tary canal and air passages and of the cellular parts of the internal glands.

These researches of Remak appear in some measure to reconcile the views of Von Baer with those of other embryologists, as to the constitution of the blastoderm and the relation of its several layers to the fundamental systems and organs of the embryo. Recent observation, though modifying them in some respects, has not led to any important invalidation of their general results; and we may therefore in the meantime regard them as forming the principal basis or starting-point of modern embryological inquiries, although much still remains to be ascertained as to the source of the mesoblast and its relation to the two primitive layers of the blastoderm. More especially important in a comparative embryological view is the formation of the *cœlom* or somato-visceral cavity, as connected with the gradual appearance in the animal series of the lymphatic and blood vascular cavities.

But while the researches of Remak and others had thus in the commencement of the sixth decade of our century brought the history of the general phenomena of development or embryogeny into a consistent and systematic form, especially as known in the higher vertebrates, much still remained to be done in the more minute investigation of the origin of the ovum and its germ, and the intimate nature of the process of fecundation, as well as in regard to the histological and morphological changes in which the organogenic processes consist. The progress of discovery in these departments has been greatly promoted by the very great improvements which have been introduced into the methods of investigation, the successful prosecution of which has had an equally favourable influence on the whole range of minute anatomy and histology, viz.—(1), the hardening, clearing, and tinting processes of preparation; (2), the method of fine section of the parts to be observed; and (3), the permanent preservation of specimens in the moist or dried state.

The first of these methods may be said to have had its origin in the introduction of the use of chromic acid as a hardening agent by Hannover of Copenhagen in 1840; and the works on practical histology since published bear ample testimony to the prodigious advance in refinement in the adaptation of this and other methods of hardening and distinctive coloration of the tissues, which have in recent times rendered the minuter investigation of the tissues comparatively elegant and exact, and indeed now almost exhaustive.

The second method, or that of sections, as applied to embryological research, obviously suggested by the diagrams of Pander and Von Baer, seems first to have been practically applied by Allen Thomson in 1831, though without the assistance of finer modern appliances, in the ascertainment of the earliest double condition of the aorta in the bird's embryo. It was soon carried to a much greater extent by Reichert, and later by Remak, and it is now universally pursued as a principal means of embryological investigation. To show the extent to which the successful combination of the above-mentioned methods is now carried by the use of the most approved chemical reagents and the best sectional instruments, it may be stated that as many as several hundreds of perfectly clear sections may be made through the body of an embryo of only half an inch in length, and that similarly thin sections may be made in any desired direction through the smallest as well as larger ova, and that, notwithstanding the extreme delicacy of some of the parts and the inequality of their density, every one of the sections may be made to present a distinct and true view both of the microscopic histological characters and of the larger morphological relations of the parts observed.

Accordingly, during the time which has elapsed since the publication of Remak's work, the number of contributions to different parts of our subject, by the history of original observations made mainly by the way of sections, has been immense, and it goes on increasing to the present time. Among the more important of these, as influencing the general progress of embryological science, the following may be mentioned.

First, in connection with the development of Fishes, the researches of Lereboullet "On the Pike and the Perch" (*Annal. des Sciences Nat.*, 1862,); those of Joseph Oellacher "On the Trout" (*Zeitsch. für Wissensch. Zool.*, 1872); those of His also "On Osseous Fishes," appearing in 1875, and the important and elaborate researches of F. M. Balfour "On the Elasmobranch Fishes," in 1874 and following years (*Journ. of Anat. and Physiol.* and *Quart. Journal of Microscopic Anatomy*); the prize memoir of Max Schulze *On the Development of the River Lamprey*, Haarlem, 1856; and the researches of Kowalewsky "On the Development of the Amphioxus" (in the *Mem. of the St Petersburg Acad.*, tom xi., 1867), are deserving of notice.

Second, in regard to Amphibia, after the memoirs of Rusconi, Reichert, Remak, and C. Vogt of earlier date, the most important recent contributions are those of V. Bambecke "On the development of Pelobates fuscus" (*Mém. de l'Acad. de. Belgique*, vol xxxiv., 1868), and the very beautiful work of C. Götte *On the Development of the Toad, Bombinator igneus* (Leipsic, 1874, folio).

Third, in regard to Reptilia, not much has been done since Rathke's work *On the Development of the Turtle* was published in 1848. But there may be mentioned as valuable contributions to this department, the *Account of the Development of the Crocodile*, by Rathke himself in 1866, and the "Embryology of the Turtle," by H. J. Clark, in Agassiz's *Contributions to the Natural History of the United States* (vol. ii. 1857).

