germans vaguely seeking for natural affinities in mere similarities of habit, the Italian with no inconsiderable success striving towards an intellectual basis of classification. Monographs on groups of plants and animals frequently appeared, those of Belon on Birds and Rondelet on Fishes being among the earliest; and in the former of these (1555) we find a comparison of the skeletons of Bird and Man in the same posture and as nearly as possible bone for bone,—an idea which, despite the contemporaneous renaissance of human anatomy initiated by Vesalius, disappeared for centuries, unappreciated save by the surgeon Ambroise Paré. Palissy, like Leonardo before him, discerned the true nature of fossils; and such flashes of morphological insight continued to appear from time to time during the 17th century. Thus, Joachim Jung recognized "the distinction between root and stem, the difference between leaves and foliaceous branches, the transition from the ordinary leaves to the *folia floris*," and Harvey anticipated the generalizations of modern embryology by his researches on development and his theory of epigenesis.

The encyclopædic period of which Gesner is the highest representative was continued by Aldrovandi, Jonston, and others in the 17th century, but, aided powerfully by the Baconian movement, then profoundly influencing all scientific minds, it developed rapidly into one of genuinely systematic aim. At this stage of progress by far the most important part was taken by John Ray, whose classificatory labours both among plants and animals were crowned with marvellous success. He first definitely expelled the fabulous monsters and prodigies of which the encyclopædists had faithfully handed on the tradition from mediæval times, and, like his predecessor Morison, classifying in a truly modern spirit by anatomical characters, he succeeded, particularly among plants, in distinguishing many natural groups, for which his very terms sometimes survive, *e.g.*, Dicotyledons and Monocotyledons, Umbelliferæ and Leguminosæ. The true precursor of Linnæus, he introduced the idea of *species* in natural history, afterwards to become so rigid, and reformed the practice of definition and terminology. Of the many works which followed up Ray's systematic and monographic labours, though often, like those of Tournefort and Rivinus, Réaumur and Klein, of great importance, none can be even named until we come to those of his great successor Linnæus, whose extraordinary grasp of logical method and unparalleled lucidity of thought and expression enabled him to reform and reorganize the whole labours of his predecessors into a compact and definite "systema naturæ." The very genius of order, he established modern taxonomy (see BIOLOGY), not only by the introduction of the binomial nomenclature and the renovation of descriptive terminology and method, but by the subordination of the species—henceforth clearly defined—under the successive higher categories of genus, order, and class, so finally reconciling the analytic and synthetic tendencies of his predecessors. Although the classification of plants by the number of their essential organs (which vastly advanced not only the cultivation of botany but the knowledge of the flora of the globe, and by which he is popularly remembered) is highly artificial, it must be remembered that this artificiality is after all only a question of degree, and that he not only distinctly recognized its provisional character but collected and extended those fragments of the natural system with which Jussieu soon afterwards commenced to build. His classification of animals, too, was largely natural, and, though on the whole he unfortunately lent his authority to maintain "that disastrous philosophic and scientific aberration" inherited from the alchemists through the last encyclopædist of Gesner's school—the notion of three kingdoms of nature —he at least at one time discerned the fundamental unity of animals and vegetables, and united them in opposition to the non-living world as *Organisata*. At the same time he was still far more a scholastic naturalist than a modern investigator, and his works represent little more than the full completion of the ancient era, and in the hands of fanatical followers served often to retard the commencement of the modern one. So, too, his excessive systematic and descriptive precision, united as it was with comparative inattention to other than superficial characters, established a tendency, even yet not extinct, to rest contented with mere method and nomenclature instead of aiming at complete morphological knowledge.

