[Presentation Copy.]

CATALOGUE

OF THE

PREPARATIONS

OF

COMPARATIVE ANATOMY

IN THE

Museum of Guy's Hospital,

BY

P. H. PYE-SMITH, B.A., M.D., LOND.,

FELLOW OF THE ROYAL COLLEGE OF PHYSICIANS; ASSISTANT-PHYSICIAN TO THE HOSPITAL, AND LECTURER ON COMPARATIVE ANATOMY; EXAMINER FOR THE NATURAL SCIENCES TRIPOS IN THE UNIVERSITY OF CAMBRIDGE.

PRINTED BY ORDER OF THE TREASURER.

LONDON:

ASH & COMPY., PRINTERS, 10, BOROUGH HIGH STREET, S.E.

1874.

PREFACE.

When appointed Lecturer on Comparative Anatomy in 1866, I was asked by Dr. Wilks, then Curator of our Museum, to look over the Zoological Collection, and to draw up a Catalogue of the Specimens. We had then a good series of articulated skeletons, and were rich in some other departments, especially those of the Heart, the Brain, and the Uterus: but others were scantily represented, and the Invertebrate specimens were few and poor. In 1869 I arranged the Collection in the present three Divisions of Vertebrata in physiological series, Invertebrata in zoological order, and Pathological specimens. Meanwhile, the most important gaps were being gradually filled up; and when, two years ago, the Museum was removed to the New Building, I began the descriptive Catalogue which is now completed.

Since 1866 more than 300 new specimens have been added, of which 39 are microscopical, and many of the old ones have been dissected and remounted. After throwing away all those which appeared to be useless, we have now more than 1400 preparations in the Vertebrate, nearly 600 in the Invertebrate, and 180 in the Pathological division, beside 56 admirable wax models by Mr. Towne, chiefly illustrating the brain and the ovum.

In determining the numerous skeletons and detached bones which were not at all or erroneously named, I have constantly used the splendid osteological collection in the Hunterian Museum, and am much indebted to Professor Flower for his ever ready assistance. In the difficult task of naming a tolerably large collection of Snakes, sent from various parts of the world by old Guy's men, I availed myself of the unequalled knowledge of Dr. Günther, who, with great kindness, went through the whole of this department for me. My thanks are also due to other gentlemen on the staff of the British Museum for determining the species of Insects and Shells of which I was ignorant.

I have great pleasure in acknowledging the help I have received from some of our own students in the preparation of the Catalogue, particularly from Mr. F. J. Carey, M.A., from my brother, Mr. R. J. Pye-Smith, and from Mr. A. W. Green, who has also put up the excellent series of Birds' skulls.

Lastly, I owe my best thanks to my friend, Dr. Cavafy, of St. George's Hospital, for his valuable aid in correcting errors in the proof-sheets, for some of which the printer was not responsible.

31, *Finsbury Square*,

January, 1874.

CONTENTS.

CONTENTS.

INTRODUCTION.

Animals and Plants differ from inanimate objects in undergoing certain constant and regular *changes*, by which they *grow* for a limited time and then *die*, and also in *reproducing* structures like themselves, which go through the same round of change.

This power of reproduction is seen not only in the generation of individuals, but also in the development of each of their parts, and in the lowest plants and animals, which are homogeneous, the two processes of cell-reproduction and reproduction of the species become coincident. Parts thus formed, differing in structure, and fulfilling different functions, are called *organs*, and thus plants and animals together make up the Organic Kingdom.

The result of these vital processes of growth and reproduction appears to be determined in each organism—first, by its resemblance to those from which it sprang,* and secondly, by the mechanical, chemical, and other conditions by which it is surrounded.† And these processes appear to be inseparably connected with the formation and decomposition of certain chemical compounds, which consist of few elements in large combining proportions, and are in a state of high tension.

As a consequence of their limited duration, organic structures are limited in size; and, from the large amount of water they contain, possess a soft consistence and rounded form, which contrast with the inorganic dead structures often found within them, e.g., crystals of uric acid, raphides of oxalate of lime.‡

* The subject of inheritance, either from direct parents or ancestors further removed ("atavism" or reversion), is discussed in Mr. Darwin's great work on "Variation in Plants and Animals" (1868).

† There is no necessity to assume a tendency to vary as an ultimate fact. Variability may be most simply conceived of as the result of growth under varying conditions. The only internal tendency of an organism is to grow, and this growth will be equal in all directions for the "sufficient reason" of Mechanics, so as to produce a globular form, as seen in a young spheroidal epithelial cell. External pressure acting directly or by transmission from a preceding organism will prevent its growth in some directions, and so produce the shapes seen for instance in the hexagonal cells of the choroid or the hexagonal cavities of a honey comb.

‡ A great deal of the water exists in combination with solids in the physical condition known as *colloid*, or gelatinous, intermediate between the solid and liquid states. This is however occasionally seen in the Inorganic Kingdom, e.g. the gelatinous form of Silica.

Animals and plants alike grow by absorption, not by mere accretion ; but while plants feed upon inorganic compounds, animals can only absorb those already formed by plants or other animals.

One of the most important functions of the structureless albuminous compound *protoplasm*, which is found in all animals and plants, is that of contraction, which takes place under certain stimuli as light, heat, pressure, or is apparently spontaneous : e.g. in the young cells of growing plants, and the white corpuscles of human blood, or the ciliated spores of seaweed, and the ciliated epithelium of the human lungs). But in animals alone is this power of contraction at once limited and perfected in certain parts of their structure. Nor does any similar concentration of function appear among plants in organs "differentiated" for the purpose of receiving and conveying the stimuli which produce movement. These functions of Movement and Sensation are therefore called *animal*, while those of Nutrition, Growth and Reproduction, which are common to both kingdoms, are termed *organic*.*

It must be remembered that Nutrition and Respiration go on in

---

* The following table exhibits the chief distinctions between the two divisions of the organic kingdom :—

PLANTS.	ANIMALS.
CHEMISTRY.—Nitrogenous compounds in small quantity, starch, cellulose, and their allies abundant. *Exc.* Fungi.	Protein compounds abundant, starchy compounds rare. *Exc.* Cellulose in Tunicata, Glycogen in man.
The green colouring matter (Chlorophyll) is characteristic of plants.	*Exc.* Chlorophyll has been found in *Stentor*, *Hydra*, *Bonellia*, &c.
STRUCTURE.—Muscle and nerve absent.	Muscular and nervous tissues. *Exc.* Protozoa.
No internal cavity.	An internal cavity. *Exc.* Protozoa.
Compound organisms the rule.	Compound organisms less common.
FUNCTIONS—live on inorganic compounds. *Exc.* certain Fungi.	Live on organic compounds.
Absorb nutriment from without.	Absorb nutriment after ingestion.
Reproduction sexual and non-sexual.	In some classes sexual only.
Embryo absorbs albumen from without.	Embryo absorbs yelk from within.
Irritability and contraction limited.	Sensation and motion extensive.

Plants, just as in Animals, by formation of protoplasm and allied nitrogenous compounds and excretion of Carbonic Acid. But these processes are masked in most plants by the more active manufacture of starchy compounds by their green parts, under the stimulus of sunlight, with absorption of Carbonic Acid for the purpose, and excretion of Oxygen. Hence the large amount of starch, the presence of chlorophyll, and the apparently reversed respiration of plants. Those plants which are not green and do not manufacture starch (fungi and completely parasitic growths) approach animals very nearly in their nutritive functions; and the lower plants (Protophyta) are scarcely to be distinguished from the lowest animals which have no definite structure, and have therefore been classed with them as the indeterminate kingdom "Protista." But the general function of the vegetable kingdom is to store up force by forming compounds, which, when eaten by animals, expend that force in the shape of movement.

The study of the structure and functions of animals constitutes Animal Morphology and Physiology respectively, and these, with the corresponding study of plants, and organic chemistry, complete the science of Biology. The comparative anatomy of animals other than man, is illustrated in this collection by specimens, arranged for convenience in the order of the catalogue, but the following sketch will serve to show their physiological relation.

Every animal, as above stated, grows by assimilation of organic compounds, which constitute its food (*alimentum*). These are taken up and introduced into the body (*prehension, deglutition*), are there mechanically reduced, dissolved, and chemically changed (*digestion*), and the useless part or dregs passed out (*defæcation*). All these functions may be observed in a structureless animal like the Amœba, but in most cases they are performed by organs differentiated for seizing or reducing food (*limbs, jaws, gizzard*, &c.) for carrying it through the body (*alimentary canal*), and for secreting, by the growth and death of rapidly formed cells, fluids to dissolve it (*peptic glands, pancreas*, &c.) Preps. 500—758.

The digested material may, as in Protozoa, be absorbed by simple diffusion, but in most animals it passes through more or less completely separated spaces and canals (*lacunae* and *vessels*), by which it is distributed to the several parts of the body. To help in carrying on this "circulation" of nutritive fluid, all the higher animals are provided with one or more contractile cavities (*hearts*). In the Vertebrata alone are there two systems of nutrient vessels, one completely closed, to distribute the perfected liquid (*blood-vessels*), the other to absorb the crude "plasma" and to elaborate it into blood (*lymphatics* or absorbent vessels, including those of the digestive tract, which are known as *lacteals*). Appendages of the former system are the Retia Mirabilia, Erectile Tissue, Spleen, &c. Appendages of the latter, which are confined to Vertebrata, are the *Thymus*, the *Malpighian bodies* of the *Spleen*, the closed follicles of the alimentary canal known as *Glandulæ solitariæ*, *Peyer's patches*, *Tonsils*, the adenoid tissue of marrow and other parts, and the so-called *Lymph glands*. Preps. 766—905.

In all organic structures the process of nutrition is accompanied by absorption of oxygen and formation of carbonic acid; but it is in the oxidation of the complex constituents of muscle and nerve that the so-called vital forces of movement and sensation are produced, and hence *respiration*, or the introduction of oxygen and excretion of carbonic acid, is most active in the animal kingdom. The oxygen of the air, or that dissolved in water, is either absorbed directly by the surface (vague respiration), or distributed through the body by more or less perfect canals (e.g. *water-vascular system* of Vermes, *tracheæ* of insects), or thirdly, is brought into contact with an organ to which the blood is also conveyed for aëration, that is for interchange of its gases with those of the surrounding medium by diffusion (*gills*, or branchia, and *lungs*). Preps. 906—965.

The lungs and the cutaneous glands, beside regulating animal heat by conversion of water into vapour, also excrete nitrogenous products; but the most important of the depurating organs are the Kidneys, which excrete water, effete nitrogenous products and salts. Preps. 1069—1082.

Reproduction in its simplest form consists in an organism dividing into two parts, each of which maintains an individual existence. This process (*fission*) is only seen in the lowest plants and animals, or in the cells of which the remainder are composed. A second mode is that of *gemmation* or budding. A portion of a living structure grows out from the rest and becomes a new organism. Sometimes it separates entirely from its parent, but often remains attached to it, and when this process is frequently repeated there results a "compound" animal or plant. This method of reproduction is found in all but the lowest plants, and in most invertebrate animals, except the Mollusca proper and the Arthropoda. Budding is usually external (Hydrozoa), but occasionally internal (some Tæniada). Sexual reproduction or true *generation*, either alone or in addition to the preceding methods, has been observed in all but the lowest animals and plants. A germ-cell (*ovum*, egg, ovule, seed) is formed either by a process resembling internal gemmation, or by secretion; this developes into a second individual, after the contents of a sperm-cell (*spermatozoa*, pollen filaments) have been brought into contact with it. The sperm and germ-cell may both be formed in the same individual (as is frequently the case with flowers and sometimes in animals—Monœcious or Hermaphrodite), or in separate ones (Diœcious); but fertilization is necessary in both cases. Preps. 1084—1295.

These organic functions of Nutrition and Reproduction are common to both kingdoms. That of *Contraction*, the third function of living protoplasm, is sometimes limited to one part of a cell, or to the hair-like processes of its substance known as *cilia*. The next step in differentiation—the confining of this power of contraction to certain specially modified cells or fibres—is not reached among plants. Muscle is a purely animal tissue. To make the movements it produces by its contractions more effective, the muscular bands in many cases are attached to levers of chitin, cartilage, bone, &c. These, with their ligaments and other accessory structures, form the apparatus for locomotion when set in movement by the muscles, though they also serve to support the body and to protect the internal organs.

Muscular contraction is effected by stimuli conducted through efferent Nerves, cords of peculiar structure, which appear in the animal kingdom along with muscular tissue. To nerves is also limited the function of conducting external impressions to the corpuscles of Ganglia which form part of even the simplest nervous system. And the impressions conveyed by these afferent (centripetal) nerves produce in the ganglia certain ill-understood effects, which are either reflected to muscles as stimuli along the efferent (centrifugal) nerves, or are only manifested to the consciousness of the individual as psychic conditions. Preps. 966—1024.

In most animals certain parts of the nervous system are differentiated to receive and conduct special impressions (e.g. touch corpuscles, gustatory capsules, olfactory filaments), and complicated organs are constructed to bring the vibrations of light or sound into the most favourable relation to the receptive extremities of these nerves of special sense (the bacillary layer of the retina and the rods of Corti in the ear). Preps. 1025—1068[20].

Classification.—The best arrangement of animal forms must depend upon the object for which it is made. Thus it is sometimes useful to group them according to their economical importance, or according to the countries they inhabit, or, instead of considering each animal as a whole, to study consecutively the various organs which, in different animals, serve the same function.

This last plan was that on which Hunter arranged his Museum, and is obviously the most useful for the study of Comparative Physiology. In this collection it has been followed in classifying the specimens of vertebrate zoology, since these throw most light upon the functions of the corresponding organs in man. But for studying the mutual relations of animal structures,—i. e. for the purposes of Comparative Anatomy,—a classification must be morphological. An "artificial" system may be constructed, like that of Linnæus, by taking any convenient organ as the criterion for dividing and subdividing the animal kingdom into groups, which agree in possessing a number of common characters. It has, however, been found by experience that characters are not of equal "value" for classification; colour and size, for instance, are far more unstable than muscles, and these than nerves. And since Cuvier pointed out that beside Vertebrata there are other great groups of animals which agree in conforming to one and the same type or plan of structure, it has been the endeavour of zoologists to construct a perfect "natural" system, that is to say, one in which every animal shall be found ranged in company with those which it resembles in the most constant and the most numerous particulars. It has been found by experience that the most valuable, because the most constant, criteria are, first, those observed in the *embryo* of each animal,* and next, the peculiarities of the internal or external *skeleton* where present.†

The interest attaching to a Natural System of the Animal Kingdom as an efficient aid to memory, and an exhibition of the varied modifications of the four or five types of Creation, becomes enormously increased if the Theory of Evolution by Natural Selection be admitted; for then the complete system represents not merely the association of similar appearances in our own minds, but the true historical connexions of animal forms; the relationship between existing creatures becomes a blood-relationship; their alliance with extinct species becomes an alliance by descent; and if we could ever recover the forms of all the members of the race which have died out, we should be able to construct a complete genealogy of the animal creation.‡

---

* If the theory be accepted that the development of each animal (Ontogenesis) is an epitome of the development of the group to which it belongs (Phylogenesis), the study of embryology is the key to true classification. But even on empirical grounds embryonic characters are by far the most valuable, though at present only the outlines of this department of Biology have been traced by its founder Von Baer (1827) and his successors Reichert, Rathké, Barry, Joh. Müller, Bischoff, Fritz Müller, Kowalewsky.

† One of the practical advantages of a classification chiefly based on Osteology is, that it admits of the introduction of fossil forms.