Fourth, in the class of Birds, the most notable work which has appeared in recent times on the earlier phenomena of their development is that of His, entitled *Researches on the First Foundation of the Body in Vertebrate Animals* (Leipsic, 1868), in which a careful revision of the subject is undertaken from original observations, and a clearer distinction established between the axial or central and the lateral parts of the blastoderm. Under this head come also the researches of Dursy upon the primitive trace of the chick (Lahr, 1866), F. M. Balfour's paper on the same subject (1873), and the important observations of Peremeschko on the formation of the layers of the blastoderm, especially the middle one (*Vienna Acad.*, 1868), Affanasieff on the first circulation in the fowl's embryo (in 1866), E. Klein on the development of blood vessels and blood corpuscles from the middle layer (1868), along with which may also be quoted the observations of Waldeyer, Oellacher, Stricker, Götte, Balfour, and Kölliker, as tending to throw light on the origin of the blastodermic layers.

Fifth, in regard to Mammalia, the most recent observations after those of Bischoff on the process of development in this class, are those of Hensen, in *Zeitsch. für Anat. und Entwickelungsgesch.*, vol. i., 1875–6; the observations of Kölliker in the new edition of his systematic work, 1876; those of Reichert, in his *Account of the Development of the Guinea-pig*, Berlin, 1862, and his *Description of an Early Human Product*, &c., Berlin, 1873; also in the papers of E. A. Schäfer, from *Physiol. Laborat. Univ. Coll. London*, and *Proceedings Roy. Soc.*, 1876.

On the structure and morphology of the ovum may be quoted the article "Ovum" in the *Cyclopædia of Anatomy and Physiology*, by Allen Thomson (1852–56); the contributions of Gegenbaur, 1861 and 1864, and of Cramer, 1868; and the very able "Mémoire Couronné" of Edward van Beneden, *Recherches sur la composition et la signification de l'Oeuf*, Brussels, 1870.

With respect to the process of segmentation of the ovum and earliest steps in the formation of the germ, the most interesting researches have recently been communicated by Auerbach, Butschli, Strasburger, Edw. van Beneden, Oscar Hertwig, and others, which are still in progress, and will be referred to in the article GENERATION.

Several systematic works or text-books on embryology have appeared since it assumed the form and dimensions of a special branch of science. The first of these, by Valentin, referring to the development of man, mammals, and birds, was published in 1835. The next was that of Bischoff, published in 1842, as one of the volumes of the encyclopædic system of anatomy named after Soemmering. The third work of this kind was that of Kölliker, in the form of lectures, published in 1861, and giving a very full account of the development of the ovum and embryo in man and the higher animals. Of this work a second edition is now in progress, the first part having appeared in 1876. To this excellent work, as the production of one who has contributed a very large amount of original observations on embryology and the whole range of minute anatomy, the reader may be referred for the fullest and most accurate systematic information on the subject. In comparative embryology we have the interesting short treatise of Rathke, edited after his death by Kölliker in 1861, and the *Lehrbuch der Vergleichende Embryologie* by S. L. Schenk, Vienna, 1874. We may also refer here to the excellent plates illustrating embryology in the *Icones physiologicæ* of A. Ecker, 1854.

In this country, since the appearance of the very careful translation of Müller's *Physiology* by Baly, which had the advantage of revision in many of its parts by Sharpey, and the translation of Wagner's *Physiology* in 1846, there has appeared only one systematic work on embryology, viz., the *Elements of Embryology* by M. Foster and F. M. Balfour, of which the first part, which appeared in 1874, treating of the development of the embryo of birds, deserves the highest praise. A short view of human embryology is given by Allen Thomson in the 8th edition of Quain's *Anatomy*, 1876.

For an account of the relation of embryology to the classification of animals and to phylogeny or the theory of descent, the English reader is referred to various parts of the writings of Darwin and Huxley, and to the excellent translation of Haeckel's work on the *History of Creation*, 2 vols., London, 1874; to F. M. Balfour's "Comparison of the Early Stages in the Development of Vertebrates" in *Journ. of Microscopical Science*, vol. xv., 1875, and to the recently published *Notes on Embryology and Classification*, by E. Ray Lankester, 1877.

In the preceding sketch of the history of the foundation and progress of the science of embryology, no attempt has been made to trace that part of it which includes the development of different invertebrate animals, as it was felt that from the extremely numerous, varied, scattered, and fragmentary nature of many of the contributions of authors in this part of our subject, any attempt at the citation even of the more important would be quite unsuitable to this work.

It will be enough for us here to state that the first considerable original work on the development of a division of the invertebrates was that of Maurice Herold of Marburg on spiders, "De generatione Aranearum ex ovo," published at Marburg in 1824, in which the whole phenomena of the formative process in that animal are described with remarkable clearness and completeness.

A few years later an important series of contributions to the history of the development of invertebrate animals appeared in the second volume of Burdach's work on *Physiology*, of which the first edition was published in 1828, and in this the history of the development of the Entozoa was the production of Ch. Theod. Von Siebold, and that of most of the other invertebrates, was compiled by Rathke from the results of his own observations and those of others. These memoirs, together with others subsequently published by Rathke, entitle him to be regarded as the founder of invertebrate embryology.