While the artificial system was at the zenith of its fame and usefulness, Bernard de Jussieu was arranging his garden on the lines afforded by the fragmentary natural system of Linnæus. His ideas were elaborated by his nephew and successor Antoine de Jussieu, who for the first time published diagnoses of the natural orders, so giving the system its modern character. Its subsequent elaboration and definite establishment are due mainly to the labours of Pyrame de Candolle and Robert Brown. The former concentrated his own long life and that of his son upon a new "systema naturæ," the colossal *Prodromus systematis naturalis* (20 vols., 1818-1873), in which 80,000 species were described and arranged. Meanwhile the penetrative genius of Brown enabled him to unravel such structural complexities as those of Conifers and Cycads, Orchids and Proteaceæ, thus demonstrating the possibility of ascertaining the systematic position of even the most highly modified floral types. Both Candolle and Brown were thus no mere systematists, but genuine morphologists of the modern school. The former, as we shall afterwards see, established the theory of floral symmetry on grounds of pure comparative anatomy, and distinguished with greater success than hitherto between fundamental unity of structural type and mere superficial similarity of physiological adaptation. The latter (Humboldt's "facile princeps botanicorum"), using the same ideas with even keener insight, made many memorable anatomical researches, such as those on the structure of the ovule and the seed, and indeed by his demonstration of the affinities of the gymnosperms almost anticipated the discoveries of Hofmeister, who stands pre-eminent among his modern successors on account of his elucidation of the secret of phanerogamic reproduction.

The labours of Bernard and Antoine de Jussieu initiated too a vast parallel advance in zoology, the joint memoir on the classification of mammals with which Cuvier and Geoffroy St-Hilaire almost commenced their career receiving its dominant impulse from the "genera" of Antoine. Cuvier's works correspond in zoology to those of the whole period from the Jussieus to Brown, and epitomize the results of that line of advance. Although in some respects preceded by Haller and Hunter, who compared, though mainly with physiological aim, the same parts in different organisms, and much more distinctly by Vicq d'Azyr, the only real comparative anatomist of the 18th century, he truly opens the era of detailed anatomical research united with exact comparison and clear generalization. The *Règne Animal* (1817) and the theory of types (vertebrate, molluscan, articulate, and radiate) are the results of this union of analysis and synthesis (although he himself, exasperated by the aberrations of the Naturphilosophie, was accustomed to proclaim the importance of detailed empiricism alone), and mark the reconstitution of taxonomy on a new basis, henceforth to be no longer a matter of superficial description and nomenclature but a complete expression of structural resemblances and differences. More even than Linnæus he is the founder of a great school, whose names and labours are imperishable. In Germany, Bojanus, Meckel, Von Siebold, and the illustrious Johannes Müller, with his many living pupils, have carried on the work; in France, too, a succession of brilliant anatomists, such as De Quatrefages, Milne-Edwards, and Lacaze-Duthiers, are his intellectual heirs; and in England he has been admirably represented by Owen.

The histological movement inaugurated by Bichat will be subsequently discussed; the rise of embryology, however, may be briefly noted, especially since it supplied the most obvious deficiency of the Cuvierian school. Here the principal figure is Von Baer, who established independently the four types of Cuvier on developmental grounds, so for the first time applying embryology as the touchstone of anatomical classifications, besides establishing his famous law of differentiation from a general towards a special form.

It is now necessary to return to Linnæus, whose more speculative writings contain, though encumbered by fantastic hypotheses, the idea of floral metamorphosis ("Principium florum et foliorum idem est," &c.). About the same time, and quite independently, C. F. Wolff, the embryologist, stated the same theory with greater clearness, for the first time distinctly reducing the plant to an axis bearing appendages—the vegetative leaves—which become metamorphosed into bud-scales or floral parts through diminution of vegetative force. Thirty years later the same view was again independently developed by Goethe in his now well-known pamphlet (*Versuch die Metamorphose der Pflanzen zu erklären*, Gotha, 1790). In this brilliant essay the doctrine of the fundamental unity of floral and foliar parts is clearly enunciated, and supported by arguments from anatomy, development, and teratology. All the organs of a plant are thus modifications of one fundamental organ—the leaf—and all plants are in like manner to be viewed as modifications of a common type—the *Urpflanze*. The controversy as to the merits and importance of this essay, and of Goethe's morphological work in general, can scarcely be entered upon here. That Goethe discerned and proclaimed, and that more clearly than any of his predecessors or contemporaries, the fundamental idea of all morphology—the unity which underlies the multifarious varieties of organic form—and that he systematically applied this idea to the interpretation of the most important, most complex, and most varied animal and vegetable structures, is unquestionable. The difficulties arise when we seek to estimate the importance of his works in the chain of progress, and when we inquire whether, as some historians hold, his "urpflanze" was a mere ideal archetype, bringing forth as its fruit the innumerable metaphysical abstractions of the Naturphilosophie, and leading his countrymen, to their fall, into all the extravagances of that system; or whether, as Haeckel maintains, it represented a concrete ancestral form, so anticipating the view of modern evolutionists. That to him Schelling was largely indebted for the foundation upon which he erected his philosophic edifice, as also that Goethe largely shared the same ideas, is unquestionable; but it must be remembered that he lived and made progress for forty years after the publication of this essay, that he was familiar with the whole scientific movement, and warmly sympathized with the evolutionary views of Lamarck and Geoffroy St-Hilaire; it is not therefore to be wondered at that his writings should furnish evidence in favour of each and every interpretation of them. His other morphological labours must not be forgotten. Independently of Vicq d'Azyr, he discovered the human premaxillary bone; independently of Oken, he proposed the vertebral theory of the skull; and before Savigny, he discerned that the jaws of insects were the limbs of the head.