‡ Students of Comparative Anatomy, interested in these speculations, should bear in mind the following preliminary considerations:—

1. The range and quality of Mr. Darwin's earlier scientific writings, his

One animal is said to be "higher" than another in structure, when there is greater differentiation or specialization, and, at the same time, greater perfection of the functions it performs. But in classification one animal often takes higher rank than another, to which it is inferior in degree of organization, because it is related to others superior to both, i.e. it is formed upon a higher type. Thus an insect is absolutely more perfect than some of the lowest fishes,

---

extreme patience in collecting facts for more than twenty years before publishing his theory, the extent and accuracy of his knowledge, and the remarkable candour with which he treats every opposing fact or argument, have long ago secured for this illustrious naturalist the highest respect from all whose respect is valuable.

2. The doctrine of the evolution of species by the agency of natural selection has been accepted by some of the most eminent biologists in this country and abroad: among them the names of Huxley, Hooker, Gegenbaur, and Häckel, may be mentioned.

3. The evidence bearing on the subject derived from geology appears in some points to be opposed to the Darwinian theory, and on this and other grounds a few competent judges do not admit the truth of the theory.

4. Whatever may be the final verdict of science, the publication of "The Origin of Species" will always be memorable for the impetus it has given to scientific thought and the number of valuable observations of facts in Natural History which it has called forth.

In the "Zeitschrift für Ethnologie" (1871. Heft i. pp. 56—67) there are enumerated translations of Mr. Darwin's works into German ("The Origin of Species" in five editions), French, Dutch, and Italian; thirty-nine treatises devoted to the subject in German, fifteen in French, five in Dutch, and five in Italian; beside books in which it is more partially treated, and pamphlets and articles on the subject, which fill five more closely printed pages.

5. It is held by those competent to form a judgment on the point, that so far from the Theory of Evolution being opposed to Morality or Religion, it will, if proved to be true, be found in complete harmony with both.

On this subject, beside Mr. Darwin's own works, "The Origin of Species," 1859; fifth edition, 1869; "The Variation of Animals and Plants under Domestication," 1868; "The Descent of Man and Sexual Selection," 1870,—the student may consult with advantage Mr. Wallace's "Contributions to the Theory of Natural Selection," 1870, and, on the other side, Mr. Mivart's "Genesis of Species," 1871. Also Mr. Herbert Spencer's "Principles of Biology," 1864.

Among foreign works on the subject, Prof. Hæckel's "Generelle Morphologie," 1866, and "Natürliche Schöpfungsgeschichte," 1872; Dr. Fritz Müller's "Für Darwin," 1864; and "Histoire Naturelle Générale," by M. de Quatrefages, 1868, are the most important.

whether judged by its variety of functions, by the vital power it exerts, or by any other test; but it ranks beneath them because the Arthropod type as a whole is inferior to the Vertebrate. The same applies to a cuttlefish compared with a lamprey, or an eagle with a sloth. In some respects we may even consider a tiger a more highly organised animal than a monkey, but the latter ranks above it in virtue of its resemblance to man. The position of man himself at the head of the creation is justified by the opinion of the only animal capable of forming a judgment on the question.

In arranging the present Collection, the double object of representing the principal groups of the Animal Kingdom, and illustrating the several physiological systems in those most nearly allied to man, has been kept in view; and to this end the specimens have been divided into the following sections*:—

Part I.—Vertebrate Anatomy.

1. Skeletons arranged in zoological sequence. The order adopted is based on that of Prof. Huxley's "Introduction to the Classification of Animals," but reference is also made to the Cuvierian orders, to those adopted by Prof. Owen in the Catalogue of the Hunterian Museum, and to the classification of Gegenbaur's "Grundzüge der Vergl. Anat." Along with the skeletons are included in this section such stuffed and otherwise preserved entire specimens as show the outward form, colour, and appearance of vertebrate animals.

2. The Exo-skeleton, including specimens of dermal bones, spines, scales, feathers, horns, hoofs, and other epidermic appendages.

3. The Alimentary System, including—

   a. A complete series of typical specimens of the teeth of Mammals, arranged according to the structure of these organs, together with specimens of other varieties of vertebrate teeth.

* This order is also followed in enumerating the characters of each group of animals.

b. A series illustrating the various parts of the digestive canal, especially the tongue, stomach, and cœcum.

c. The Liver and other digestive viscera.

4. The Circulatory System, the hearts of Mammalia being arranged according to the way in which the primary branches of the aorta divide.

5. The Absorbent System, including some beautiful injections of the lymphatics by Sir Astley Cooper.

6. The Respiratory System, aërial and aquatic, including the larynx and swimming bladder.

7. The Nervous System; brain, nerves, and organs of special sense.

8. Urinary Organs.

9. Reproductive System.

a. Male generative organs.

b. Female organs, together with specimens of fœtal membranes and appendages, and of various forms of eggs. Most of these were prepared by Dr. Oldham.

10. The Thyroid and other viscera of unknown functions.

Part II.—It would be difficult to carry out a corresponding physiological arrangement in the other primary groups of the Animal Kingdom, and the comparatively small number of specimens of Invertebrate anatomy would prevent the attempt here. Nor can the question of the homology of Invertebrate with Vertebrate organs be considered as solved. The remaining preparations are therefore arranged zoologically, the limits of the orders and classes, as well as of the larger divisions, being observed. The classification followed is in the main that adopted by Prof. Huxley in the work already referred to.

Part III.—Lastly, all specimens illustrating Comparatively Pathology have been separated from the rest and arranged in a Series by themselves.

The Classes of the Animal Kingdom are distinguished by being printed in small capitals, their Orders in large text, and their Families, Genera, and Species in italics. The specific name is only added in cases where some history has given the requisite information, or where the specimen itself does not admit of doubt.

The references, given after many of the specimens in the First Series of the Vertebrata, refer to preparations in other Series illustrating the anatomy of the same species, genus, or family. Thus the references which follow Prep. 120, the *last* of those in the First Series referring to *Equus caballus*, enable the student to follow the anatomy of the horse through all its organs, so far as they are represented in this Collection.

GEOGRAPHICAL DISTRIBUTION.—The first time that the name of any Species occurs in the catalogue its Habitat is given, and a notice of the Geographical Distribution of each Class or Order is added to the account of its principal characters. For this purpose the following Zoological Regions have been recognised:—

1. The Northern Region, which consists of two vast provinces—the PALÆARCTIC, including the whole of Europe, Africa north of the Sahara, and all Asia, except the great peninsulas of Hindoostan and Further India; and the NEARCTIC, which corresponds to America north of Mexico. The Japanese Islands, Greenland, and the rest of the Polar regions, may be regarded as provinces of this enormous territory. The Caucasian race of man, of which the Xanthochroic stock may be taken as the most characteristic, certain families of Insectivora, the true stags and the whalebone whales appear to be indigenous in this region. On the other hand, whole orders like the Edentata and the Marsupiata (with one exception) are unrepresented, and monkeys are almost absent; the colours of the fauna, especially of birds and insects, are less brilliant than in the warmer regions; and reptiles, especially crocodiles and poisonous snakes, are few in comparison. While there is a remarkable general correspondence between the Palæarctic and Nearctic divisions of this region, the same family is in almost every instance represented by different species on the two sides of the Atlantic.

The British Isles form zoologically an unimportant corner of the Palæarctic region, and our native fauna does not include any species not found elsewhere, with the exception of the Red Grouse (*Lagopus Britannicus*). Ireland bears much the same relation to Great Britain as the latter to the continent of Europe.

2. The Neotropical Region, or "Austro-Columbia," including the whole of South America (except Patagonia), the West India Islands and Mexico. This may perhaps be the primitive seat of the copper-coloured races of mankind. Its fauna is very characteristic, the typical groups of mammals being Edentata, Rodentia, Vampires, and Platyrrhine monkeys. The Insectivora are almost absent and the Ungulata scantily represented by peculiar forms like the Tapir, the Peccary, and the Llama. Among the characteristic birds of this region may be mentioned Toucans, Macaws, and Humming birds.

3. The Australian Region, including Tasmania, New Guinea, and the adjacent islands of the East Indian Archipelago as far as "Wallace's Line."* This contains the most isolated fauna of any zoological province. Except mice and bats, which are nearly ubiquitous, all its mammals belong to the orders Marsupiata or Monotremata;† and, except Opossums, none of these animals are found elsewhere. There are no vultures, woodpeckers, pheasants or grouse, but Megapodidae, Cockatoos, Cassowaries, and brush-tongued Lories. Peculiar fishes also occur, like the *Cestracion* of Port Jackson and the *Ceratodus* of Queensland, and the aborigines, formerly called Australian or Papuan negroes, form a race of men distinct from all others. As in South America, the peculiarities of the fauna also existed in the later geological periods.

4. The Ethiopian Region, comprising all Africa south of the great Desert. Here alone the true Negro race is found. The fauna

* This natural boundary was pointed out by Mr. A. R. Wallace, the independent discoverer of the law of Natural Selection, in his "Malay Archipelago," one of the most delightful books of travel ever published.

† The wild dogs of Australia have probably been introduced, like the horses of South America. The Murine genera Hydromys and Hapalotis are peculiar.

is very rich in all departments, and includes peculiar genera as *Hippopotamus*, *Hyrax*, *Proteles* and *Orycteropus*. Among the characteristic birds are Hornbills, Plantain-eaters, and Weaver-birds. The order Ophidia is scantily represented. Among the more striking groups for their number and variety may be mentioned the Antelopes and Baboons. The great island of Madagascar forms a sub-region of this Ethopian province. Its most characteristic forms belong to the family of Lemurs, and it has been supposed by Häckel to be the remains of a submerged continent lying between Asia and Africa, which he has named "Lemuria."

India is usually counted the fifth zoological region. But the peninsula of Hindoostan appears to have formed a great *impasse*, into which have drifted the faunas of many regions. Its ethnology is the most complicated that exists: some of its inhabitants belong to the Caucasian stock, and, like ourselves, speak an Indo-European language; others appear to be related to the Australian race, and others again are Mongols. Similarly, while a portion of the Indian fauna is allied to that of the Palæarctic region, more than half bears the same relation (of general likeness with specific distinctness) to that of Africa, which we have seen exists between the animals of Europe and North America.* As we pass east of the Ganges however, the fauna gradually loses these characters, and a greater number of peculiar forms appear, e.g., the Ourangutang, the *Tarsius*, the Babirussa, and the Birds of Paradise. So that it seems probable that zoologists will have to recognise a Malayan Region, including Further India, the Philippine Isles, and the East India Archipelago as far as Wallace's Line, while Hindoostan will form a sub-region only, of a mixed zoological character.

The scattered islands of the Pacific are of recent, many of volcanic origin, and contain a very scanty fauna, which appears together with their human inhabitants to be derived from the Malay Islands. New Zealand, though perhaps it may be included in the same primary

---

* On a small scale Palestine occupies a somewhat similar zoological position.

division, contains a very remarkable and distinct fauna, comparable in some respects to that of Madagascar. The Hatteria lizard (*Sphenodon*) and the Apteryx, with other wingless birds very recently extinct, are characteristic of the New Zealand fauna, which is remarkably poor in mammals and in reptiles. The inhabitants of all these islands, excluding those of the Australian region, appear to be more or less allied to the Malays.

Refs. P. L. Sclater: Proc. Linn. Soc. Vol. ij. p. 130.
Andrew Murray: Geographical Distribution of Mammals, 1866.
Huxley: Address to the Geological Society, 1870.
Schmarda: Die Geographische Verbreitung der Thiere, 1853.

The influence of *Climate* on the distribution of Animals is a subordinate one, and is best seen within the limits of the great Northern Region. Within the Polar Circle there is great uniformity of the fauna in Europe, Asia, and America; the species are few, but the individuals numerous. The chief Mammals are the white bear, the reindeer, musk ox, hare and fox, lemming, seals, and whales. Almost all the birds are web-footed. Reptiles and amphibia are absent, fishes abundant, mollusks few, except *Tunicata;* insects very rare; Crustacea numerous, especially the lower orders; Anthozoa almost absent; Hydrozoa and *Beroidæ* abundant; Echinodermata represented chiefly by *Asteridæ.* The fauna of the Temperate Zone is more numerous and less characteristic, and is divided into the sub-regions of California, North America east of the Rocky Mountains, Europe north of the Alps and Pyrennees, the basin of the Mediterranean, Siberia, Thibet, and China with Japan. Within the Tropics in all the regions above described we find a very abundant fauna, especially in monkeys, parrots, insects, and coral polyps; but almost every group of animals is represented by more numerous species, and these are usually of larger size and almost invariably of more brilliant colours.

Only birds and insects are fitted for aërial life. Cetacea, turtles, most fishes, almost all Mollusks and Crustacea, many Annulata and Coelenterata, Echinodermata, and sponges are marine; while some turtles, most Amphibia, about a fourth of the species of fish (chiefly

Malacopteri), a few Mollusks, Crustacea and Annulata, *Hydridæ*, and many Protozoa, inhabit fresh water. In the sea the following zones are distinguished: Littoral, above low water mark; Laminarian, to 15 fathoms; Coralline, to 50; Coral, to 100 fathoms; and deep sea, above that depth. Each has characteristic fauna.

Lastly, some animals live parasitically in or upon others (Entozoa and Epizoa). These are found among Insecta, Arachnida, Crustacea, Vermes and Protozoa. Certain others live near (but not on or in) their hosts, so as to share their food. This habit has been named Commensalism.

PALÆONTOLOGY.—A complete view of the Animal Kingdom would include all known forms extinct as well as recent, but our acquaintance with the former is still fragmentary. In many instances fossil species fill up gaps between existing groups of animals, so as to throw much light upon their mutual affinities, but the disappearance of the earlier forms renders it easier to classify those which remain. If the whole animal creation were recovered and arranged in order, it would probably present an unbroken series of allied forms, in which it would not be possible to draw strong lines of demarcation, but only to group each species in continuous order around the more specialized types.

There are few specimens of fossil anatomy in this Collection, and only the larger and more important extinct groups are referred to in the Catalogue.

The following Table will give some notion of the order in which the chief fossiliferous strata occur, and of some of the most remarkable animal forms which they contain. The earliest, unstratified, so called "igneous" or "plutonic," rocks—granite, felspar, syenite, trap—and the metamorphic slate and similar formations, contain no organic remains:—

I. THE PRIMARY OR PALÆOZOIC STRATIFIED ROCKS.—These contain Corals, *Echinodermata*, *Annulata*, *Mollusca*, and *Cartilaginous fishes*, with some reptiles.

Characteristic forms—*Brachiopoda*, *Rugosa*, *Crinoidea*, *Blastoidea*, *Cystidia*, *Trilobita*, *Nautilidæ*, *Ganoidei*, *Placoidei*.

Archilithic Period.

*Laurentian** (Canada).

Cambrian (Dolgelly) . . . *Tubicolous Annulata, Oldhamia.*

Silurian (Wales), Lingula Flags (Wenlock) . . . *Foraminifera.*
"The age of Brachiopoda". *Calcareous Sponges, Trilobites. Graptolites, Lingula.*

Ludlow Limestone . . . . *Pteraspis* (*first Vertebrate*).

Palaeolithic Period.