It would be quite unsuitable in this article to attempt to pursue further the history of research in the embryology of invertebrate animals, as may well be seen from the following enumeration in an alphabetical order of the names of some of the more prominent original observers, to whom has been mainly due the great progress in this part of our science, viz., Agassiz, Allman, Balbiani, Edward van Beneden, P. J. van Beneden, Victor Carus, Claparéde, Cohn, Dalyell, Darwin, Dujardin, Ecker, Eschricht, Gegenbaur, Haeckel, Huxley, Kölliker, Kowalewsky, Krohn, Lacaze Duthiers, Lereboullet, Leuckart, Leydig, Lovén, Lubbock, Metschnikoff, Milne-Edwards, H. Müller, Johannes Müller, Nordmann, Prévost, Quatrefages, Salensky, Sars, Max Schultze, Semper, Steenstrup, Stein, C. Vogt, R. Wagner, Strethill Wright. But this list includes only a small part of the observers whose contributions to the knowledge of this wide field of research would require to be noticed in any account of its literature.

The most general results which are deducible from the numerous observations which are now being accumulated in this department of embryology may be briefly stated as follows.

In the Protozoa there is no true sexual generation, although in some the phenomena of conjugation form an approach to that mode of reproduction. The greater number usually multiply either by fission or by gemmation; but in some, and probably in all, reproduction also appears to take place from extremely minute particles separated from the parent animals, which can scarcely be called ova, but which, for want of a better term, we may designate germinal particles.

In all animals above the Protozoa, including the sponges, male and female reproductive elements are to be distinguished, that of the female taking the form of an ovum, in which the germinal part has the protoplasmic structure of a true organized cell.

Fecundation of the ovum takes place, as in all vertebrates, by the direct access of the substance of the male element to the germinal part of the ovum.

The first steps in the development of a fecundated ovum are in all instances among the invertebrates, just as in the vertebrates, those of cellular multiplication by fission or cleavage of the protoplasmic germ of the ovum, which results in the formation of a more or less laminar blastoderm.

This blastoderm presents at first two layers of cells, ectoderm and endoderm, in all animals above the Protozoa, and in the lowest of the Cœlenterata only two; but in all the higher animals there appears an additional intermediate layer or layers, constituting the mesoderm.

From these layers the rudiments of the several systems and organs of the body are developed by processes of cellular multiplication and differentiation according to certain histological and morphological laws essentially analogous to those which have been in part previously referred to in this article, and which will be more fully described in that on GENERATION.

Having now traced the principal steps by which, upon the basis of extended morphological and histological observations during a century, extending from Wolff to Darwin, the science of embryology has been securely founded, enough has been adduced to show the important place which this science must occupy in relation to other departments of biology. It will be seen that histology owes to embryological observations the greatest amount of its recent extraordinary progress. It is also apparent that many of the most important facts in physiology, especially as related to growth and nutrition, can only be understood from a full and minute acquaintance with the various changes of differentiation observed in the development of organic structure. It is equally obvious that the nature of certain kinds of congenital malformation receive their rational explanation in the knowledge of the natural organogenetic process of development, from which they are no more than deviations in different modes and degrees. Nor can it be doubted that the arrangement of animals under an approved zoological system, in which the various affinities and gradations of their organization are fully recognized, can only be undertaken upon the basis of a complete knowledge of the metamorphoses of the young of animals and the relation of the embryonic to the adult forms of the species. Lastly, the general views which we may attempt to form of the process by which in the long lapse of time since the creation the various kinds of animals, including man, may be supposed to have originated must be founded on the correlation of the ascertained facts of embryology, as observed in every animal species, with the fuller knowledge of the different forms and gradations of all existing animals, and with the more complete observation of the different forms of organization, the evidence of whose existence at successive periods of the earth's history is to be found in their fossil remains which are inclosed in the various strata composing its superficial crust. (A. T.)

EMDEN, formerly EMBDEN, a maritime town of Prussia, in the district of Aurich, province of Hanover, is situated near the mouth of the Ems, on the Westphalian railway,

45 miles W.N.W. of Oldenburg. The town is much intersected by canals, and more than thirty bridges are required to connect its different parts. It has a considerable maritime trade, chiefly in corn, butter, cheese, and wood. Its industries are ship-building, tanning, and the manufacture of paper, cement, and tobacco. Amongst its public buildings may be named the town-house, the orphanage, the poorhouse, the museum, the great Reformed church, the gymnasium, and the deaf and dumb institute. Emden belonged originally to East Friesland. From 1595 it was a free town under the protection of Holland until 1744, when, along with East Friesland, it was transferred to Prussia, after which it came into the possession of Holland in 1806, of France in 1809, of Prussia in 1814, and of Hanover in 1815; and finally in 1866 it was, along with Hanover, incorporated with Prussia. The population of Emden in 1875 was 12,874.