In 1813 A. P. de Candolle published his *Théorie Élémentaire de la Botanique*, which he developed into the classic *Organographie Végétale* (1827). Although at first unacquainted with Goethe's essay, and not clearly discerning the homology of leaves and floral parts, he established his theory of symmetry, reducing all flowers to "symmetrical" groupings of appendages on an axis and accounting for their various forms by cohesion and adhesion, by arrested or excessive development. The next great advance was the investigation by Schimper and Braun of *phyllotaxis*—the ascending spiral arrangement of foliar and floral organs—thus further demonstrating their essential unity.

The term *morphology* was first introduced by Goethe in 1817, in a subsequent essay (*Zur Naturwissenschaft überhaupt, besonders zur Morphologie*). It did not come into use in botany until its popularization by Auguste de St-Hilaire in his admirable *Morphologie Végétale* (1841), and in zoology until later, although De Blainville, who also first employed the term *type*, had treated the external forms of animals under "morphologie." Though the Naturphilosophie of Schelling and its countless modifications by his followers, its mystic theories of "polarization" and the like, its apparatus of assumption and abstraction, hypothesis and metaphor, cannot here be discussed, its undoubted services must not be forgotten, since it not only stimulated innumerable reflective minds to the earnest study of natural science, but, by its incessant proclamation of the unity of nature and the free use of Platonic archetypes, gave a most powerful impulse to the study of comparative anatomy, and nobly vindicated the claims of philosophic synthesis over those of merely analytic empiricism. Among its many adherents, some are of more distinctly theological type, others metaphysical, others mystical or poetic, others, again, more especially scientific; but its most typical and picturesque figure is Lorenz Oken, who epitomizes alike the best and the worst features of the school, and among whose innumerable pseudo-morphological dreams there occasionally occurred suggestions of the greatest fruitfulness,—notably, for instance, the independent statement of the vertebral theory of the skull.