Devonian, including Old Red Sandstone (North Devon, North-east of Scotland) . . . . *Ganoid fishes, Petrospongiadæ.*

Carboniferous: Mountain Limestone (Pennine range) and Coal Measures, Millstone Grit, Carboniferous Shale, Ironstone *Reptiles, Insects, Eurypteridæ, Productus.*

Permian: (Durham), Magnesian Limestone, &c.; Lower New Red Sandstone . . . *Brachiopoda, Cartilaginous Fishes.*

II. Secondary or Mesozoic Formations.—In this Series *Reptiles* reach their fullest development. *Homocercal fishes, birds*, and *mammals* also appear. *Echinidæ, Cirripedia, Decapod Crustacea, Conchifera, Belemnites, Ammonites, Corals.*

Trias: "Bunter Sandstein," Muschelkalk, and Keuper, or Upper New Red Sandstone, Salt beds (Cheshire) - - - *Encrinus liliiformis, Dicynodon, Labyrinthodon, Microlestes* (*first Mammal*).

Lias: sometimes classed with the Oolite as "Jurassic" (Lyme Regis, Whitby) . . . . *Ichthyosauri, Plesiosauri.*

Oolitic, Lower (Jura) . . . . *Gryphæa, Belemnites.*
Stonesfield Slate . . . . *Plesiosauri, Phascolotherium, and other Marsupials.*
Middle—Bathstone . *Amphicoelous Crocodiles, Foraminifera.*
Upper—Oxford Clay: coral rag.
Lithographic slate (Solenhofen) . . . *Pterosauria, Archæopteryx, Compsognathus.*

Wealden.
Kimmeridge Clay, Portland Stone; Purbeck, Hastings, Sussex Weald . . . . *Megalosaurus, Iguanodon.*

---

* In this formation has been discovered the *Eozoon Canadense*, which, if really organic, is by far the earliest trace of life known.

Cretaceous.

Greensand and Gault (Isle of Wight) . . . *Hamites, Echinidæ.*

Chalk: Across England from Hants to Norfolk. Over the North of Europe. Absent in America).

Foraminifera, Sponges, Bryozoa, Rhynchonella, Inoceramus. Echini, Corals, Ammonites, Spondylus, Crustacea. Osseous fishes, Pterodactyles. Procœlous Crocodiles.

Maestricht beds . . . . *Mososaurus.*

III. Tertiary or Caenozoic.—The characteristic fossils of this Period are *Gasteropoda, Birds, Mammals.*

Eocæne.

Lower Eocæne. London Clay (Hants, Sheppey, Harwich). *Lophiodon.*

Middle Eocæne. Nummulitic Limestone . . . . *Foraminifera.*

Upper Eocæne. Paris Stone . . *Palæotherium, Anoplotherium.*

Miocæne (Vienna) . . . . *Hipparion, Zeuglodon. Dinotherium, Mastodon, Machærodon.*

Pliocæne.

Older Pliocæne.

Coralline and Suffolk Red Crag . *Bryozoa, Cetacea, Sivatherium.*

Newer Pliocæne. Norwich Crag. . . . . *E. priscus.*

IV. Quaternary, or Post Tertiary.—These strata contain *animals of existing genera.*

Plistocæne or Postpliocæne . . . . *Thylacoleo, Dinornis, Aepiornis. E. primigenius (Mammoth). R. tichorrhinus. Glyptodon, Megatherium,* and *Mylodon.*

Glacial Drift (Cromer, Kent's Hole, Scarboro').

Older and more extensive Glacial Period of Europe.

Milder Period.

Second less extensive Glacial Period—Floods—Diluvium.

Turbary . . *Flint weapons and other human palæolithic implements.*

The Mammoth Period.

The Intermediate Period.

The Reindeer Period.

Recent Alluvial Deposits . . . . *Neolithic implements.*

Modern Period . . . . *Human skeletons.*

The periods adopted in this Table are those which are found convenient; but there is rarely a sharp demarcation, in fact, between the several strata, or the character of the fossils they contain.

There is no fossil order of plants which is now altogether unrepresented.

Nor any extinct order of Mollusca, Pisces, or Mammalia.

Among Cœlenterata the order *Rugosa* is extinct.

Among Echinodermata, *Cystidea*, *Blastoidea*, and *Hedriasteridea*, none of which survived beyond the Palæozoic Period.

Of Crustacean Orders, *Trilobita* and *Eurypterida* became extinct in the Carboniferous Period.

Of Amphibia, *Labyrinthodontia.*

Of Reptilia, *Ichthyosauria*, *Plesiosauria*, *Pterosauria*, *Dinosauria.*

Of Aves, *Saururæ.*

It must be remembered that our knowledge of fossil forms is very imperfect: —

1. Because only hard parts are preserved. Thus we have no record of what, in some respects, would be the most important groups of all—Infusoria and Vermes, Tunicata, and the lowest Fishes.

2. Because, although it is possible to gain some knowledge of the perished soft structures—as of the paws of Reptiles and the feet of Annulata, from the tracks they left in mud, which has afterwards hardened; of the brain, by taking casts of the inside of the skull; and of the intestines, by observing the form of petrified fæces, or *coprolites*—yet we can never hope to learn anything of the structure of the ovum, embryo, or fœtal membranes: and these are the most important points in Zoology.

3. Because, even of the bones, &c., which were preserved after the death of the animals, and still exist as fossils, only a few are within reach when searched for, and only a small part of the earth's surface (excluding the sea, which no doubt covers fossiliferous strata, now subsided) has yet been even cursorily explored for this object. Europe, a few places in India and Australia, and in North and South America, are almost the only regions where organic remains have been looked for.

The *duration* represented by the various formations is incalculable. If we suppose that the changes which have taken place were gradual and comparable to those now going on (and there is no sufficient reason to assume anything else), the time since the close of the Tertiary Period is far greater than our chronology can represent. Attempting to estimate only the relative duration of the four great Geological Periods, Hæckel estimates the Palæolithic at three times the length of the Mesozoic, this at five times that of the Cænozoic, and the latter at more than four times the length of the Quaternary Period.

Lyell: Elements of Geology. Jukes: Student's Manual of Geology. Owen: Palæontology. Nicholson: Manual of Palæontology.

SOME IMPORTANT DATES IN THE HISTORY OF ANATOMY AND ZOOLOGY.

B.C. 384. ARISTOTELES, born at Stagira in Macedonia. "De Animalibus Historia," "De Partibus animalium," "De generatione Animalium," "De Animalium incessu."

322. Died at Chalcis in Eubœa of carcinoma ventriculi.

270. ERASISTRATUS. Alexandria.

A.D. 23. C. PLINIUS Secundus. Born at Verona: killed in the eruption of Vesuvius, A.D. 79. Published "Historia Naturalis," 77.

130—200. Claudius GALENUS. Born at Pergamum. Dissected Monkeys.

1193—1282. ALBERTUS MAGNUS, Bishop of Ratisbon.

1513—64. ANDREAS VESALIUS. Brussels and Padua.

1532—62. GABRIELUS FALLOPIUS. Padua.

1573. John Kaye (CAIUS) ob. "De Canibus Britannicis." "De rariorum Animalium Historia."

1537—1619. FABRICIUS ab Aquapendente. Disc. Valves in the Veins.

1570. Bartholomæus EUSTACHIUS, John Bapt. INGRASSIAS fl.

1578—1657. William HARVEY. Born at Folkstone. "De Circ. Sang." 1628. "De Generatione," 1751.

1622. ASELLI discovered the Lymphatic Vessels.

1625. Adrianus SPIGELIUS ob.

1647. PREQUET discovered the Thoracic Duct.

1650. BARTHOLINI, GLISSON, WILLIS, WINSLOW fl.

1658. SWAMMERDAM disc. the Blood Corpuscles in the Frog.

1661. MALPIGHI disc. the Capillary Blood Vessels, the Pulmonary Vesicles, and the Tracheal Tubes of Insects.

1668. REDI, "De Generatione": experiments on Spontaneous Generation and on Rotifera.

1670. Robert HOOKE. "Micrographia."

1673. LEEUWENHOEK disc. Human Blood Corpuscles.

1686. WILLOUGHBY, "Historia Piscium," publ. by Ray.

1694. John Ray (born at Black Notley, near Braintree, in 1628), publ. "Synopsis Animalium Quadrupedum et Serpentium.

1700. Publ. "Methodus Insectum."

1707—1778. Carolus Linnæus. Publ. "Systema Naturæ, 1735."

1707. Buffon.

1745. Trembley's experiments on *Hydra viridis* (Geneva).

1728—93. John Hunter.

1735—94. Caspar Fr. Wolff, embryologist.

1769—1832. Georges Cuvier. Born at Montbéliard; succeeded Daubenton at the Collége de France. "Règne Animal," 2nd ed. 1829.

1781—1833. J. F. Meckel, zootomist.

1794—1865. Pander, embryologist.

1824. Segmentation of the Yolk, disc. by Prevost and Dumas.

1827. Von Baer, "Entwickelungsgeschichte."

1839. Schwann. Cellular theory.

1801—58. Johannes Müller.

1859. Darwin. "Origin of Species."

GENERAL BIBLIOGRAPHY.

Elementary Books:—

Milne Edwards. "Zoologie."

Carpenter. "Zoology."

Dallas. "Animal Kingdom."

Nicholson. "Manual of Zoology."

Mivart. "Elementary Lessons in Anatomy."

Text Books:—

Huxley. "Introduction to the Classification of Animals," 1869.

Gegenbaur. "Vergleichende Anatomie." 2te. Aufl. 1870.

Bronn. "Klassen und Ordnungen des Thierreichs:" begun 1859.

Van der Hœven. "Handbook of Zoology" (translated from the Dutch by the late Prof. Clark), 1856-58.

Rolleston. "Forms of Animal Life," 1870.

Part I.—PHYSIOLOGICAL SERIES OF SPECIMENS FROM VERTEBRATE ANIMALS.

The Vertebrata constitute a primary division, or sub-kingdom, nearly corresponding with Aristotle's Ἔναιμα, i.e. animals with (red) blood, and not more than four feet. It was recognised by Ray, Linnæus, Cuvier, and all succeeding naturalists.

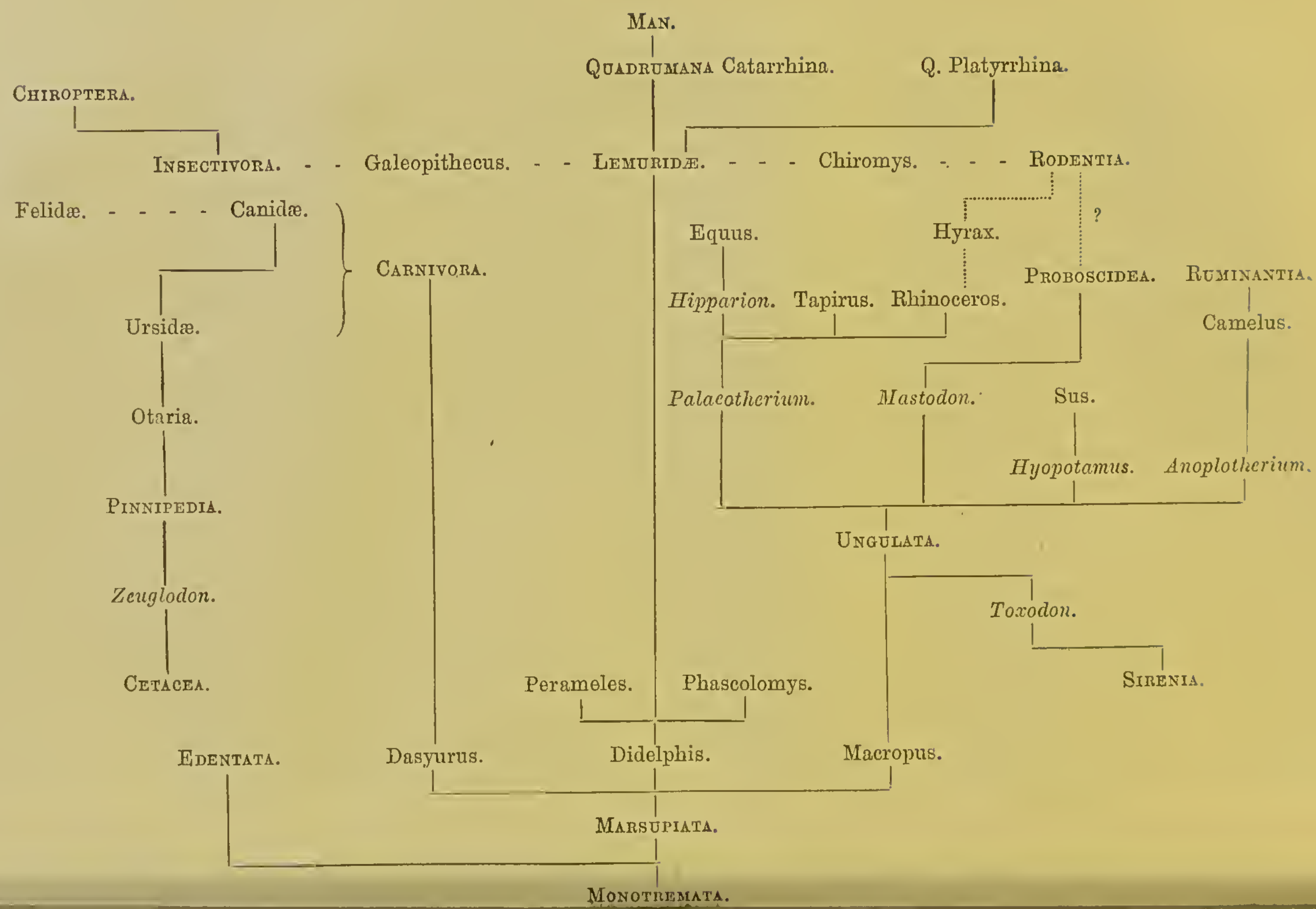
Synonyms.—Diploneura (Rudolphi), from these animals possessing a sympathetic and cerebro-spinal system; Osteozoa (De Blainville), from their vascular endoskeleton; Myelencephala (Owen), or Spinicerebrata (Grant), from the brain and spinal cord, which are peculiar to them.

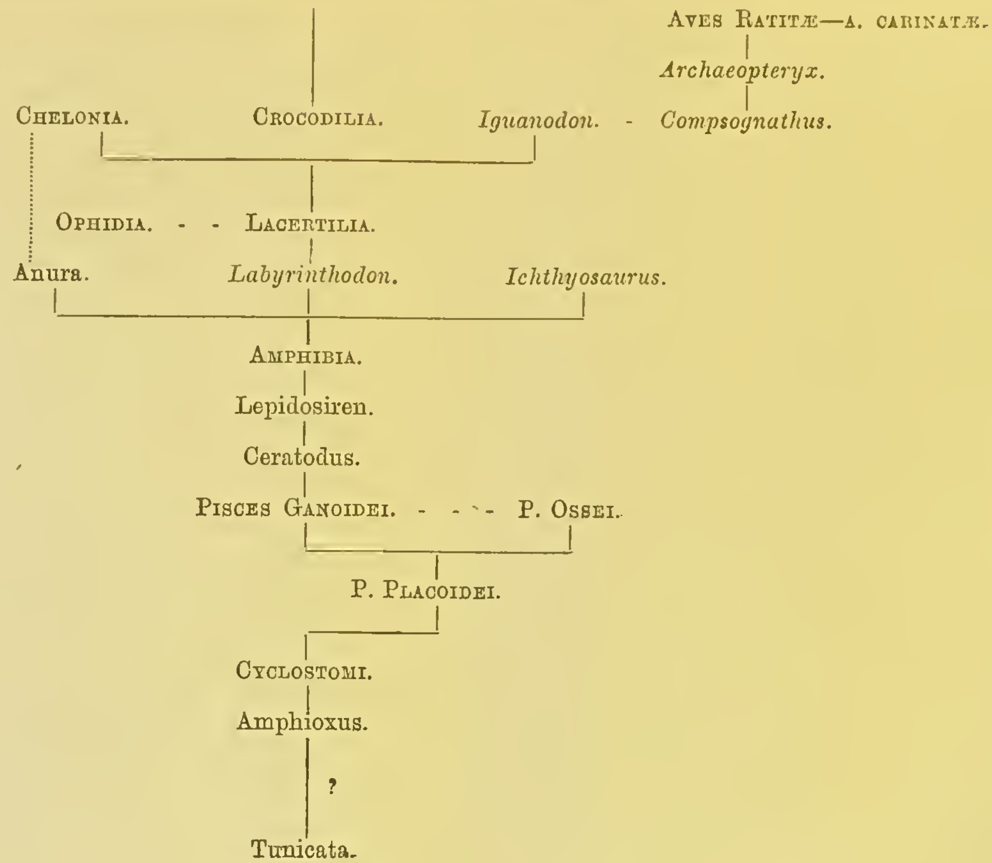
Characters.—An internal, vascular skeleton, forming more or less completely a double tube, one dorsal and neural, the other ventral and alimentary. When limbs are present they are arranged in pairs, do not exceed four, and have an articulated skeleton. The jaws are vertical. The blood-system is "complete," i.e. without lacunæ: the blood contains red corpuscles, and there is a portal system of vessels. A separate lymphatic system with lymph glands and spleen is peculiar to Vertebrata. There is a spinal cord and brain. In the vertebrate embryo there are always found a notochord and visceral arches.