EMERALD (Greek, *σμάραγδος*), a precious stone classed mineralogically with the beryl (see vol. iii. p. 613), from which, however, it differs in having a fine green colour, attributed to the presence in it of chromium sesquioxide: it also never presents the internal striæ often seen in the beryl. The chemical composition of the emerald may be represented by the formula $6SiO_2,Al_2O_3,3GlO$. It occurs in six-sided prismatic crystals of the hexagonal system, the edges of which not unfrequently show various modifications. The emerald is transparent or translucent, and has a vitreous, rarely resinous lustre, an uneven and conchoidal fracture, a hardness of 7·5–8, and a specific gravity of 2·670 to 2·732. It is brittle and comparatively soft when fresh from the mine, but hardens on exposure to the air. The specific gravity of crystallized emeralds after fusion was found by Greville Williams to be 2·4, 9 per cent. of the original weight having been lost. The emerald is unaffected by acids, but with borax gives before the blowpipe a transparent greenish glass. On friction it becomes electric. Wöhler, Rose, Hofmeister, and Greville Williams have shown that the emerald may be heated to a very high temperature without destruction of its colour, which cannot therefore, as supposed by Lewy, be due to the organic impurities discovered in the stone. Cleavage of the emerald at right angles to the axis of the crystals may be effected without much difficulty, and in the East, previous to about the middle of the 15th century, the stone was generally worn in slices so obtained. The finest emeralds are procured from Muzo, in Colombia (see vol. vi. p. 154). The fossiliferous character of the limestone in which they occur at Muzo, and the presence in them of from 1·65 to 2·15 per cent. of water, led Mr Lewy to the conclusion that they must have been crystallized out of aqueous solution. Other localities are Henbachthal in Salzburg, Odontchelong in Siberia, and Canjargum in India. The emeralds of Colombia, according to Boussingault, are divided into several classes, the principal of which are the *canutillos* or the crystallized and more valuable stones, and the *morallons* or amorphous stones, poor in colour, and of little value. The Hebrew word *nophech*, rendered "emerald" in the English version of the Scriptures, appears to have been the carbuncle. The emerald was highly valued by the ancients (see Pliny, *Nat. Hist.*, xxxvii. 5). Various virtues were formerly ascribed to the gem: it was said to be good for the eyes, to colour water green, to assist women in childbirth, and to drive away evil spirits; and in the East it is still accredited with talismanic and medicinal properties. One of the most celebrated examples of the emerald is that in the possession of the duke of Devonshire, measuring upwards of 2 inches in length, and across its three diameters 2¼, 2⅛, and 1⅞ inches. Other fine stones are the Hope emerald, weighing 6 oz, and those of the Russian, Saxon, and Papal crowns. Emeralds are cut on a copper wheel with emery, and polished on a tin wheel with rotten-stone. "In a good gem," says Mr Emanuel, "the surface must be perfectly straight and smooth, so as to cast no darkening shadow on any of its particles." The form usually given to emeralds is that of a square table with the edges replaced, the lower surface being cut into facets parallel to their sides. When fine they are always set without a foil; and, as their brilliancy is somewhat impaired by candle-light, they are generally surrounded with small diamonds or pearls, which enhance their effect. The gem has been very successfully imitated by manufacturers of paste stones, the colouring matter used being oxide of chromium. As a gem the emerald is reckoned inferior only to the diamond and ruby, but, unlike them, it does not increase in value in proportion to the cube of its weight. What is termed the Oriental emerald is a green variety of corundum, an exceedingly scarce gem.

See H. Emanuel, *Diamonds and Precious Stones*, 1865; Greville Williams, "Researches on Emeralds and Beryls," *Proc. Roy. Soc.* xxi. 1872–3, p. 409.

ÉMERIC-DAVID, Toussaint-Bernard (1755–1839), a French archæologist and writer on art, was born at Aix, in Provence, 20th August 1755. He was destined for the legal profession, and having gone in 1775 to Paris to complete his legal education, he acquired there a taste for art which influenced his whole future career. After being made advocate, he went to Italy, where he continued his art studies. He soon returned, however, to his native village, and followed for some time the profession of an advocate; but on the death of his uncle Antoine David in 1787 he succeeded to his printing business. He was elected mayor of Aix in 1791; and although he speedily resigned his office, he was in 1793 threatened with arrest, and had for some time to adopt a vagrant life. When danger was past he returned to Aix, sold his printing business, and engaged in general commercial pursuits; but he was not long in renouncing these also, in order to devote himself exclusively to literature and art. From 1809 to 1815 he represented his department in the legislative chamber, and in 1816 he was elected a member of the Institute. He died at Paris, 2d April 1839.

Émeric-David was placed in 1825 on the commission appointed to continue *L'Histoire littéraire de la France*. His principal works are *Recherches sur l'art statuaire, considéré chez les anciens et les modernes*, Paris, 1805, a work which obtained the prize of the Institute; *Suite d'études calquées et dessinées d'après cinq tableaux de Raphael*, Paris, 1818–21, in 6 vols. fol.; *Jupiter, ou recherches sur ce dieu, sur son culte*, &c., Paris, 1833, 2 vols. 8vo, illustrated; and *Vulcain*, Paris, 1837.