Although Lamarck shared in this movement, his great work (the *Philosophie Zoologique*, 1809), being ætiological rather than morphological, scarcely claims discussion here. By far the most distinguished anatomist of the transcendental school is Geoffroy St-Hilaire, who being comparatively free from the extravagances of Oken, and uniting a depth of morphological insight scarcely inferior to that of Goethe with greater knowledge of facts and far wider influence and reputation in the scientific world (which affected to sneer at the poet as necessarily a mere amateur), had enormously greater influence on the progress of science than either. He started from the same studies of anatomical detail as Cuvier, but, profoundly influenced by Buffon's view of unity of plan and by the evolutionary doctrines of Lamarck, he rapidly diverged into new lines, and again reached that idea of serial homology of which we have so frequently noted the independent origin. His greatest work, the *Philosophie Anatomique* (1818-1823), contains his principal doctrines. These are—(1) the theory of unity of organic composition, identical in spirit with that of Goethe; (2) the theory of analogues, according to which the same parts, differing only in form and in degree of development, should occur in all animals; (3) the "principe des connexions," by which similar parts occur everywhere in similar relative positions; and (4) the "principe du balancement des organes," upon which he founded the study of teratology, and according to which the high development of one organ is allied to diminution of another. The advance in morphological theory is here obvious; unfortunately, however, in eager pursuit of often deceptive homologies, he wandered into the transcendentalism of the Naturphilosophie, and seems utterly to have failed to appreciate either the type theory of Cuvier or the discoveries of Von Baer. He earnestly defended Buffon's and Bonnet's earlier view of unity of plan in nature; and the controversy reached its climax in 1830, when he maintained the unity of structure in Cephalopods and Vertebrates against Cuvier before the Academy of Sciences. On the point of fact he was of course utterly defeated; the type theory was thenceforward fully accepted and the Naturphilosophie received its deathblow, while a "second empiric period" of exact anatomical and embryological research seemed for ever to replace it. Such was the popular view; only a few, like the aged Goethe, whose last literary effort was a masterly critique of the controversy, discerned that the very reverse interpretation was the deeper and essential one, that a veritable "scientific revolution" was in progress, and that the supremacy of homological and synthetic over descriptive and analytic studies was thenceforward assured. The irreconcilable feud between the two leaders really involved a reconciliation for their followers; theories of homological anatomy had thenceforward to be strictly subjected to anatomical and embryological verification, while anatomy and embryology acquired a homological aim. This union of the solid matter and rigorous method of Cuvier with the generalizing spirit and philosophic aims of Geoffroy is well illustrated in the works of Owen; and, in short, the so-called Cuvierian school is in reality thenceforward also Geoffroyan.

The further evolution of the idea of homology is sketched below (§ 7), while the extent and rapidity of the subsequent progress of the knowledge of all the structural aspects of plants and animals alike make an historical survey impossible up to the appearance of the *Origin of Species* (1859); however, no further *qualitative* advance was possible, since, as Sachs has best pointed out, morphology necessarily contains, under the Linnæan dogma of the constancy of species, the same two inconsistent and irreconcilable lines of thought which we saw represented by Cæsalpinus and the early German botanists respectively,—on one side the want of strictly scientific classification, and on the other the vaguely-felt existence of a natural relationship. Strict classification of forms supposed constant excludes in fact any *natural* relationship. The type theory, the theory of unity of organic composition, and the like, are susceptible indeed of two explanations—they may be regarded as either expressing a creative plan, or taken as purely Platonic and archetypal ideas. Both are tenable on theological and metaphysical grounds respectively, but the fact must not be disguised that of this unity of type no explanation in the least degree scientific, *i.e.*, in terms of the phenomena of the natural world, does or can exist. The needful solution was effected by Darwin. The "urpflanze" of Goethe, the types of Cuvier, and the like, at once became intelligible as schematic representations of ancestral organisms, which, in various and varying environments, have undergone differentiation into the vast multitude of existing forms. All the enigmas of structure become resolved; "representative" and "aberrant," "progressive" and "degraded," "synthetic" and "isolated," "persistent" and "prophetic" types no longer baffle comprehension; conformity to type represented by differentiated or rudimentary organs in one organism is no longer contradicted by their entire disappearance in its near allies, while systematist and morphologist become related simply as specialist and generalizer, all through this escape from the Linnæan dogma of the fixity of species. The phenomena of individual development receive interpretation in terms of ancestral history; and embryology thus becomes divided into ontogeny and phylogeny, the latter, too, coming into intimate relation with palæontology, while classification seeks henceforth the reconstruction of the genealogical tree. All these results were clearly developed in the most important work of the new period, Haeckel's *Generelle Morphologie* (1866), while the valuable contemporaneous *Principles of Biology* of Herbert Spencer also gave special attention to the relation of morphology to physiology.[1]