Vertebrata are now divided into five classes, as follows:—

Embryo without an amnion Gills present at some period	Anamniota v. Branchiata v. Ichthyopsida		1. Pisces. 2. Amphibia.
Embryo with an amnion No gills ever present	Amniota v. Abranchiata	Sauropsida	3. Reptilia. 4. Aves.
		Mammary glands	5. Mammalia.

The following table is intended to show some of the most important relations between the various groups of Vertebrate Animals. Extinct genera are printed in italics.


MAN.
QUADRUMANA Catarrhina.
Q. Platyrrhina.
CHIROPTERA.
INSECTIVORA. - - Galeopithecus. - - LEMURIDÆ. - - - Chiromys. - - - RODENTIA.
Felidæ. - - - - Canidæ.
Equus.
Hyrax.
?
CARNIVORA.
PROBOSCIDEA.
RUMINANTIA.
Hipparion.
Tapirus.
Rhinoceros.
Camelus.
Ursidæ.
Palaeotherium.
Mastodon.
Sus.
Otaria.
Hyopotamus.
Anoplotherium.
PINNIPEDIA.
UNGULATA.
Zeuglodon.
Toxodon.
CETACEA.
Perameles.
Phascolomys.
SIRENIA.
EDENTATA.
Dasyurus.
Didelphis.
Macropus.
MARSUPIATA.
MONOTREMATA.


AVES RATITÆ—A. CARINATÆ.
Archaeopteryx.
CHELONIA.
CROCODILIA.
Iguanodon. - Compsognathus.
OPHIDIA. - - LACERTILIA.
Anura.
Labyrinthodon.
Ichthyosaurus.
AMPHIBIA.
Lepidosiren.
Ceratodus.
PISCES GANOIDEI. - - - P. OSSEI.
P. PLACOIDEI.
CYCLOSTOMI.
Amphioxus.
?
Tunicata.

Series I.—ENDOSKELETON, &c.

A vascular internal skeleton is peculiar to Vertebrata, but is not universal among them, being represented in the lower forms, as in the early stages of development of all, by cartilage or fibrous tissue. Three kinds of bone may be distinguished: that developed from cartilage, like the human femur; that from fibrous tissue, like the parietal bone; and surface ossifications of perichondium, as the clavicle, in part.

Structurally, the skeleton is divided into the Axial part, consisting of the vertebræ (cervical, thoracic, lumbar, sacral, and caudal), with the sternum and vertebral and sternal ribs (or costal cartilages), and the bones of the skull; and the Appendicular skeleton of the limbs.

The following is a list of the principal bones, with those in human anatomy to which, so far as is ascertained, they correspond.

The bones marked with an asterisk are developed from membrane. Words in italics are names used by French or German anatomists.

Vertebræ (Columna Spinalis, ράχις, Rückengrat).

Regions.

Cervical	*Halswirbel.*
C 1	Atlas.
C 2	V. dentata, epistropheus, axis.
Thoracic	V. dorsales, *Brustwirbel.*
Lumbar	V. abdominales, *Lendenwirbel.*
Sacral	Os sacrum, *Kreutzbein.*
Caudal	Os coccygis, *Stiessbein.*

Parts.

Centrum	Body, with occasionally an azygos Hypapophysis.
Neural arch	Pedicles and laminæ.
Sup. transverse processes (Diapophyses)	post. tubercles of cervical transv. prs. Transv. prs. of dorsal vert.
Inf. do. (Parapophyses)	transv. prs. of lumbar, ant. pr. of cerv. vert. (Cervical ribs.)
Anterior Zygapophyses	sup. articular pr.
Posterior do.	inf. do.
Accessory transverse processes, Metapophyses	Mamillary processes.
Anapophyses	

Neural spine .. .. spinous process.
Remains of Notochord .. .. .. Intervertebral substance.
Chevron, subcaudal, or V-shaped bones .. .. .. absent.

SKULL.

FIRST CRANIAL SEGMENT (azygos).
Basioccipital, *Hinterhauptsbein*, Occipitale basilare .. Basilar pr.
Exoccipital, R. & L., Occipitale laterale .. Condyles and adjacent parts.
Superoccipital, Occipitale superius .. Lamina vel squama occipitis.

AUDITORY CAPSULE, R. & L.
Pro-otic }
Epi-otic } Periotic or Petrosal (*Pyramide*) .. .. Pars petrosa.
Opisthotic }
Tympanic * .. .. Ring of Meatus auditorius externus, *Paukenbein.*
Squamosal * .. Pars squamosa. *Portion écailleuse, Schläfenbein.*
Malleus.
Incus.
Stapes = Columella.
Parasphenoid.* .. .. Absent.

SECOND CRANIAL SEGMENT.
Basisphenoid .. .. Hind part of body of sphenoid (*Keilbein*).
Alisphenoid, R. & L. .. .. Alæ Majores.
Parietal, R. & L.* .. .. Parietal, *Scheitelbein.*
Interparietal.*

OPTIC CAPSULE, R. & L.
Bony sclerotic plates * .. .. Fibrous sclerotic.

THIRD CRANIAL SEGMENT.
Praesphenoid .. .. .. Front part of body of sphenoid.
Orbitosphenoid, R. & L. .. .. Alae minores.
Frontal, R. & L. * (often united) .. Frontal, *Os coronal*, *Stirnbein.*
Præfrontal, R. & L.
Postfrontal, R. & L.

OLFACTORY CAPSULE, R. & L.
Ethmoturbinal .. .. Superior and middle turbinated.
Maxilloturbinal .. .. Inferior do., *cornet inférieur*, *Muschelbein.*
Mesethmoid .. .. Perpendicular plate of Ethmoid.
Os en ceinture (Cuv.), part of Ethmoid in Frogs, or = Orbitosphenoid (Gegenbaur).

Nasal, R. & L.*

Lacrymal, R. & L.*	Os unguis, *Thränenbein.*
Vomer, sometimes R. & L.*	*Pflugscharbein.*
Præmaxilla, R. & L.*	Intermaxillary bone, Zwischenkiefer.
Maxilla, R. & L.*	Maxilla superior, *Oberkiefer.*
Jugal, R. & L.*	Os Malæ, *Jochbein.*
Quadrato-jugal, R. & L.*	Absent.
Palatine, R. & L.	Os Palati, *Gaumenbein.*
Pterygoid, R. & L.	Pr. Pterygoideus internus.
Ectopterygoid, Os transversum in Reptiles	Absent.
Metapterygoid, R. & L. (= Cuvier's "tympanique" in Fishes)	Absent.
Os quadratum	Absent.
Mandible, R. & L., Meckel's Cartilage	Inferior Maxilla, *Unterkiefer.*
Pars Articularis	Condyle.
Angularis	Angle.
Dentalis	Alveolar process.
Accessoria,* splenial = opercular of Cuvier?	Inner plate.
Suspensorium { Hyomandibular = Cuvier's "temporal"	Absent.
Suspensorium { Symplectic	do.
Hyoid apparatus.	
Basihyal = Copula	Body of hyoid bone, *Zungenbeinkörper.*
Anterior median spine = Os entoglossum or glossohyal	Absent.
Posterior do. = urohyal	Absent.
Thyrohyal	Greater process.
Ceratohyal	Lesser process.
Branchiostegal rays	Absent.
Epihyal*	Stylohyoid ligament.
Stylohyal	Styloid process.
Tympanohyal	Ancylosed.
Opercular bones, or Gillcover	Absent.
Operculum—praeoperculum—suboperculum—interoperculum.	
Branchial Skeleton	Absent.
Median chain of bones (copulæ), and 5 or more pair of branchial arches.	

THORAX.

Ribs (Costæ) R. & L.	
Vertebral (pleurapophyses)	Bony ribs.
Sternal (hæmapophyses)	Costal cartilages.
Sternum, *Brustbein.*	
Prosternum (rostrum)	Manubrium.
Episternum = †Interclavicle or omosternum	Absent.

† United with the claviclos in Birds to mako the *furcula* or merrythought.

Mesosternum	Gladiolus.
Xiphisternum	Ensiform process.

UPPER (ANTERIOR) LIMB R. & L.

Scapula, *Omoplate*, *Schulterblatt.*

Præscapular fossa	supraspinous fossa.
Postscapular do.	infraspinous do.
Mesoscapula	spine and acromion.
Suprascapula ..	Epiphysis along the vertebral edge of scapula.
Coracoid, second or posterior clavicle	Coracoid process.
Epicoracoid.	
Procoracoid (Gegenbaur) or præcoracoid (Parker).	

Clavicle, κλεῖς, *Schlüsselbein.*

Clavicle * (proper)	Clavicle.
Mesoscapular segment (Parker)	Acromial end.
Humerus, *Oberarmbein*	Humerus.
Radius, *Speiche*	Radius.
Ulna or Cubitus, *Elle* †	Ulna.

MANUS.

Radiale	Sometimes united as the Scapho-lunar bone or astragalus of the hand	Scaphoid.
Intermedium, os lunatum		Semilunar.
Ulnare, os pyramidale, os triquetrum		Cuneiform.
Centrale		.. absent.
Carpale i.		Trapezium.
ii.		Trapezoid.
iii. os capitatum		Magnum.
iv. ‡ v. os hamatum, *os crochu*		Unciform.
Metacarpale i.		bearing the Pollex, or thumb.
ij.		,, Index, or fore finger.
iij.		,, Medius, or middle finger.
iv.		,, Annularis, or ring finger.
v.		,, Minimus, or little finger.
Phalanx v. internodius i.		proximal.
ij.		median.
iij.		ungual.

† Whence our Elbow (*Ellenbogen*) the bow or bend of the Ell or Cubit.

‡ The pisiform bone is merely a sesamoid nodule, and is balanced by a similar one in the radial flexor in some animals.

LOWER (POSTERIOR) EXTREMITY R. & L.

Ilium, *Darmbein*	Ilium.
Super-ilium	Sup. epiphysis of ilium.
Ischium, *Sitzbein*	Ischium.
Pubes, *Schambein*	Pubes.
Marsupial bone * = Ossification of internal pillar of Ext. abdominal ring.	Absent.
Femur, *Schenkelbein*	Femur.
Tibia, *Schienbein* †	Tibia.
Fibula, *περόνη*, *péroné*, *Wadenbein*	Fibula.

PES.

Tibiale .. .. / Intermedium ..	Talus	Astragalus.
Fibulare	Calcaneum ..	Os Calcis, *Fersenbein.*
Centrale	Navicular	Scaphoid.
Tarsale j.	Entocuneiform ..	.. Internal Cuneiform.
ij.	Mesocuneiform ..	.. Middle do.
iij.	Ectocuneiform ..	.. External do.
iv. .. / v. ..	Cuboid	Cuboid.

Metatarsals and phalanges as in the manus, except that the term *hallux* is applied to the digit borne by the first metatarsal.

Bibliography.

Owen: Comparative Anatomy and Physiology of Vertebrates, 1866.

Huxley: *The Anatomy of Vertebrated Animals*, 1871.

——— Elements of Comparative Anatomy, 1864. The second part on the Vertebrate Skull.

Parker: Monograph on the Shoulder-girdle and Sternum, published by the Ray Society, 1868.

---

† The Patella or rotula is only a sesamoid bone in the Quadriceps extensor.

Class.—Mammalia.

Characters.—They are more or less completely clothed with hair ("Pilifera"—*Ray*).

The skull articulates with the spinal column by two condyles, and the mandible directly with the squamosal.

They are hot blooded, i.e. they can keep the temperature of the blood above that of the surrounding medium. The heart has four chambers and a single, left aorta. The red corpuscles are non-nucleated. They breathe by lungs only, and have a complete diaphragm.

The brain possesses a corpus callosum and pons.

The embryo has, beside an amnion and small allantois, a placenta (except in the orders Marsupiata and Monotremata), and, after birth, is suckled by the mammary glands of the mother.

Temminck: "Monographies de Mammalogie," pl. 1827. Blainville: "Osteographie," pl. 1839—44. Bell: "History of British Quadrupeds," figs. 1837. Owen: "History of British Fossil Mammals and Birds," figs. 1846. "*Flower: "Introduction to the Osteology of the Mammalia,*" figs. 1870. G. H. Morrell: "Student's Guide to Dissection (Mammalia)," 1873.

Order. Primates.

Char.—Unguiculate; clavicles; only four præmaxillary teeth. Placenta discoid and deciduate.

Fam.—*Anthropidæ.*

Char.—Plantigrade; attitude erect, with various corresponding modifications of the form and proportions of the skeleton. Long hair, only partially developed. Pollex opposable; hallux not. Teeth i. $\frac{2-2}{2-2}$ c. $\frac{1-1}{1-1}$ pm. $\frac{2-2}{2-2}$ m. $\frac{3-3}{3-3}$, forming an even and uninterrupted series. Complicated cerebral convolutions.

For a complete list of the anatomical charactors in which Man differs from the Anthropoid Apes, seo Mivart, p. 494; also, Huxley, "Anat. Vert. Animals," pp. 488—493. (The possession of articulate languago and of various mental endowments are omitted from a classification based purely on structural peculiaritics.)

Distribution.—The natural Family of Man is a single genus and species: it has been divided into various Races according to the colour of the skin and hair, the form of the skull, language, &c.

1. The Caucasian, or Aryan race, speaking Indo-European or Semitic languages.* The Xanthochroic or fair variety of this group is the most characteristic. The "Dark Whites" (Melanochroi) are believed by Prof. Huxley to result from a mixture of Xanthochroi with another race. The primitive seat of the Caucasians was probably the Highlands of Western Asia.

2. The Mongol or Turanian race, speaking languages without inflexions.† Mostly brachycephalic (with round skulls). Inhabiting Asia, north of Persia and Hindoostan and west of the Ganges.

3. The "Red Indians" of North and South America. These are classed by Professor Huxley with the Mongol race, of which they are supposed to be the parents.

4. The Malays, inhabiting part of the East Indian Islands, Polynesia, and New Zealand, and including the Hovas of Madagascar.