EMERSON, William (1701–1782), an eminent but eccentric mathematician, was born May 14, 1701, at Hurworth, near Darlington, where his father, Dudley Emerson, also a mathematician of high attainments, taught a school. From him young Emerson received a thorough mathematical education, and the bequest of a good mathematical library. For his classical training he was indebted to the curate of Hurworth, who lodged in his father's house. In the earlier part of his life he followed his father's profession, but with little success; and this, coupled with the fact of his having received as an only child a moderate competence from his parents, led him to devote himself entirely to studious retirement. Towards the close of 1781 he relinquished his studies and disposed of his library. His death took place soon after, May 20, 1782, at his native village, in the eighty-first year of his age. Emerson in dress, manners, and appearance was eccentric and indeed clownish, but he possessed remarkable independence of character, and intellectual energy of a very high order. The boldness with which he expressed his opinions on religious subjects led to his being charged with scepticism, but for this there was no foundation. He invariably shut himself up in London during the publication of his works, and carefully revised them sheet by sheet himself, so that they are singularly free from errata. In mechanics, he never advanced a proposition which he had not previously tested in practice, nor published an invention without first proving its effects by a model. Emerson was married, but had no family. His wife employed her leisure in spinning on a curious wheel, of which an accurate drawing is given in his *Mechanics*. His own favourite recreation was fishing. He was skilled in the science of music, the theory of sounds, and the ancient and modern scales; but he never attained any excellence as a performer.

The following is a list of Emerson's works:—*The Doctrine of Fluxions*, 1748, 8vo; *The Projection of the Sphere, orthographic, stereographic, and gnomical*, 1749, 8vo; *The Elements of Trigonometry*, 1749, 8vo; *The Principles of Mechanics*, 1754, 8vo; *A Treatise of Navigation*, 1755, 12mo; *A Treatise of Algebra*, in two books, 1765, 8vo; *The Arithmetic of Infinites, and the Differential Method, illustrated by Examples*, 1767, 8vo; *Mechanics, or the Doctrine of Motion*, 1769, 8vo; *The Elements of Optics, in four books*, 1768, 8vo; *A System of Astronomy*, 1769, 8vo; *The Laws of Centripetal and Centrifugal Force*, 1769, 8vo; *The Mathematical Principles of Geography*, 1770, 8vo; *Tracts*, 1770, 8vo; *Cyclometheis, or an easy Introduction to the several branches of the Mathematics*, 1770, in ten vols. 8vo; *A short Comment on Sir Isaac Newton's Principia*; to which is added, *A Defence of Sir Isaac against the objections that have been made to several parts of his works*, 1770, 8vo; *A Miscellaneous Treatise containing several Mathematical Subjects*, 1776, 8vo.

EMERY (Greek, *σμύρις*; Spanish, *esmeril*), an impure variety of the mineral corundum, bluish-grey to brownish in colour, dimly translucent, and granular and rough in fracture, and having a hardness of 9, and specific gravity varying between 3·7 and 4·3. Much of the emery of commerce is artificially coloured of a rich reddish brown. Analyses of emery show a percentage composition of from about 60 to 80 per cent. of alumina, and 8 to 33 per cent. of ferric oxide, with small quantities of lime, silica, and water. It occurs in amorphous masses in schists, gneiss, granular limestone, and other crystalline rocks, and in rolled and detached pieces and in granules in soils. The principal European source of emery is the island of Naxos, which in 1872 exported to England 1270 tons, to Hamburg 250 tons, and to Rotterdam 300 tons of the mineral. It occurs also near Smyrna, and in Sweden, Saxony, Spain, Greenland, Massachusetts, and other localities. Emery is used as a polishing material for plate-glass, crystal, lapidaries' work, and metals, and in cutting granite and marble. It is prepared for use by breaking with hammers, crushing with steel stamps, and sifting. Combined with leather by the American "tanite" process, or treated after Ransome's method for the manufacture of artificial stone (see Concrete, vol. vi., p. 243), emery powder is formed into grinding wheels, hones, and similar instruments. Emery, more especially that used for emery-paper and emery-cloth, is commonly adulterated with garnet, zircon, iron-slag, and other substances harder than quartz sand.