§ 2. *Results.*—Though the preceding is but a meagre outline of the rise and progress of the science, no corresponding sketch of its results can be here attempted. A description of the refined applications of the doctrine of floral metamorphosis, an inquiry into the morphology of the Cryptogams, or an account of such beautiful homologies as those presented by the Arthropods or the Echinoderms is alike impossible; least of all can we consider the splendid simplification of the supremely complex problem of vertebrate structure by the elaboration of a new theory of the skull, and by such luminous discoveries as those of the segmental organs, or of the origin and homologies of the spinal and cranial nerves. For these organological conceptions the reader must study such articles as those on AMPHIBIA, BIRDS, HYDROZOA, MOLLUSCA, &c., and such works as those of Huxley, Gegenbaur and Haeckel, Balfour and Parker, Payer, Eichler, or Asa Gray, and (provided with the needful bibliographical equipment afforded by the various "*Jahresberichte*" and the kindred English publications) must indeed also plunge into the current literature of the science. And there too must be sought the innumerable attempts at taxonomic synthesis which such organological progress is constantly originating (see ANIMAL KINGDOM, BIOLOGY, vol. iii. p. 690 *sq.*, and VEGETABLE KINGDOM). Embryological generalizations, such as Haeckel's "gastræa theory," Lankester's rival "planula theory," or the ingenious "cœlome theory" of Hertwig, have been recently thoroughly criticized in Balfour's *Embryology*. The present article will be confined to a brief discussion of a few main problems, commencing with the cell theory and the problem of organic individuality—these being selected partly because of their special illustrativeness and intrinsic importance, partly because they have somewhat less recently been summarized.

§ 3. *Histology—Cell Theory.*—Although the application of the simple microscope to the minute structure of plants and animals had been in progress since the end of the 17th century, the rise of modern histology really dates from the *Anatomie Générale* (1801) of Bichat, which analyses the organism into a series of simple tissues with definite structural characters. This new impulse, together with the improvement of optical appliances, led to much further research. "Fibres" and "globules," "laminæ" and "nuclei," were described, and even "cells" by Mirbel in 1806, and in 1835 Johannes Müller pointed out the existence of cells resembling those of plants in the vertebrate notochord. The cellular and nucleated structure of epidermis and other tissues was soon demonstrated, while Robert Brown discovered the nucleus of the vegetable cell. In 1838 Schleiden referred all vegetable tissues to the cellular type, and traced back the plant embryo to a single nucleated cell, while in 1839 Schwann boldly extended this conception of plant structure and development to the animal world, and so fully constituted the "cell theory."

Schwann's cells were essentially nucleated vesicles with fluid contents which originated in an intracellular substance; but this view was soon abandoned. Dujardin had discovered that the bodies of Foraminifera were composed of a viscous granular contractile *sarcode*, and Von Mohl described independently in similar terms the contents of the vegetable cell as *protoplasm*. This was identified by Max Schultze as Dujardin's sarcode, the newer name surviving; and this living matter, and not the membrane, he showed to be the essential constituent of the cell, since which his amended definition of the cell as a unit-mass of nucleated protoplasm has been generally accepted. Prevost and Dumas had noticed the segmentation of the ovum into masses as early as 1824, and these were naturally identified as cells immediately after the publication of Schwann's work. In 1846 Kölliker showed that all tissues arise from these segmentation masses, and that the multiplication of animal and vegetable cells takes place by a continuation of the same process,—that of transverse division already observed in the Protozoa.