5. The Australian race, including the Tasmanians (and Papuans ?) with perhaps some tribes in Southern India.

6. The true Negroes, with woolly hair (Ulotrichi), inhabiting Africa. Mostly dolichocephalic (with long heads).

Pritchard: "Races of Mankind." 18 . Lawrence: "Lectures on the Natural History of Man." 1823. Huxley: "Anat. Vert. An." pp. 494—7.

Palæontology.—There is no doubt that mankind is the last in time of all organised creatures. Human skeletons, as at present known, all belong to the recent geological period, and perhaps to historical times; but human remains (stone and flint and bone implements, drawings of animals, refuse heaps, &c.) have been found along with the bones of the mammoth and other extinct animals.

Lubbock: "Prehistoric Times, 1869." Lyell: "Geological Evidences of the Antiquity of Man," 1863.

---

* Sanscrit (ancient Indian), Zend (ancient Persian), Greek, Latin, Teutonic, Lithuanian, Celtic, Sclavonic, &c., and Hebrew, Arabic, Aramaic (ancient Syrian), &c.

† Chinese, Japanese, Gourkas, Esquimaux, Finns, Basques (?), &c.

PRIMATES.

1. Human skeleton: adult male.

2. Human skeleton: adult female.

3. Skull of New Zealander.

This man died in the Hospital. He was of full stature and of remarkably fine development.

3^5. Wax-model of head of the same individual.

3^{10}. Ditto with Calvaria removed.

3^{15}. Ditto showing upper surface of brain.

4. Skull of a Turk; brachycephalic and globular.

4^5, 4^{10}. Wax model of head and brain of the same individual.

5, 5^5, 5^{10}. Three wax models of the head and brain of a Mulatto.

6, 6^5. Two wax models of the head and brain of a Negro.

7, 7^5. Two wax models of the head and brain of a Peruvian.

This man died in the Hospital of pneumonia after measles.

Fam. *Simiadæ.*

This family corresponds to the Quadrumana of Cuvier, exclusive of the Lemurs.

Char.—The whole body is covered with hair, and on the forearms this slopes upward. The arms, and especially the forearms, are very long. The hallux is short and opposable. Some have gluteal callosities, some a prehensile tail. The chest is deeper than it is broad, the pelvis narrow, and its axis nearly that of the trunk. The orbit is usually complete.

The teeth have a diastema. Formula as in man, or p.m. $\frac{3-3}{3-3}$. The heart is placed less obliquely than in man. The brain is convoluted in most monkeys, but in some of the smallest it is smooth. The testes are scrotal; the penis pendent and without an ossification of its fibrous *septum pectiniforme*. The fundus of the uterus is single, and the placenta discoid and deciduate.

Monkeys do not readily walk, and cannot maintain the erect position, but they are climbers, and arboreal in habit. They are all frugivorous, but also eat insects, &c.

Distr.—They inhabit warm countries only—Barbary (with Gibraltar) and China in the Palæarctic region; India, Africa, Malaya, and Tropical America.

Extinct forms (e.g. *Dryopithecus*) occur in various parts of Europe. These belong to the Catarrhine division, as do all the fossil monkeys yet found in the old world; while all yet found in America are, like the existing species, Platyrrhine.

Catarrhina.—This group of genera is confined to the old world (*Eopitheci*); the nostrils are near together, and the molars only five above and below. The tympanic bone forms an external meatus as in man, and there is no auditory bulla.

11. A young Ourang-outang (*Simia* v. *Pithecus satyrus*). Habitat Borneo.

Twelve pair of ribs; nine carpal bones, the extra one being the os centrale (p. 27). See also prep. 767.

12. A young Chimpanzee (*Troglodytes niger*). W. equatorial Africa.

Thirteen ribs; only eight carpal bones as in man. See also prep. 768.

14. Mandril (*Cynocephalus mormon*) ... ... Africa.

Notice its longer tail, more produced jaws, and larger canines, compared with 11 and 12.

15. Skull of Baboon; lower jaw wanting.

16. Articulated vertebrae and limbs of *Cynocephalus chacma.*

See also prep. 769.

17. Barbary Ape (*Macacus inuus*) ... ... N. Africa.

Twelve pair of ribs; eight carpal bones; short tail.

18. Pigtailed Baboon (*M. nemestrinus*) ... ... Java.

19. Skull of Macaque (*M. cynomolgus*)... ... ... India.

20. Skeleton of Monkey (*Cercopithecus sp.*) ... ... Africa.

20[3]. Skull of young specimen of the same genus.

20[5]. Stuffed Green Monkey (*C. callitrichus*) ... W. Africa.

Platyrrhina or *Cebidæ*, including Spider Monkeys (*Ateles*), and Howlers (*Mycetes*). They are only found in the new world (*Hesperopitheci*). Their nostrils are widely separated, and there are six molars above and below. They have a tympanic bulla and usually more ribs than the Catarrhina.

21. Spider Monkey (*Ateles*). S. America.

Rudimentary pollex; hallux well developed; fourteen ribs; prehensile tail, with chevron bones; milk dentition.

22. Capuchin Monkey (*Cebus*). Brazil.

23. Squirrel Monkey (*Callithrix* v. *Saimaris sciureus*). Guiana.

24. Marmozet Monkey (*Hapale Jacchus*). Brazil.

This genus differs from other American monkeys in having five molars above and below, like the Catarrhina; but three of them are præmolars. The cranium is large. Neither pollex nor hallux opposable.

26. Disarticulated bones of a small Monkey.

27, 28. Upper and lower extremities of a Monkey, articulated.

See also Preps. 500 – 502, 612, 612^5, 770 – 775, 927, 966, 1011, 1058, 1069, 1078, 1084, 1085, 1118.

Fam. *Lemuridæ.*

Syn. Prosimiæ, Strepsirrhina. This group is probably of ordinal or subordinal value. It is lower and older than the true monkeys.

Char.—Hallux and pollex opposible. Fourth digit long. Hard palate, thickened at its edge (v. prep. 502^5).

Dental formula varies. Orbit open behind, though the marginal ring is completed by the malar joining the frontal bone. Sublingua. Cerebrum only slightly convoluted. Uterus two horned, as in other mammals. Mammæ pectoral; placenta deciduate—not discoid, but peculiar in form, the villi covering the whole surface of the chorion except at the os uteri.*

Distr. Madagascar; also some parts of Africa, India, and S. E. Asia.

---

* See Alphonse Milne Edwards' description, "Ann. des Sc. Nat." Tom. xv. 1872.

29. Lemur (*Lemur* sp.) Presented by Mr. Morgan. Hab. Madagascar.

Notice the elongated face, large opposable hallux, and long lumbar region. Molars 6, C. vert. 7, D 12, L 7. Habits nocturnal.

30. Another skeleton of Lemur, disarticulated.

See also preps. 502^5, 613, 613^5, 776.

Order Chiroptera.

Char.—Insectivora modified for flight. Large clavicles; anterior extremities very long and slender, especially the four outer digits on which a prolongation of the skin (*patagium*) forms an enormous web-fingered wing. The thumb has a strong nail and is used by the Bat to hang itself to trees. Some have a keeled sternum, like birds. Teeth various; canines always present. Insectivorous, sanguisugous, or frugivorous.

Two innominate arteries.

Brain unconvoluted.

Cryptorchous, i. e. the testes do not descend from the position in the abdomen which they occupy during fœtal life in all mammalia. Placenta, deciduous, discoid; mammæ pectoral.

Bats are nocturnal and arboreal in habit, and are found in all regions of the globe, including Australia; but most abundantly in the East India Islands and in South America.

The genera of Bats may be grouped in two large families: (1) the Insectivorous, to which the Common *Vespertilio* of these islands belongs; and also the blood-sucking Vampire (*Desmodus*) of South America. (2) The Frugivorous, are represented by the "flying foxes" (*Pteropus*) of the East Indies.

31. Skeleton of Common Bat (*Vespertilio noctula*).

Notice the clavicles, developed for flying; the curious angular curvature of the lumbar vertebræ, the open symphysis pubis, and rudimentary ulna and fibula: twelve ribs, five lumbar vertebræ.

32. Stuffed Fruit Bat (*Pteropus*). E. Indies.

See also Prep. 601, 614, 778.

Order Insectivora.

Char.—Teeth i. and c. irregular, p.m. and m. various in number, but always broad, with sharp cusps. Clavicles in all genera but *Potamogale*. Five digits: unguiculate.

Cerebrum unconvoluted.

Testes abdominal. Vesiculæ seminales.

Placenta deciduous, discoid.

Distr.—This order is most abundantly represented in the North temperate regions of the old and new world (Palæarctic and Nearctic regions), and is absent in Australia and South America. *Galeopithecus*, the "flying Lemur," inhabits the East India Islands. Cuvier placed it at the end of the Bats, St. Hilaire among Carnassiers, Linnæus and others among the Lemurs, and Van der Hoeven makes the order Ptenopleura for its reception.

Affinities.—The smooth brains, the large comparative development of a coracoid bone, and hybernating habits of the Insectivora show a "low" organisation. Their nearest allies seem to be the Bats and Lemurs, but they also have resemblances to the true Carnivora, the Rodents, and the insectivorous Marsupials.

Mivart: Notes on the osteology of the Insectivora, Jour. Anat. and Phys. i. 281, and on Hemicentites, P.Z.S., 1871.

33. Skeleton of common Mole (*Talpa Europæa*).

Notice the wedge-shaped head, short neck, long narrow scapulæ, strong clavicles,* humerus with marked muscular impressions, and broad manus. In the carpus, beside the usual sesamoid bone on the ulnar side (pisiform of human anatomy), there is a sesamoid bone in the tendon of the *Flexor carpi radialis*, as in the dog, and this is large and sickle-shaped (*os falciforme*). The pelvis of the mole is so narrow that the rectum and urinogenital canals do not pass through, but below, and external to it.

34. Two other specimens.

---

* These are probably chiefly coracoids, the true clavicle being represented (as in *Ornithorhynchus*) by a slender membrane bone lying on the anterior surface, and early united with the rest.

35. Skull and Bones of fore-limb of Mole.

Notice the prolonged median cartilage of the nose, which contains a small bone, the prænasal, found also in the snout of the pig, which is used somewhat in the same manner. See also Preps. 503, 616, 1093, 1119.

36. Skeleton of common Shrew (*Sorex aranea*).

See also Prep. 504[5].

37. Two skeletons of Hedgehogs (*Erinaceus Europæus*).

Notice the process projecting backward from the spine of the scapula (*metacromion*) and the large clavicle. There are twenty dorsolumbar vertebræ:—i. $\frac{3-3}{2-2}$ c. $\frac{1-1}{1-1}$ p.m. $\frac{3-3}{2-2}$ m. $\frac{3-3}{3-3}$

38. Another specimen.

See also Preps. 467, 504, 615, 777, 979, 980, 1012, 1105.

Order Carnivora.

Syn.—" Carnassiers " of Cuvier, *Feræ* of Linnæus, without Insectivora.

Char.—Clavicles absent or rudimentary. Orbits incomplete. Four or five fingers and toes: unguiculate. Scapholunar bone. Ribs usually thirteen. Dorso-lumbar vertebræ usually twenty.

Teeth as in preceding orders, diphyodont,* heterodont, with the three normal tissues (enamel, dentine or ivory, and cement, "crusta-petrosa " or bone;) canines large.

Aorta gives off Left Carotid and Right Carotid and Subclavian together, Left Subclavian separate.

Brain convoluted. Testes in scrotum. No vesiculæ seminales. Placenta deciduous and zonary. Uterus often bicorporate. Teats abdominal.

Distr.—The Carnivora are found in all parts of the world except Australia, New Zealand, and some other islands.

Their remains have only yet been found in tertiary strata, where extinct forms like the sabre-toothed tiger (*Machaerodon*), the cave-lion and cave-bear, occur both in the old world and the new.

---

* Some of the seals, however, have only a partial succession of teeth. See Flower (Journal of Anat. and Phys. iij., 262).

CARNIVORA.

The order may be divided into four primary groups* :—

1. *Æluroidea* including *Felidæ*, with their allies, as hyænas, civet-cats, and ichneumons. Globular tympanic bullæ with septum; short cæcum.

2. *Cynoidea v. Canidæ*, including wolves, foxes, &c. Bullæ with rudimentary septum; curled cæcum.

3. *Arctoidea*, including *Ursidæ*, and genera resembling bears, as weasels, polecats, and otters, coatis and racoons, badgers and the panda (*Ælurus fulgens*). Flat undivided bulla, no cæcum.

4. *Pinnipedia*, the web-footed carnivora, including the common seals (*Phocidæ*), the eared seals (*Otaria*), and the walrus (*Trichecus rosmarus*).

The Carnivora are a central group of placental mammals, having some adaptive likeness to carnivorous Marsupials. The dogs are the least differentiated family, the cats the most so, while the Pinnipedia appear degraded by aquatic habitat.

Felidæ. Retractile claws; digitigrade.

39. Skeleton of Lion (*Felis leo*): a young specimen killed in the Tower by fighting with Tigers.

Hab. Africa and parts of Asia.

Notice that the limbs are supported on the phalanges only, of which there are five in front and four behind, the hallux being absent. There is a rudimentary clavicle, which does not reach the sternum or acromion, and has been lost in macerating this skeleton. Vertebræ C. 7, D. 13, L. 7, S. 3, Cd. 25. The "anticlinal" vertebra is D.xi, to which the spines in front slope backwards, and those behind forward.

39[1]. Atlas.

Notice the deep hollow for the condyles, the foramen for the first cerv. (sub-occipital) nerve, and the facet for the odontoid pr. This process probably represents the centrum of the atlas, and the bony ring in front of it an ossified ligament. See Macalister, J. of Anat. and Phys., Nov., 1868, p. 57.

39[2]. Axis.

Notice its long and deep spinous pr. and its short single transverse pr. directed backwards and perforated for the vertebral artery.

---

* Flower, P.Z.S., Jan. 14, 1869.

39^3. Cerv. vert. iii.

Scarcely any spine; short single transverse pr. vertebral foramen.

39^4. Cerv. vert. iv.

Small spinous pr. bifid transverse pr. vertebral foramen.

39^5. Cerv. vert. v.

Small spine; trans. pr. drawn outwards and backwards under a small bifid tubercle; vertebral foramen.

39^6. Cerv. vert. vi.

Longer spine; single trans. tubercle; post. transv. pr. large; vertebral foramen.

39^7. Cerv. vert. vii.

Spine moderately long; trans. pr. a simple tubercle; vertebral foramen present on the left, absent on the right, side.

39^8. Dorsal vertebræ.

The spines of the anterior ones are very long compared with those of man, but not so long as in the Ungulata (cf. 95^{10}, 108^{10}). The ant. zygapophyses overlap the post., and their facets are directed more or less directly up and down. The (sup.) trans. prs. or diapophyses have a facet for the tubercle of the rib, except Dxii and xiii. Dx first shows a small "anapophysis," sloping backwards from the neural arch. This is much larger in xi, which also shows a blunt "metapophysis" just behind the ant. articulating pr. The spine is very short in xi, which is the "anticlinal" vertebra. Dxii and xiii have large metapophyses and long, slender anapophyses; and in the latter the post. zygapophyses are long and their facets look outwards, so that they are embraced by instead of overlapping the next.

39^{21-27}. Lumbar vertebræ.

Li has a slender anapophysis and small (inf.) trans. pr. or "parapophysis." By vi the anapophysis has disappeared, and the trans. pr. attained its maximum. In Lvii the metapophysis is small, the spine pointed and nearly vertical, and the trans. pr. slender and directed forwards.