EMETICS, substances which are administered for the purpose of producing vomiting. They are usually regarded as of two varieties, viz., those which produce their effect in virtue of their absorption into the blood and consequent influence upon the nerve centres, and those which act topically on the mucous membrane of the stomach, giving rise to vomiting as the result of reflex action. The former class of emetics are slower in their operation and are attended with much greater depression of the system and antecedent nausea than the latter, the action of which is prompt. The use of emetics in medicine is comparatively rare, although at one time they were often resorted to in the early stages of acute diseases, such as fevers and inflammations, with the object of cutting them short. Their power, however, to accomplish this is more than questionable. Among the purposes for which emetics are employed are the following—to empty the stomach in certain cases of poisoning, such as by narcotics or where indigestible substances are giving rise to disturbance which calls for their removal, and to clear the air passages of obstructions, as in certain cases of bronchitis or croup, where the respiratory tubes become filled with morbid material which threatens death by asphyxia, and which cannot be dislodged by coughing. For both these purposes the stimulating emetics are to be preferred, such as the sulphates of zinc and copper, or, where these are not available, mustard stirred into water. Again, emetics are employed in producing, short of their emetic action, a certain degree of nausea and consequent relaxation during the early stages of acute inflammation in strong persons, and for this purpose the more depressing emetics are resorted to, such as antimony, ipecacuanha, apomorphia, &c. The latter are likewise employed in obstetric practice with the view of producing relaxation in cases of protracted labour from uterine and muscular rigidity. Emetics ought always to be administered with caution, since the act of vomiting may be attended with danger where there exists any tendency to brain disease or in cases of disease of internal organs; or further, from the vomiting continuing longer than was intended, injury may be done to the mucous membrane of the stomach as well as serious shock inflicted on the system.

EMEU, evidently from the Portuguese *Ema*,[1] a name which has in turn been applied to each of the earlier-known forms of Ratite Birds, but has in all likelihood finally settled upon that which inhabits Australia, though, until less than a century ago, it was given by most authors to the bird now commonly called Cassowary—this last word being a corrupted form of the Malayan *Suwari* (see Crawfurd, *Gramm. and Dict. Malay Language*, ii. pp. 178 and 25), apparently first printed as *Casoaris* by Bontius in 1658 (*Hist. nat. et med. Ind. Orient.* p. 71).

The Cassowaries (*Casuariidæ*) and Emeus (*Dromœidæ*)—as the latter name is now used—have much structural resemblance, and form the Order *Megistanes*,[2] which is peculiar to the Australian Region. Professor Huxley has shewn (*Proc. Zool. Soc.* 1867, pp. 422, 423) that they agree in differing from the other *Ratitæ* in many important characters, into the details of which it is now impossible to enter; but one of the most obvious of them is that each contour-feather appears to be double, its *hyporrhachis*, or aftershaft, being as long as the main shaft—a feature noticed in the case of either form so soon as examples were brought to Europe. The external distinctions of the two families are, however, equally plain. The Cassowaries, when adult, bear a horny helmet on their head, they have some part of the neck bare, generally more or less ornamented with caruncles, and the claw of the inner toe is remarkably elongated. The Emeus have no helmet, their head is feathered, their neck has no caruncles, and their inner toes bear a claw of no singular character.

The type of the *Casuariidæ* is the species named by Linnæus *Struthio casuarius* and by Latham *Casuarius emeu*. Vieillot subsequently called it *C. galeatus*, and his epithet

[1] By Moraes (1796) and Sousa (1830) the word is said to be from the Arabic *Na'ámas* or *Na'ma*, an Ostrich (*Struthio camelus*); but no additional evidence in support of the assertion is given by Dozy in 1869 (*Glossaire des mots espagnols et portugais dérivés de l'arabe*. Ed. 2, p. 260). According to Gesner in 1555 (lib. iii. p. 709), it was the Portuguese name of the Crane (*Grus communis*), and had been transferred with the qualifying addition of "*di Ger*" (*i.e.*, Ground-Crane) to the Ostrich. This statement is confirmed by Aldrovandus (lib. ix. cap. 2). Subsequently, but in what order can scarcely now be determined, the name was naturally enough used for the Ostrich-like birds inhabiting the lands discovered by the Portuguese, both in the Old and in the New World. The last of these are now known as Rheas, and the preceding as Cassowaries.

[2] *Ann. and Mag. Nat. Hist.* ser. 4, xx. p. 500.

has been very commonly adopted by writers, to the exclusion of the older specific appellation. It seems to be peculiar to the island of Ceram, and was made known to naturalists, as we learn from Clusius, in 1597, by the first Dutch expedition to the East Indies, when an example was brought from Banda, whither it had doubtless been conveyed from its native island. It was said to have been called by the inhabitants "Emeu," or "Ema," but this name they must have had from the earlier Portuguese navigators.[1] Since that time examples have been continually imported into Europe, so that it has become one of the best-known members of the subclass *Ratitæ*, and a description of it seems hardly necessary. For a long time its glossy, but coarse and hair-like, black plumage, its lofty helmet, the gaudily-coloured caruncles of its neck, and the four or five barbless quills which represent its wing-feathers, made it appear unique among birds. But in 1857 Dr George Bennett certified the existence of a second and perfectly distinct species of Cassowary, an inhabitant of New Britain, where it was known to the natives as the *Mooruk*, and in