These points gained, the attention of histologists was withdrawn for a considerable time from the scrutiny of the minute structure of the cell itself to be concentrated on the modes of origin of these unit-masses, and their subsequent differentiation and aggregation into tissues and organs. The minute structure and histogenesis of plants, as well as of at least the higher animals, have been studied with much and ever-increasing accuracy of detail. (See ANATOMY, HISTOLOGY, EMBRYOLOGY.) Both vegetable and animal tissues have been simply classified both according to their adult forms and according to the embryonic layers from which they respectively arise. This scrutiny of plant and animal structure over and above the special generalizations of the botanist and the zoologist has afforded much result to general histology. The improvement of technical methods has of late years largely aided the progress of discovery. A return from the study of the cell-aggregate to that of the cell has commenced, and the question of cell-structure may be said to be again paramount in histology. The process of transverse division has of late been much elucidated, and, although its complex details cannot here be entered upon, the result has been to establish a minute and thorough correspondence in cases so widely dissimilar as pollen-grains from a flower-bud, the epidermis of a tadpole, or the cells of a tumour—a result which obviously enhances the morphological completeness of the cell theory. Minor modes of cell-multiplication also are not without their morphological interest. Gemmation, familiar in the yeast plant, occurs in other low and simple organisms, and may probably be identified with the formation of polar vesicles in ova as a modification of transverse division. Schleiden had supposed all new cells to originate within pre-existing cells, and this process, known as free-cell-formation, may really be observed in various plant and animal tissues. The protoplasm groups itself round new nuclei, the new cells being in fact formed much as Schwann had in his turn supposed; but these nuclei have repeatedly been shown to arise from segmentation of the original nucleus, and thus this process too seems a mere modification of the general one of transverse division. Conjugation, too—that coalescence of two similar cells which may be observed in many Algæ, Fungi, and Protozoa—is to be considered as the undifferentiated form of that fertilization which occurs in higher animals and plants, the two apparently similar masses having become respectively differentiated into ovum and spermatozoon, or into egg-cell and antherozoid. An indefinite number of amœboid cells sometimes flow together into a single mass,—a phenomenon regarded by some as multiple-conjugation, or perhaps more probably as an almost mechanical coalescence of exhausted cells, from which conjugation proper and finally fertilization may indeed have originated. The amœboid cells of higher animals similarly unite when drawn, and this formation of *plasmodia*, as these are termed, seems to be a deep-seated property of the amœboid cell. Similarly, too, the process of rejuvenescence which occurs in many of the lowest plants and animals, such as Protococcus and Amœba, where the protoplasm passes from a resting and encysted to a naked and mobile stage, has many analogues not only among the Protista but even in the tissues of higher animals, while the phases which the lowest organisms more or less exhibit—the encysted, the ciliated, the amœboid, and the plasmodial—may be regarded as the fundamental forms of a "life-cycle," fully represented indeed only in such extremely low organisms as Protomyxa and Myxomycetes, yet nowhere completely suppressed. The very highest plants and animals may thus be considered as aggregates of more or less differentiated and variously arranged encysted, amœboid, and ciliated cells, while their development and subsequent changes, their variations normal and pathological, in reality exhibit phases more or less distinct of the ancestral life-cycle.

The examination of the precise modes of cell-division, particularly in the hands of botanists (see BIOLOGY, and summary in Sachs's *Vorlesungen über Pflanzen Physiologie*, 1883), are also constantly throwing the most interesting light upon the structure of the adult organism. Thus then, in our own day as in those of Bichat or Schwann, the labours of the histologist, when inspired by higher aims than that of the mere multiplication of descriptive detail, are of supreme morphological importance, and result in the demonstration of a unity of organic structure deeper even than any which we owe to Linnæus or Cuvier, Goethe or Geoffroy.

§ 4. *Individuality.*—Probably no subject in the whole range of biology has been more extensively discussed than that of the nature of organic individuality. The history of the controversy is of interest, since besides leading up to solid results it serves, perhaps better than any other case, to illustrate the slow emergence of the natural sciences from the influence of scholastic thought. Starting from the obvious unity and indivisibleness of Man and other higher animals, and adopting some definition such as that of Mirbel (exceptionally unmetaphysical, however), "Tout être organisé, complet dans ses parties, distinct et séparé des autres êtres, est un individu," it was attempted times without number to discover the same conception elsewhere in nature, or rather to impose it upon all other beings, plants and animals alike. The results of different inquirers were of course utterly discrepant. It seemed easy and natural to identify a tree or herb corresponding to the individual animal, yet difficulties at once arose. Many apparently distinct plants may arise from a common root, or a single plant may be decomposed into branches, twigs, shoots, buds, or even leaves, all often capable of separate existence. These, again, are decomposable into tissues and cells, the cells into nucleus, &c., and ultimately into protoplasmic molecules, these finally into atoms,—the inquiry thus passing outside organic nature altogether and meeting the old dispute as to the ultimate divisibility of matter. In short, as Haeckel remarks, scarcely any part of the plant can be named which has not been taken by some one for the individual. It is necessary, therefore, briefly to notice some of the principal works on the subject, and these may conveniently be taken in descending order.

While Cassini practically agreed with Mirbel in attempting to regard separate plants as individuals, the widest interpretation of the individual is that of Gallesio (1816), who proposed to regard as an individual the entire product of a single seed, alike whether this developed into a uni-axial plant extended continuously like a Banyan, or multiplied asexually by natural or artificial means like the Weeping-willow or the Canadian Pondweed, of each of which, on this view, there is only a single individual in Britain, happily discontinuous.