39^{28-30}. Sacrum of three vertebræ.

The two anterior only articulate with the ilia, as seen by the auricular rough surface on their ankylosed "sacral ribs," so that it would perhaps be better to call the third vertebra the first Caudal.

39^{31}. Caudal vertebræ.

The anterior ones have no spinous pr. but well marked metapophyses and trans. prs. Gradually the centra lengthen, the trans. pr. moving backward. The neural canal, the anterior, and, afterwards, the posterior zygapophyses successively vanish. An anterior transverse process appears in front, and two small diverging hypapophyses below. Lastly, these also can be no longer traced, and the vertebræ are reduced to short cylinders representing centra and joined only by fibrocartilage.

39[60]. Sternum.

Of the eight "sternebræ" composing it, the manubrium has a slight prolongation forwards, and the last, or xiphisternum, is long and expanded behind.

39[65]. First, second, fifth, and thirteenth Ribs.

The anterior ribs are broad and but slightly curved; the last two have only a capitular articulation. The sternal ribs are unossified.

40. Scapula, R. and L.

Notice the large antaxial (supraspinous) fossa, the short acromion, and rudimentary coracoid.

41. Humerus, R. and L.

Notice the supracondylar foramen above the inner condyle for the median nerve and brachial artery.

42. Left Radius and Ulna.

The ulna is fully developed (cf. 109[10]), and there is slight supination possible.

43. Disarticulated bones of foot.

43[10]. One digit of a Lion's Paw, articulated.

Observe the process of the ungual phalanx which surrounds the base of the retractile claw.

43[15]. Innominate bones, R. and L.

The ilia are narrow compared with those of Man, but much broader than e. g. in *Macropus*, No. 214.

43[20]. Femur, R. and L.

The neck is short and nearly transverse; there are two trochanters and a very deep digital fossa.

43[25]. Tibia and Patella, R. and L.

43[30]. Right Fibula.

Slender, but complete and not ancylosed to the tibia.

43[35]. Disarticulated bones of right Pes.

44. Skull, in longitudinal section.

Notice the anterior position of the face to the cranium, so that the cribriform plate of the ethmoid is nearly vertical; also the great development of the turbinal bones.

45. Skull of the Lion "Hector," from the Tower Menagerie.

Notice the large orbit, not complete, but more nearly so than in the Dog (68), the enormous width of the zygoma, the short jaws, and few molar teeth; also the bullous inflation of the floor of the meatus auditorius externus, and the inconspicuous paroccipital process. See Flower, l. c. pp. 145—7, and compare with the skulls of the Monkey, Dog, and Sheep.

45^5. Skull of young Lion, with horizontal section of calvaria.

45^6. Another specimen.

45^{10}. Skeleton of Lioness.

See also preps. 516, 517, 619, 784, 1018, 1060, 1069^5, 1136, 1137.

46. Skeleton of Tiger (*Felis tigris*). Hab. Bengal, Sumatra, &c.*

Notice that the nasal bones reach further back than the maxillæ, whereas in the lion they are on the same level, or fall short.

46^5. Skull of Tiger.

46^{10}. Another large specimen—left maxilla diseased.

46^{15}. Another specimen.

See also Preps. 600, 906, 1014, 1129.

47. Skeleton of Panther (*Felis leopardus*). Hab. India.

The African leopard has been described as *F. varia*. See also 779.

48. Tiger Cat (*Felis leopardus* var.)

49. Ocelot (*Felis pardalis*). Hab. America.

50. Disarticulated bones of Jaguarondi (*Felis pardalis* var.) Central America.

See also Preps. 620, 621, 780, 781.

51. *Felis Catus* (domestic variety).

52. Another specimen.

53. Skeleton of a fœtal Kitten.

Notice the large, smooth, globular cranium, and small face. The generic characters are slightly marked, as is usual in young animals.

55. Disarticulated bones of a Cat.

56. Fore Foot of Cat, with Ligaments dissected.

---

* Tigers also extend into China, and are found in the cold regions of Northern Asia.

56[5]. Skull of Cat.

Notice the large tympanic bullæ, interparietal bone, large orbits with nearly complete margins and short muzzle. The calvarium has been sawn across to show the ossified tentorium.

56[10]. Another specimen.

56[15]. Ditto.

56[20]. Ditto.

See also Preps. 514, 617-618, 743, 744, 782, 783, 968, 969, 1015, 1069[10], 1130--1135.

Monograph of this species, Straus Durckheim, "Anat. Descr. et Comp. du Chat." 1845.

Hyaenidae. Claws not retractile ; four toes to each foot ; dental formula,

$$\text{i. } \frac{3-3}{3-3} \text{ c. } \frac{1-1}{1-1} \text{ m. } \frac{5-5}{4-4}.$$

57. Skeleton of striped Hyæna (*H. striata*). Hab. Africa ; also through Arabia and Persia to Hindoostan. The spotted and hairy species (*H. crocuta*, *H. villosa*) are only found in South Africa.

Notice that there are fifteen ribs, two more than in Cats, but only five lumbar vertebræ.

57[10]. Skull of Hyæna.

See also Prep. 517[5], 622, 623, 1086, 1087.

Viverridæ. Dental formula, $\text{i. } \frac{3-3}{3-3} \text{ c. } \frac{1-1}{1-1} \text{ p.m. } \frac{4-4}{4-4} \text{ m. } \frac{2-2}{2-2}.$

58. Skeleton of Civet Cat (*Viverra Civetta*). Hab. Africa.

59. Skeleton of Ichneumon. (*Herpestes*). Hab. Africa and India.

59[5]. Two other specimens.

59[10]. Stuffed Ichneumon (*Herpestes griseus*). Hab. India.

See also Preps. 623[5], 793, 1088.

59[50]. Skull of Paradoxurus (*P. typus*). Hab. India.

This Civet, known as the Palm-cat, is plantigrade, and arboreal in habits. It lives chiefly on fruits. The specimen first described was named from the individual peculiarity of carrying its tail twisted.

Canidæ. In the genus *Canis* the tympanic bulla is very slightly divided ; usually five toes in front, and four in hind feet ; digitigrade ; dental formula, $\text{i. } \frac{3-3}{3-3} \text{ c. } \frac{1-1}{1-1} \text{ p.m. } \frac{4-4}{4-4} \text{ m. } \frac{2-2}{3-3}$; Cæcum.

60. Skeleton of a Fox (*Canis vulpes*). Or, subgenus *Vulpes*, sp. *alopex.*

See also Prep. 628, 629, 788, 789.

61. Skeleton of a Wolf (*Canis lupus*).

62. Vertebral Column of Jackal (*C. aureus*), with intercostal arteries injected. India.

63. Skeleton of a Dog (*C. familiaris*).

Twenty dorso-lumbar vertebræ, thirteen bearing ribs; three sacral and about twenty caudal; sternum narrow; clavicle very small and does not reach any other bone; humerus perforated between the fossæ for the olecranon and coronoid process, but without a supracondylar foramen. See description, Huxley, p. 415.

63^5. Skeleton of a Dog, which belonged to Mr. William Hunt, of Petersham.

64. Skeleton of a Kamtschatka Dog.

65. Skeleton of a Newfoundland Dog. (*C. familiaris*, var. *Novæ-terræ*).

66. Skeleton of Fœtal Puppy.

67. Disarticulated Skeleton of Dog.

68. Skull of Newfoundland Dog.

Notice the incomplete orbits, the wide zygoma, and sagittal crest for the great temporal muscles, the supra-angular process of the mandible, and the small interparietal bone which is united with the supra-occipital. Cf. 44, 56^5, and 80.

68^1. Skull of a large Dog.

68^3. Another specimen.

68^5. Disarticulated Skull of a Dog.

68^{15}. Skull of an American Dog.

69. Skull of Spaniel.

70. Skull of Bull-terrier.

71. Skull of Bull-dog.

72. Skull of Barbet.

73. Another specimen.

74. Skull of Greyhound.

77, 78. Anterior and posterior extremities of Dog, articulated (both left).

See also preps. 518—521, 624—627, 736[5], 742, 785—787, 907, 970, 971, 1092, 1138—1143.

Mustelidæ. The Weasels and their allies are tho Vermigrade Carnivora of Linnæus.

79. Skeleton of British Pole Cat (*Mustela Putorius*).

i. $\frac{3-3}{3-3}$ c. $\frac{1-1}{1-1}$ p.m. $\frac{3-3}{3-3}$ m. $\frac{1-1}{2-2}$. See also preps. 507, 508.

80. Skeleton of common Otter (*Lutra vulgaris*).

80[5]. Another specimen disarticulated.

Notice the entire absence of a post. wall to the orbit, the narrowing between the flat, broad cranium and long face, and the flattened tympanic bulla. See also preps. 509, 510, 790.

Subursidæ v. *Procyonidæ*. Plantigrade.

81. Stuffed Kinkajou (*Cercoleptes candivolvulus*). Hab. Guiana.

81[5], 81[10]. Two skeletons of Coati (*Nasua*). Hab. America.

See also preps. 513, 631.

82. Skeleton of Racoon (*Procyon lotor*). Hab. America.

See also prep. 511.

83. Skeleton of common Badger (*Meles taxus*).

Fifteen ribs, five lumbar vertebræ.

84, 84[10]. Two Badgers' Skulls.

See also prep. 632.

Ursidæ. Plantigrade. The true bears are less exclusively carnivorous than the preceding families. They are widely distributed.

85. Skeleton of a Black Bear (*Ursus Americanus*).

Neartic Region.

Notice that there is no supracondylar foramen: the clavicle is entirely absent. Fourteen ribs, six lumbar vertebræ.

86. Skull of a Black Bear (lower jaw wanting).

Notice the flattened form of the tympanic bulla and the long palate; also, the great size of the anterior nares.

87 } 87^{5} } Two Skulls of Brown Bears (*Ursus arctos*). Hab. Europe.

87^{10}. Another specimen, young.

88 } 88^{5} } 88^{10} } Three Skulls of White Bear (*Ursus* v. *Thallassarctos maritimus*).

"One was shot in Parry's Expedition, and was four feet ten inches long." Notice the elongated skull compared with 86, 87.

88^{20}. Skull of Cub of White Bear.

See also Preps. 633, 797, 1144.

Phocidæ.—Beside their webbed feet, these Carnivora are remarkable for the absence of a lacrymal bone and imperfect teeth.

89. Skeleton of the Common Seal (*Phoca vitulina*).

Notice the position of the hind limbs and the long outer digits of the hind feet; also the episternum. Fifteen ribs, five lumbar vertebræ.

There are four other British seals, *P. fœtida* (v. *hispida*, v. *annellata*), the ringed seal; *P. groenlandica*, the harp seal; *P. barbata*, the bearded seal; and *Halichœrus gryphus*, the great grey seal.

90. Section of Skull of Fœtal Seal, showing the nasal passage and its folds of mucous membrane.

91. Turbinated bones of a Seal.

The superior and middle (ethmoidal) bones are small, but the anterior (maxillo-turbinal) is very large.

92. Sternum and vertebræ of Seal.

The sternum consists of nine pieces, beside the cartilaginous episternum, or anterior prolongation of the manubrium.

92^{5}. Left upper extremity and pes of fœtal Seal.

93. Section of rib of Seal.

See also Preps. 521^{5}, 598, 635, 636, 799, 798, 904^{20}, 905^{15}, 908, 1016, 1017, 1035, 1069^{15}, 1089, 1145.

94. Two Skulls of the Walrus (*Trichecus rosmarus*).

Hab. Arctic Seas.

"One was presented by Capt. Parry to Capt. Browill, and by Mr. Jas. Browill to the Museum."

Notice the long palate and small tympanic bulla.

See also Preps. 522—523^{5}, 1091.

Order Proboscidea.

This order contains only one existing genus, *Elephas*, with two species *E.* (v. *Euelephas*) *Indicus* and *E.* (v. *Loxodon*) *Africanus*, of which the former is the more specialized, the latter more allied to the extinct genus *Mastodon* and to the other herbivorous mammals.

Char.—Teeth monophyodont and diphyodont, i. $\frac{1-1}{0-0}$ c. $\frac{0-0}{0-0}$ m. $\frac{1-1}{1-1}$ or $\frac{2-2}{2-2}$. Snout prolonged into a long muscular proboscis, at the end of which the nostrils open.

Skull large, deformed by extensive formation of air-sinuses in the adult animal. Anterior nares very high ; no clavicles ; very large ulna ; very long femur, with only one trochanter. Almost planti- and palmi-grade. Five digits, united and enclosed each in a hoof. Aorta divides into a common ascending and a descending branch.

Testes abdominal. Placenta deciduous, zonary. Mammæ axillary.

Affinities and Distribution.—The Elephant has some curious resemblances to Rodentia in its dentition, the form of its scapula and some other points, but on the whole it appears to be an aberrant and highly developed Ungulate.

The two existing species are only found in India and in Africa respectively.

The Mammoth (*E. primigenius*) existed in comparatively recent times in Europe and Northern Asia. One was found frozen entire in Siberia in 1805. The Mastodon, representing another family of the order, is very widely distributed, especially in North America. The third family (genus *Dinotherium*) had lower incisor tusks only, while some Mastodons had upper and lower. All the extinct Proboscidea belong to the middle and later Tertiary strata.

95. Skeleton of a Female Indian Elephant, which died at Chiswick. Presented by the late Duke of Devonshire.

Compare the backward process from the spine of the scapula (*metacromion*) with that of the Capybara, No. 187. Notice also the long, straight thigh bones, the large ulna, short carpus and tarsus, projecting forehead, and spout-like process to the lowerjaw. Ribs 20, D—L. vert. 23.

95[1]. Atlas.

95[2]. Axis, with small odontoid process partially united.

95[3]. Third cervical vertebræ.

95[5]. Fifth cerv. vert.

95[6]. Sixth cerv. vert.

Notice the thin centrum with its epiphyses ununited, and the neuro-central suture.

95[7]. Seventh cerv. vert.

95[10, 20]. Dorsal vertebræ.

95[31]. Sacrum: four vert. centra free, laminæ united.

96. Skull of a young Elephant. Presented by Mr. Bell.

Notice how much less extensive the air sinuses are, compared with those of the adult (99). Cf. Flower: figs. 59, 60.

97. Skull of an African Elephant (lower jaw wanting).

The forehead is more convex than in the Indian species; the pattern of the molars is different and the ears larger.

98. Lower jaw of Indian species. Presented by Mr. Morgan.

99. Longitudinal section of skull. Presented by Lieut.-Colonel Herriot.

100. Scapula: right and left.

100[5]. Humerus: right and left; one in section.

101. Ulna: right and left.

101[5]. Radius of a young Elephant.

The lower epiphyses of both have been separated, and both cut through longitudinally to show the whole interior filled up with cancellous tissue, without any medullary cavity.

101[6]. Carpal bones. All left, except the pyramidale (p. 27).

101[10]. Ossa innominata of Elephant.

Notice the broad expanded ilia.

101[15]. Femur of Large Elephant, cut to show the cancellous tissue of the head, and condyles.

Notice that there is only a single trochanter.

101[17]. Right Femur of Young Elephant, with the three epiphyses ununited.

101[18]. Patella, R. and L.

101[20]. Tibia.

101[25]. Fibula.

101[30]. Tarsal bones, right.

101[35]. Metatarsal and phalangeal bones.

101[40]. Tibia of Fossil Elephant (*E. etruscus*).

See also Preps. 471, 656, 804, 805, 901[10], 905, 910, 911, 929, 1019, 1020, 1146.

Genus Hyrax.