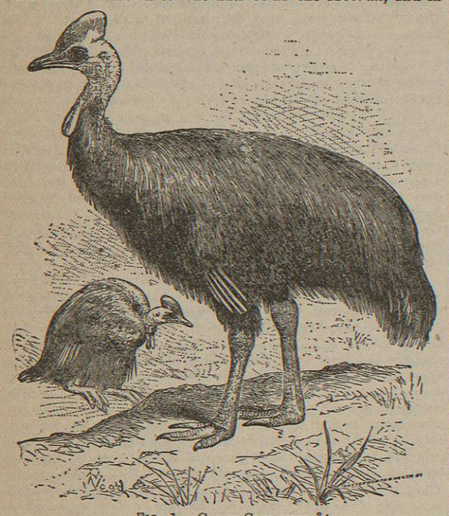

FIG. 1.—Ceram Cassowary.[2]

his honour it was named by Mr Gould *C. bennetti*. Several examples were soon after received in this country, and these confirmed the view of it already taken. Of late years a considerable number of other species of the genus have been described (see BIRDS, vol. iii. p. 740, note) from various localities in the same Subregion.[3] Conspicuous among them from its large size and lofty helmet is the *C. australis*, from the northern parts of Australia. Its existence indeed had been ascertained, by the late Mr T. S. Wall, in 1854, but the specimen obtained by that unfortunate explorer was lost, and it was not until 1867 that an example was submitted to competent naturalists.

Not much seems to be known of the habits of any of the Cassowaries in a state of nature. Though the old species occurs rather plentifully over the whole of the interior of Ceram, Mr Wallace was unable to obtain or even to see an example. They all appear to bear captivity well, and the hens in confinement frequently lay their dark-green and rough-shelled eggs, which, according to the custom of the *Ratitæ*, are incubated by the cocks. The nestling plumage is mottled (*Proc. Zool. Soc.* 1863, pl. xlii.), and when about half-grown they are clothed in dishevelled feathers of a deep tawny colour.

Of the Emeus (as the word is now restricted) the best-known is the *Casuarius novæ-hollandiæ* of Latham, made by Vieillot the type of his genus *Dromæus*,[4] whence the

FIG. 2.—Emeu.

name of the family (*Dromœidæ*) is taken. This bird immediately after the colonization of New South Wales (in 1788) was found to inhabit the south-eastern portion of Australia, where, according to Hunter (*Hist. Journ.*, &c., pp. 409, 413), the natives call it *Maracry*, *Marryang*, or *Maroang*; but it has now been so hunted down that not an

[1] It is known that the Portuguese preceded the Dutch in their voyages to the East, and it is almost certain that the latter were assisted by pilots of the former nation, whose names for places and various natural objects would be imparted to their employers (see DODO, vol. vii. p. 822).

[2] The figures are taken, by permission, from Messrs Mosenthal and Harting's *Ostriches and Ostrich Farming*, Trübner & Co., 1877.

[3] The enterprise of travelling naturalists in New Guinea and its adjacent islands has recently been so great that the list given in the passage above referred to is already out of date, and it seems at present hardly possible to place the exact state of our knowledge of the species of *Casuarius* before the reader. Several of them have been described from immature examples living in menageries, which have not always lived to assume the characteristics of the adult, and a comparison of such examples has not in every case been practicable. Moreover, the precise localities whence some of them have been brought have perhaps been wrongly assigned. The promised work of Prof. Salvadori on the ornithology of New Guinea will very likely clear up many points that are now open to doubt; and though it is probable that in some instances the same species has been designated by more than one name, it cannot be maintained that every existing species has been brought to our knowledge.

[4] The obvious misprint of *Dromeucus* in this author's work (*Analyse*, &c., p. 54) has been foolishly followed by many naturalists, forgetful that he corrected it a few pages further on (p. 70) to *Dromaius*—the properly latinized form of which is *Dromæus*.

example remains at large in the districts that have been fully settled. It is said to have existed also on the islands of Bass's Straits and in Tasmania, but it has been exterminated in both, without, so far as is known, any ornithologist having had the opportunity of determining whether the race inhabiting those localities was specifically identical with that of the mainland or distinct. Next to the Ostrich the largest of existing birds, the common Emeu is an inhabitant of the more open country, feeding on fruits, roots, and herbage, and generally keeping in small companies. The nest is a shallow pit scraped in the ground, and from nine to thirteen eggs, in colour varying from a bluish-green to a dark bottle-green, are laid therein. These are hatched by the cock-bird, the period of incubation lasting from 70 to 80 days. The young at birth are striped longitudinally with dark markings on a light ground. A remarkable structure in *Dromœus* is a singular opening in the front of the windpipe, communicating with a tracheal pouch. This has attracted the attention of several anatomists, and has been well described by Dr Murie (*Proc. Zool. Soc.* 1867, pp. 405–415). Various conjectures have been made as to its function, the most probable of which seems to be that it is an organ of sound in the breeding-season, at which time the hen-bird has long been known to utter a remarkably loud booming note. Due convenience being afforded to it, the Emeu thrives well, and readily propagates its kind in Europe. It is the only form of Ratite bird which naturally takes to the water, and examples have been seen voluntarily swimming a wide river.