At once the oldest and most frequently maintained view is that which regards the bud or shoot consisting of a single axis with appendages as the plant-individual, of which the tree represents a colony, like a branched hydroid Polyp. This conception, often attributed to Aristotle, but apparently without foundation, appears distinctly in the writings of Hippocrates and Theophrastus,—the latter saying, "The bud grows on the tree like a plant in the ground." The aphorism of Linnæus, "Gemmæ totidem herbæ," is well known; and in this view C. F. Wolff and Humboldt concurred, while Erasmus Darwin supported it by an appeal to the facts of anatomy and development. The most influential advocate of the bud theory during the first half of the present century was, however, Du Petit-Thouars, who, although starting much as usual with a "principe unique d'existence," supported his theory on extensive though largely incorrect observations on stem structure and growth. For him the tree is a colony of *phytons*, each being a bud with its axillant leaf and fraction of the stem and root. Passing over numerous minor authors, we come to the central work of Alex. Braun (1853), in which, as Sachs has clearly pointed out, the illegitimate combination of Naturphilosophie with inductive morphology reaches its extreme. He reviews, however, all preceding theories, admits the difficulty of fixing upon any as final, since the plant, physiologically considered, is rather a *dividuum* than an *individuum*, and proposes as a compromise, or indeed as a partial cutting of the knot, the adoption of the shoot as the morphological individual, comparable to an animal, especially because, unlike the cell, leaf, &c., it includes all the representative characters of the species. Darwin and Spencer on the whole also accept the bud or shoot as at any rate the most definite individual.

The theory of metamorphosis naturally led Goethe, Oken, and others to regard the leaf as the individual, while Johannes Müller, Steenstrup, and others adopted the same view on various physiological grounds. Gaudichaud elaborated a theory intermediate between this view and that of Du Petit-Thouars, according to which the plant was built up of individuals, each consisting of a leaf with its subjacent internode of stem, which was regarded as the leaf-base, and this was supported by Edward Forbes and others, while the nominally converse view—that of the leaf as a mere outward expansion of the stem-segment—was proposed by Hochstetter.

Though sundry attempts at identifying various tissues, such as the fibro-vascular bundles, as the constituent individuals may be passed over, those associated with the cell theory are of great importance. Schwann decided in favour of the cell and regarded the plant as a cell-community, in which the separate elements were like the bees of a swarm,—a view virtually concurred in in all essential respects by Schleiden, Virchow, and other founders of the cell theory. Yet, although the structure and functions of the plant are ultimately and exclusively cellular, it is impossible to ignore the fact that, save in the very lowest organisms, these are subordinated and differentiated into larger aggregates, and form virtually but the bricks of a building, and hence the later theories outlined above. Of attempts to find the individual in the nucleus or the protoplasm granules it is of course unnecessary to speak further.

So far the theories of absolute individuality. The conception of relative individuality is well traced by Fisch upwards from the more or less vague suggestions in the writings of Goethe, Roeper, and the elder De Candolle to its clear expression in Alphonse de Candolle and Schleiden, both of whom take the cell, the shoot, and the multi-axial plant as forming three successive and subordinated categories. Nägeli too recognized not only the necessity of establishing such a series (cell, organ, bud, leafy axis, multi-axial plant) but the distinction between morphological and physiological individualities afterwards enunciated by Haeckel.

Passing over the difficulties which arise even among the Protozoa (see FORAMINIFERA), we find that a similar controversy (fully chronicled in Haeckel's *Kalkschwämme*) has raged over the individuality of Sponges. While the older observers were content to regard each sponge-mass as an individual, a view in which Lieberkuhn

[1] For bibliography see Carus, *Geschichte der Zoologie*; Sachs, *Geschichte d. Botanik*; Cuvier, *Hist. d. Sci.*; Is. G. St-Hilaire, *Hist. Nat. Gén.*; Masters in *Méd.-Chir. Rev.*, 1858, &c.; also articles GOETHE, LINNÆUS, OKEN, &c.