The animal which forms this genus was placed by Pallas and by Linnæus among the Rodents.* It agrees with these chiefly in its incisor teeth and its external form and habits. Cuvier showed the likeness of its molar teeth to those of the Rhinoceros, and placed it in his order "Pachydermata." But it has so many peculiarities of its own, that it is best regarded as an isolated form, for which the ordinal name Lamnungia (Illiger) or Hyracoidea (Huxley) may be used for the sake of uniformity.

There are several species, found in Abyssinia, the Cape, and other parts of Africa; and also in the adjacent regions of Arabia and Syria.

No allied fossil forms have yet been found.

Chars.—Plantigrade, unguiculate, with four anterior and three posterior toes; thick fur and whiskers.

Dental formula, i. $\frac{2-2}{2-2}$ c. $\frac{0}{0}$ p.m. $\frac{4-4}{4-4}$ m. $\frac{3-3}{3-3}$.

Beside a cæcum, the colon has two extra appendages.

The testes are abdominal, the uterus bicornuate, and the placenta deciduous and zonary.

102. Skeleton of a Daman (*Hyrax syriacus*).

Notice the nearly complete orbits, a small interparietal bone, and the deep mandible. There are as many as twenty-nine dorso-lumbar vertebræ, and twenty-one ribs. Clavicle and acromion absent. Complete ulna. Small third trochanter. Complete fibula. Peculiar astragalus.

Order Ungulata.

Char.—Hoofed, herbivorous mammals. No clavicles; no more than four fingers or toes; unguligrade; diphyodont and heterodont. Brain convoluted. Placenta non-deciduous.

* The name was given by Hermann (1783): ὕραξ, as a Greek word seems to have meant a shrew (*sorex*). This animal is the rabbit or coney of the English Bible.

This order, with Proboscidea and *Hyrax*, corresponds with Cuvier's Pachydermata and Ruminantia.

On the Palæontology of Ungulata, see Flower: Lectures in "Nature," March 20—April 3, 1873.

Sub-order Perissodactyla.

Syn.—Imparidigitata, Anisodactyla.

Char.—The third digit is in the centre of the foot, and the others are smaller and symmetrical with regard to it; hence they are called "odd-toed." There are twenty-two dorsolumbar vertebræ. The femur has a third trochanter. Simple stomach; large cæcum; diffuse placenta.

There are only three existing families: the *Tapiridæ*, the *Rhinocerotidae*, and the *Equidae*, or *Solidungula*.

Beside fossil species of these families which have been found in temperate climates (e.g. the woolly rhinoceros—*R. tichorhinus*), numerous intermediate forms of this Sub-order occur in the tertiary and post-tertiary formations. Of these the tapir-like animals *Palæotherium* and *Anchitherium* were first described by Cuvier from the Eocene strata around Paris; and the *Hipparion* completes the gradation between them and existing horses.

103. Indian Rhinoceros (*R. unicornis*). Hindoostan.

Beside a closely allied one-horned sp. (*R. sondaicus*) there are two smaller two-horned sp. (*R. sumatranus* and *R. lasiotis*) in the Indo-Malayan region, and two larger ones, also with two horns, in South Africa, *R. bicornis* and *R. simus*.

Notice the strong arched nasal bones for carrying the horn; the absence of canines, the small incisors (which in the African species drop out early) and complete series of molars, four false and three true. The ribs are nineteen, the digits three, equal; the ilia expanded, the ulna and fibula complete. No acromion, large metacromion.

See also Prep. 476.

104. American Tapir (*T. terrestris*). Neotropical Region.

Beside a remarkable species from Panama (*T.* vel *Elasmognathus Bairdii*), there is another larger one in the East India Islands (*T.* vel *Rhinochœrus bicolor*, *sumatranus* v. *indicus*).

Notice the short nasals and large anterior nares for its proboscis, with grooves by the side for air sacs; also the eighteen ribs, the additional anterior digit (no. v.) and complete ulna.

See also Preps. 531, 657, 808, 1018, 1070^5, 1155.

Murie: "J. Anat. and Phys." Nov. 1871.

PERISSODACTYLA.

105. Zebra (*Equus zebra*). Africa.

See also Prep. 817, 1187.

106. Skull of an Ass (*E. asinus*); in longitudinal section.

See also Prep. 653, 814.

107. Horse (*Equus caballus*). From M. Bosanquet. Central Asia.

Domesticated and introduced into all civilised countries. Wild in South America, since brought thither in the 16th century.

Notice the triangular scapula, with no acromion, the short, oblique humerus, rudimentary ulna, the knee or carpus with large pisiform, but no trapezium, the cannon bone or third metacarpal with the second and fourth as rudimentary splint bones, the long and sloping pastern (first phalanx of middle finger), and broad coffin bone (ungual phalanx). Also the broad triangular ilia and long oblique pelvis, the third trochanter of the femur, corresponding to the rough surface in human anatomy for the attachment of the glutæus maximus, the rudimentary fibula, ancylosed below to the tibia, the raised calcaneum forming the hock, and the metacarpal bone and phalanges of the middle toe resembling those of the fore limb. In this skeleton there are eighteen (sometimes nineteen) ribs.

Contrast this skeleton with that of the Elephant close to it; and compare it with that of the Elk as examples of the perissodactyle and artiodactyle skeleton.

108. Skull of a Horse.

Notice the long nasal bones, the complete orbits, narrow palate, and high lower jaw with long coronoid process. Long paramastoid pr.

108^{5}. Atlas of Horse.

108^{6}. Axis, fourth and sixth cervical vertebrae.

108^{10}. Sixth dorsal vertebra.

108^{15}. Sacrum.

108^{20}. Caudal vertebrae.

109. Stylohyal Bones.

These correspond to the stylohyoid ligaments in man. The triangular end is superior.

109^{3}. Left Humerus of Horse.

109^{5}. Humerus of Foal.

The upper epiphysis is not yet united.

109^{10}. Left Radius with rudimentary ulna of Horse.

110. Metacarpus and phalanges of Horse.

Cannon-bone and splint bones (iii, ii, and iv metacarpals) and three phalanges of middle digit (pastern, coronal, and coffin bone). Compare 158.

110^{5}. Two third metacarpal Bones of a Foal, the epiphyses not yet united.

110^{10}. First phalanx (great pastern) of Horse.

110^{20}. Second phalanx (lesser pastern or coronet).

110^{30}. Third phalanx (coffin bone).

111. Metacarpus and phalanges of Horse, with ligaments.

112. Metacarpus and phalanges of Horse, with ligaments and tendons. Three specimens.

113. Metacarpus and phalanges of Horse, with ligaments and tendons, in section.

114. Phalanges and hoof, in section.

114^{5}. The three phalanges, with the shuttle-bone (*os naviculare*), a sesamoid bone, in situ.

115, 115^{5}. Metacarpus and phalanges, with ligaments and tendons; the vessels injected. Two specimens.

116, 116^{5}. Foot of Foal, in section. Two specimens.

No. 116 shows an epiphysis forming at both ends of the first phalanx, none in the second. 116^{5} has no epiphysis at the distal end of the first, but one at the proximal end of the second.

117. Foot of Horse, injected, showing the matrix of the hoof.

118. Foot of fœtal Foal. The nail has been removed and the matrix injected.

118^{5}. Similar injected specimen, at an earlier stage.

118^{10}. A third injected specimen, still earlier.

119. Left Femur of Horse with third trochanter.

120. Tibia; with rudimentary head and malleolus of fibula.

Monographs.—Youatt on the Horse, 1843. The Horse: Walsh and Lupton, 1861.

See also Preps. 473, 474—532–540, 648–651, 735, 755, 756, 809—812, 912, 930, 974, 1021, 1022, 1025, 1107, 1296.

Sub-order Artiodactyla.

Syn.—Paridigitata, Isodactyla.

Char.—Ungulate herbivora, with the first digit (or pollex and hallux) suppressed, the third and fourth being large and symmetrical, and the second and fifth more or less rudimentary. Hence they are called "even-toed." Many of them have horns, i.e. processes of the frontal bone, bilaterally symmetrical, and in many cases covered by a hollow epidermic sheath. There are nineteen dorso-lumbar vertebræ.

ARTIODACTYLA.

The stomach is usually complex, sometimes very much so; the cæcum much more simple than in Perissodactyla.

Teeth diphyodont, heterodont.

Brain convoluted.

Testes in scrotum ("phanerorchic"). Placenta diffuse or cotyledonous.

Class.—The Artiodactyla include the most specialized Ungulates. Beside the Ruminantia of Cuvier (Pecora of Linnæus), some of the "Pachydermata" are included in this group. It is divided into the following families :—

(*a*) Non-ruminant, comprising the genus *Hippopotamus* and the family *Suidae*.

(*b*) Tylopoda, or *Camelidae*.

(*c*) Tragulidæ; the Chevrotains, *Tragulus* and *Hyomoschus*.

(*d*) Pecora or Cotylophora, including the genera *Moschus* and *Camelopardalis*, the family *Cervidae*, and the *Cavicornia*, or hollow-horned ruminants.

Pal.—Of fossil genera may be mentioned *Sivatherium*, a four-horned Indian antelope, with probably a proboscis; the Irish Stag, erroneously called an Elk (*Megaceros Hibernicus*); the *Toxodon* from South America, and a new form with great canines and six horns (*Dinoceros*), from Nebraska.

(*a*) *Non-ruminant Artiodactyla.*

No horns; canines and upper incisors; tubercular molars ("bunodont"); more or less complex stomach, simple cæcum; diffuse placenta.

121. *Hippopotamus amphibius.* Africa.

Notice the small acromion, broad ilia, distinct ulna and fibula, and the four toes.

122. Skull of Hippopotamus.

Notice the enormous præmaxillæ, the complete and produced orbits, and the massive mandible, with an everted angle. Dental formula, i. $\frac{2-2}{2-2}$ c. $\frac{1-1}{1-1}$ p.m. $\frac{3-3}{3-3}$ m. $\frac{3-3}{3-3}$.

Monograph.—Gratiolet: "Recherches sur l'Anat. de l'Hippopotame," 1867. Beside the account of this Animal in the Book of Job, Herodotus describes it as the Egyptian River-horse, ii, 71.

124. Collared Peccari (*Dicotyles torquatus*). S. America.

The hind feet have only one non-functional digit instead of two, and there is a cannon-bone in the front and hind limbs. In other respects the skeleton of the peccary agrees generally with that of the true pigs, whose place it takes in the new world.

See also preps. 645, 646, 807.

125. Skull of Boar (*Sus scrofa*). Hab. Europe and N. Africa, whence it has been introduced into other regions, as Polynesia.

Notice the triangular shape of the skull, long nasals, large bullæ, and long styliform paramastoid. Cf. Rymer Jones, figs. 294, 295.

126. Skull of Boar. Presented by Dr. Dowler.

Cf. 524, 527, 528, 647, 806, 913, 973, 1058^{10}, 1104, 1147—1154.

127. Disarticulated Skull of a young Pig.

128. Skull of Babirussa (*Babirussa alfurus*). Celebes.

See also prep. 526.

(*b*) *Tylopoda v. Camelidae.*

No horns; canines and upper incisors; complex stomach; diffuse placenta. This family is distinguished from all other mammals by the red blood corpuscles being oval.

130. Skeleton of Dromedary (*Camelus Arabicus ;* var. *dromedarius*). Arabia, Syria, Persia, and Central Asia.

Notice that the radius is indistinguishable from the ulna, that there is no trace of any but the iii and iv digits, and that the ungual phalanges are constructed for nails, not for true cloven hoofs. Also, that the canal for the vertebral artery runs not through the tr. pr., but the laminæ of the cerv. vert.

$130^{2, 4, 5}$. Axis and fourth and fifth cervical vertebræ.

Beside their length, and the position of the vertebral foramen, notice the small sp. prs. and large inf. trans. prs. bent downwards. Centra convex in front and slightly opisthocœlous.

130^{10}. Dorsal and lumbar vertebræ.

130^{15}. Sacrum of four vertebræ.

130^{20}. Left Scapula.

130^{25}. Left ulna and radius of a very large Camel.

130^{30}. Right Femur and Tibia.

130^{35}. Tibia from the same specimen as 130^{25}.

131. Skeleton of Llama (*Auchenia*). South America.

The Llamas represent the Camels in the new world. They have no hump, and are clothed with long hair, from which the alpaca of commerce is manufactured. See also prep. 829.

(c) *Tragulina.* Africa and East India Islands.

The "pigmy musk-deer," or chevrotains, resemble the Camel in having no third stomach, canines, no horns, and a diffuse placenta. They have the smallest red blood disks of all Mammalia. There is no musk bag.

132. Skeleton of Male Chevrotain (*Tragulus javanicus* ♂). Java.

Notice the absence of horns, the large upper canines, and the separate metacarpals and metatarsals.

(d). *Pecora.*

These genera have four stomachs, bony "horns," no canines or upper incisors, six crescentic ("solenodont") molars, and cotyledonous placenta.

133. Wax model of Giraffe (*Camelopardalis giraffa*). Africa.

There are two permanent short "horns" in both sexes, covered with velvety hair. Cervical vertebræ much produced.

See also preps. 660—665, 754.

134. Elk (*Alces machlis*).* Palæarctic and Nearctic regions.

Compare this with the skeleton of the horse (106), and notice the complete orbit, the pedicles for antlers on the frontal bone, and the short nasal bones (the last is a generic character). There is a small acromion, the iij and iv metacarpals are ancylosed, pelvis narrow; thirteen ribs.

See also prep. 671.

135. Skeleton of Red-deer (*Cervus elaphus* ♂). Presented by Mr. Morgan. Palæarctic region.

It is represented by the Wapiti (*C. Canadensis*) in North America.

136. Hind of the same species (*C. elaphus* ♀). Presented by Mr. Bell.

137. Head and horns of Red-deer. Presented by Mr. B. Cooper.

137[5]. Antlers of Red-deer, in section, showing the cancellous tissue inside, and their connection with the frontal bone.

137[10], 137[15]. Horn of Deer in first year, in section.

137[50]. Antler of Deer still covered with velvet.

---

* The family *Cervidæ* is distinguished by annual, branching, bony horns (antlers), covered with velvet-like skin, which is rubbed off when the antler is fully formed. True deer are chiefly found in the Palæarctic and Nearctic regions, but also occur in India and in Chili.

138. Skull and horns of Sambur Deer. (*Cervus Aristotelis*). India.

139. Skeleton of Fallow-deer (*C. dama* ♂).

140. Skull and horns of Fallow-buck.

141. Skull of Deer, disarticulated.

142. Foot and hoof of Deer.

143. Skeleton of a young male Axis-deer (*C. axis* ♂). India.

See also 819, 977, 1100.

144. Skeleton of Reindeer (*Rangifer tarandus*). Hab. Lapland and Greenland.

The pedicles only of the antlers are present. Their palmate form is seen in the following specimen.

See also preps. 818, 1032, 1101.

145. Horns of American Reindeer. Presented by Mr. Glayser.

In this genus both sexes have antlers.

146. Horns of Roebuck (*C. capreolus*). Presented by Mr. Morgan.

147. Skeleton of one of the Antelopidæ (*Cephalophus ?*)* Africa.

In this and several other Antelopes the frontal sinuses are not continued into the bony core of the horns.

The Antelopes are not found in the new world nor in Australia. They are most abundant in Africa.

148. Anterior and posterior extremities (right and left) of Gazelle (*Antilope* v. *Gazella dorcas*). Arabia and Syria.

See also preps. 604, 822, 1023, 1099.