The existence in Australia of a second species of *Dromœus* had long been suspected, and Broderip in 1842 stated (*Penny Cyclop.* xxiii. p. 145) that Mr Gould had even supplied a name (*D. parvulus*) for it; but there can be little doubt that this suggestion was founded on a mistake. However, in 1859 Mr Bartlett described, under the name of *D. irroratus*, what has since been generally admitted to be a good species, and it now seems certain that this fills in the western part of Australia the place occupied by the older-known form in the Eastern. It is a more slender bird, and when adult has the feathers barred with white and dark-grey ending in a black spot which has a rufous margin, while those of *D. novæ-hollandiæ* are of a uniform blackish-grey from the base to near the tip, which is black with a broad subterminal rufous band. Both species have been figured by Mr Sclater from admirable drawings by Mr Wolf (*Trans. Zool. Soc.* iv. pls. 75, 76), and interesting particulars as to their domestication in England are given by Mr Harting (*Ostriches and Ostrich Farming*, pp. 131–174). (A. N.)

EMIGRATION, now one of the most constant and orderly movements of human society, must have been one of the earliest, however irregular, of human impulses. It is the act of men, families, tribes, or parts of tribes, leaving the place of their birth with the view of settling in some other place. They are emigrants in the country they leave, and immigrants in the country they pass into. But this converse nomenclature describes an identical class of persons and the same kind of adventure, more necessary now than ever to be distinguished from migrations within a given territory, or the frequent travellings between distant countries in which many engage, whether on purposes of business or pleasure. Emigration is a going out with a design of permanently settling in new seats of residence, labour, trade, and society. It is the practical response which mankind have given in all ages to the command to "multiply, and replenish the earth, and subdue it;" or, in other words, it is a necessary result of the increase of population within a limited though cherished space, and of the appointed destiny of our race to people and develop the world.

The natural law of population, though probably the deep underlying force of all emigrations, is not the only force at work in the general movement by which people, and races of people, have migrated from one part of the world to another. Not only famines, which may be said to present the pressure of population in its intensest form, but wars of official conquest and ambition, religious persecutions and religious phantasies, civil broils and political revolutions, the discovery of gold and silver mines, the envy of more genial climes and fertile lands than people have been born to, the individual love of change and adventure and pushing one's fortune, have considerable power in promoting emigrations, apart from the rude pressure of physical wants. Famines in India, for example, do not result in much emigration; and yet the Irish famine in 1846–7 led immediately to one of the most remarkable removals of persons and families from one hemisphere to another in modern times. It would be difficult to account by the law of population for the successive immigrations of Saxons, Danes, and Normans into England, or to maintain that it was a force of hunger only which impelled the Northern barbarians to attack the Roman Empire. In the invasion of Turkey in 1877 the Russian soldiers are said to have been surprised at the plenty of the Bulgarian towns and villages, and to have had curious reflections why they should have been led so far afield to battle for the relief of a population so much more comfortably bestowed than themselves. Yet when the Russian soldiers return to their comparatively sterile homes, having seen the abundance of grain and fruits and flowers on the slopes of the Balkans, their accounts will probably only increase the Muscovite passion to penetrate by force of arms into more productive regions than those of Northern Europe and Asia. We must allow, in short, for many causes of emigration, as well as many wrong views of the means by which the advantages of emigration are to be realized.

The passage of Scripture which relates what took place between Abraham and Lot in the plains of Bethel, adduced by J. R. M'Culloch in the article "Emigration" in the last edition of this work, will always remain a strikingly natural and suggestive picture of the outward movement of society in its primitive elements. There was no want apparently of material resources. "Is not the whole land before thee," were the words of Abraham; and Lot, lifting up his eyes, saw the plain of Jordan unoccupied and well-watered. But there was strife among the servants, quarrels as to pasturings and waterings, with Canaanites and Perizzites dwelling in the land as an additional element of disorder. The kinsmen could not agree, or adjust their rule; and separation would be judicious, if not necessary. The narrative exhibits the influence of individualism on human affairs—on the affair of emigration as on others. In early times it was found difficult or impossible to make any important progress on the basis of social unity.

Nomads taking possession of vacant territory or invading the territory of others, victorious kings carrying whole tribes or nations into captivity, citizens driven out of civilized states by political rage, or attracted to adjacent lands by the promised wealth of agriculture or trade, and colonies more or less officially organized in the track of war and conquest, are the pictures we have of emigration in the ancient world.

"Many of the emigrants from the Greek States, as Mr M'Culloch wrote in the article above referred to, "consisted of citizens forced by the violence of contending factions to seek new settlements in other countries. But Greece also sent forth emigrants, impelled by the difficulty of maintaining themselves at home, or allured by the glowing descriptions of the comparative abundance they would enjoy in distant lands. Both these classes of emigrants established themselves, for the most part, either in countries with a scanty population, or whose inhabitants were in a decidedly lower state of civilization. And the greater refinement and ingenuity of the