149. Horns of a Spring-buck, or Blesbok (*Gazella euchore*). South Africa.

150. Head and horns of a Chamois, or Gemsbok (*A. rupicapra*). Europe and West Asia.

151. Head and horns of White Oryx (*Oryx leucoryx*). Presented by Mr. Bransby Cooper. North Africa.

---

* The Antelopidæ and remaining families of Ruminants are often classed together as Cavicornia. They agree in the "horns" being permanent and covered with an epidermic sheath, and also in possessing a gall bladder, which the Deers want.

152. Head and Horns of Koodoo (*A. strepsiceros*). South Africa.

153. Horns of Koodoo. Presented by Mr. Bransby Cooper.

154. Skeleton of Nylgau (*Portax picta*). India.

155. Skeleton of White-tailed Gnu, or Wildebeest (*Catoblepas gnu*). S. Africa.

156. Skull and Horns of Brindled Gnu (*C. gorgon*). S. Africa.

157. Disarticulated Bones of fœtal Calf (*Bos taurus*),* taken from a case of extra-uterine fœtation.

158. Metacarpus and phalanges of Ox, articulated.

The iii and iv metacarpals are united to make a double cannon bone. Each of these has its three phalanges, forming the cloven foot, and the two nodules behind represent those of ii and v.

Compare this preparation with 110.

159. Hoof of Ox.

160. Skull of Ox.

161. Skull and Horns of Ox. Presented by Mr. Stocker.

162. Skull of Ox, in section.

162[5]. Skull of Ox, with sections in various directions.

See also preps. 666, 673, 745—748, 823, 901, 931, 1075, 1033, 1102, 1103, 1159—1172.

163. Skull and Horns of large Indian Ox (? *Bos gaurus* v. *frontalis*). Presented by Dr. Babington. Hindoostan.

164. Horns of an Ox, from the Cape of Good Hope.

165. Horns of Cape Ox.

166. Bony core of Horns of Buffalo (*Bubalus buffalus*). India; also introduced into Italy.

167. Skull and Horns of Arnee Bull (*Bubalus arni*). India.

168. Skull and Horns of Ram (*Ovis aries* ♂).

169. Skull and Horns of Ram.

---

* The genera *Bos*, *Ovis*, and *Capra*, with their allies, form a single natural family, which may be called *Bovidae*.

169⁵. Skull of Ram, in longitudinal section.

See the description and figure in Flower's Osteology, pp. 167—170.

170. Skull and Horns of a Four-horned Ram. Iceland.

171. Skull and Horns of Goat (*Capra hircus*).

172. Skull and Horns of Goat.

173. Horns of Goat.

174. Hoofs of Sheep.

174⁵. Bones of Foot of Sheep, articulated.

See also preps. 541—544, 750—753, 824—827, 904¹⁵, 932, 976, 1026—1030, 1173—1186, 1297.

Order Sirenia.

Char.—Teeth planted in alveoli (thecodont) partially succeeding a deciduous set (diphyodont) and different in form (heterodont).

No clavicles. Anterior extremities pentadactyle, enveloped in skin.

Posterior extremities and pelvis are absent, though the latter is represented by nodules of bone. They have a horizontal expansion of the skin at the end of the tail, which serves as a fin. Third eyelid. No external ear.

Placentation unknown. Two thoracic mammæ.

There are only three recent genera of this order, and one of these (*Rhytina*), which was once numerous about Behring's Straits, has not been seen since the last century. It was edentulous. The *Halitherum*, another Sirenian, occurred as early as the Miocene period.

The Sirenia, though classed as herbivorous Cetacea by Cuvier, have only superficial analogies with the true Whales. Their real affinities appear to be to the Ungulata and Proboscidea.

175. Skeleton of Dugong (*Halicore dugong*). Indian and Australian coasts.

Notice the enormous præmaxillæ for lodging the incisor tusks. The scapula has no spine, and the pollex is rudimentary. The nineteen ribs are massive, and the whole skeleton very heavy. The sternum consists only of manubrium and xiphisternum.

See also preps. 914, 928.

176. Skeleton of Lamantin or Manatee (*Manatus*).

Two species inhabit the South American estuaries (*M. australis* and *M. latirostris*), and one the west coast of Africa (*M. senegalensis*).

This animal has *only six cervical*, seventeen thoracic, and two lumbar vertebræ. The skull is not distorted by great tusks. As in *Halicore*, the nasal bones are rudimentary. Notice the large chevron bones for protecting the caudal aorta (= A. sacri media). The v digit is the longest, cf. 89. Murie, Zool. Trans. viii., 1872.

Order Cetacea.

Char.—They resemble Sirenia in outward form and in habitat; so also the posterior extremities and pelvis are absent, and the anterior are converted into paddles, while the tail is provided, with a horizontal caudal "fin," and the surface is almost destitute of hair.

But the nostrils open on the top of the head and are sometimes united. Beside other peculiarities of the skull, the mandible has a very small ascending ramus and does not articulate by a synovial joint. The same applies to the joints of the fore limb, and there are more than three phalanges to the digits. They have no *membrana nictitans*, or salivary glands, or vesiculæ seminales.

There is no odontoid process, and the cervical vertebræ are more or less ancylosed. The ribs articulate with the tubercles only of some of the ribs.

Teeth are either absent or are numerous, without separate milk dentition (monophyodont), uniform (homodont), and not implanted in distinct sockets.

The brain is convoluted; olfactory lobes absent or rudimentary.

The teats are two, inguinal; the placenta diffuse.

The Cetacea are all marine animals, and are very widely distributed. The toothless or whalebone Whales are not found in tropical seas.

Professor Huxley has shown that the true affinity of this Order is with the Aquatic Carnivora, the extinct *Zeuglodon* forming a connecting link. They have also some curious resemblances to Ruminants in the whalebone, which answers to the horny ridges on a cow's palate, a complicated stomach (formed, however, on a different plan), and the possession of a third bronchus, found also in the Bear and Walrus.

There are two very distinct suborders of Cetacea, the Odontoceti or toothed Whales, and the Mystacoceti or whalebone Whales. The latter is the more aberrant of the two.

Memoirs by Eschricht, &c. (Ray Soc.) 1866.

Odontoceti. Fam. *Delphinidae.*

177. Skeleton of Porpoise (*Phocaena communis*).

Notice the short neck which yet has seven vertebræ; also the ribs, most of which only reach the transverse processes, and the V-shaped bones below the caudal vertebræ, which enclose the end of the aorta. There is no clavicle, and the anterior fossa of the scapula is very small. Radius and ulna flat; phalanges more than three in each digit. No trapezium.

178. Skull of Porpoise, longitudinally divided, and lower jaw.

179. Skull of Porpoise.

Notice the globular, birdlike cranium, the long snout, the anterior nares placed so far back that the passage from them runs more downwards than backwards: hence the nasals are short, the præmaxillæ long. The mandible has no ascending ramus.

Cf. Flower, pp. 183—190.

182. Vertebræ and other disarticulated bones of Porpoise.

183. Skull of Porpoise, injected and dried, showing the position of the single blow-hole, and how the larynx is produced above and encircled by the soft palate, so as to open directly into the posterior nares.

184. Tail of Porpoise, injected and dried.

See also preps. 464 – 6, 637, 639, 831—834, 895—900, 915, 933_5, 978, 1108—1112, 1192—1196.

186. Skull of Narwhal (*Monodon monoceros*). Arctic Ocean.

See also prep. 556.

Mystacoceti. Fam. *Balænidæ.*

These are the whalebone or toothless Whales, with enormous mouths and heads; double blowholes.

186^5. Ear Bone of the Southern "Right" Whale (*Balæna australis*).

The tympanic bulla is ancylosed with the petrous or periotic bone. Cf. fig. 105 in Huxley's "Anat. of Vert."

See also preps. 493, 466^5, 1036.

Order Rodentia.

Char.—Incisors, $\frac{1-1}{1-1}$ (except in Hares and Rabbits, which have two small extra præmaxillary teeth), large and with persistent pulps. No canines; molars with transverse ridges; clavicles usually present; scapula with a metacromion. Digits usually five; unguiculate. Orbits incomplete. Dorsolumbar vertebræ usually nineteen; inter-parietal bone; extra carpal bone (*Os centrale*).

Brain unconvoluted.

Testes abdominal; placenta deciduate, discoid.

The Rodents are small animals, almost ubiquitous, but most fully represented in South America. They are very numerous, both in species and individuals. They are almost exclusively root or leaf-eaters, and usually gregarious.

They resemble birds in having two superior Venæ cava, and also in their small smooth brains, nest-building, and gregarious habits.

The following are some of the chief families of Rodentia:—

1. *Leporidæ* v. Lagomorpha, Rabbits and Hares.
2. *Hystricidæ*, Porcupines.
   Caviidæ, Guinea Pigs, with the Capybara and Agouti.
3. *Muridæ*, Rats and Mice, Chinchillas, &c.
   Castoridæ, Beavers.
   Dipodidæ, Jerboas.
4. *Sciuridæ*, Squirrels and Marmots.
   Myoxidæ, Dormice.

Waterhouse: "Natural History of Mammalia," vol. ii.

187. Skeleton of Capybara (*Hydrochœrus capybara*). South America.

Notice the large backward process from the spine of the scapula, metacromion. There is a long episternum to the manubrium and no clavicle.

188. Skeleton of Beaver (*Castor fiber*). North America.

Notice the large infraorbital foramen, and the clavicle correlated with the building habits of the animal.

190. Stuffed Beaver.

191. Fore and Hind Legs of Beaver, showing webs of latter.

See also preps. 470, 799, 1128.

192. Skeleton of Porcupine (*Hystrix cristata*). Presented by Mr. Bell. Southern Europe and Asia.

Notice the large nasal and præmaxillary bones. The cranial bones are not yet united, and hence show their shape and size well. Also the enormous infraorbital foramen supplying the 2nd. div. of the v nerve to the great sensory whiskers, but also transmitting part of the masseter. The long episternum, the clavicle connected with the sternum, but not reaching the acromion; the post-acromial process, separate ulna and fibula, and plantigrade feet with five unguiculate digits, but the pollex and hallux very small.

See also preps. 468, 800, 909, 1299.

194. Skeleton of Marmot (*Arctomys marmotta*). Europe.

This belongs to the same group as the Squirrel. The complete clavicle is related to its burrowing habits.

195. Skeleton of Agouti (*Dasyprocta sp. ?*) South America and West Indies.

No clavicles.

196. Skeleton of Hare (*Lepus timidus*).

No clavicles. i. $\frac{2-2}{1-1}$ c. $\frac{0-0}{0-0}$ m. $\frac{6-6}{5-5}$.

Notice beside the extra præmaxillary tooth, the vacuity in the maxilla, showing its internal cancellous structure, and the inferior spines of the lumbar vertebræ (hypapophyses); also the third trochanter on the femur and the incomplete fibula.

See also prep. 801.

197. Disarticulated Bones of Rabbit (*L. Cuniculus*).

197^5. Lumbar vertebra of Rabbit.

Notice the long, slender, transverse processes, the "mamillary process" (metapophysis) of the anterior articulating process, and the long azygos hypapophysis.

See also preps. 602, 736^{10}, 802, 982.

Monograph.—Krause: "Anatomie des Kaninchens."

198. Rodent Skulls.

199. Case containing four Skeletons of Rats.

Those numbered (1) and (2) belong to the old English black species (*Mus rattus*); (3) and (4) are the common Brown, or "Hanoverian" Rat (*Mus decumanus*), introduced into this country at the beginning of the last century. This has supplanted the black species, which is now only found in Lundy Island. According to Alphonse Milne-Edwards, *M. rattus* is only a black variety of Geoffroy St. Hilaire's

M. alexandrinus, and the common Brown Rat in France is now itself becoming black (Ann. d'Hist. Nat., tom. xv. 1872).

199[5]. Disarticulated Skull of Rat.

200. Skeleton of Mouse (*M. musculus*).

203. Skeleton of one of the *Muridae*.

See also preps. 642—644, 985, 1094—1097, 1120—1124.

204. Two articulated Hind Legs of Jerboa (*Dipus*). Egypt, &c.

See also prep. 981.

205. Skeleton of Squirrel (*Sciurus*).

$$\text{i.}\ \frac{1-1}{1-1}\quad \text{c.}\ \frac{0-0}{0-0}\quad \text{m.}\ \frac{5-5}{4-4}$$

The clavicles are related to the prehensile power of its fore feet.

206. Skeleton of Squirrel.

207. Skull of Squirrel.

208. Stuffed Squirrel.

See also preps. 603, 803, 983.

Order Edentata.

Syn.—Bruta.

Char.—Teeth, when present, have no enamel and imperfect roots. Canines are always, incisors usually, and molars occasionally, absent. Monophyodont; clavicles usually present. Unguiculate.

Brain unconvoluted.

Testes abdominal.

Placenta various: in the Sloths cotyledonous and, in *Cholopus* at least, deciduous (Turner, Pr. R. S. Edin, May 19, '73); in *Dasypus* discoid, and in *Manis* diffuse.

This order has chiefly negative characteristics. It is the lowest among placental mammals, and has analogies with reptiles, like those of the rodents with birds.

Distr.—Its chief habitat is South America, and there most of its extinct representatives have been found, the gigantic sloths (*Megatherium* and *Mylodon*) and Armadillos (*Glyptodon*). At present only two genera exist out of the Neotropical Region, *Orycteropus* in Africa, and *Manis* in Africa and India; but Edentata inhabited Europe in the Miocene period.

The few existing Edentate genera may be thus arranged :—

(Entomophaga)—

Dasypodidae v. *Loricata*, the Armadilloes.

Manidae v. *Squamata*, the Pangolins.

Myrmecophagidae, the true Anteaters.

Orycteropus (*Tubulidentata*), the Aardvark, or Cape Anteater

(Phyllophaga) :—

Tardigrada, the Sloths, *Bradypus* and *Cholopus*.

209. Skeleton of Armadillo (*Dasypus*). South America.

A second spine is seen on the scapula. The clavicles and the strong muscular processes of the humerus are related to its burrowing habits. The femur has a third trochanter. The vertebræ articulate by additional processes (metapophyses). There are eleven ribs, the first very broad. The caudal vertebræ have chevron bones.

210. Stuffed Armadillo.

Notice the cephalic, the scapular, dorsal, and pelvic shields. The dorsal has ten bands.

211. Small Armadillo, stuffed.

212. Two Fore-limbs of Armadillo.

212[5]. Hind Leg of Armadillo, articulated.

See also preps. 469, 933, 986, 1024, 1190.

212[10]. Skull of small Anteater (*M. tamandua*). S. America.

Notice the absence of muscular impressions and processes, the elongated muzzle, small præmaxillæ, incomplete zygoma, the palate produced backwards as in the crocodile, and the two air sinuses in front of the periotic. Mandible without ascending pr. like a bird's.

213. Cervical Ribs of *Megatherium*, an extinct genus of phyllophagous Edentata, allied to the Sloths. Presented by Mr. S. J. A. Salter.

Found in post-tertiary strata in Brazil. The first skeleton was discovered in 1796.

A Cast from the Hunterian Museum.

Order Marsupiata.

Syn.—Didelphia, as a sub-class.

Char.—They are all heterodont, and more or less diphyodont. More incisors above than below; molars numerous.

The angle of the mandible is almost always inflected. All marsupials have clavicles, with one exception (*Perameles*). There are "marsupial" bones articulated to the pubes, and supporting the marsupium or pouch in the female. These are the ossified (or chondrified) internal pillars of the external abdominal ring. The dorso-lumbar vertebræ are usually nineteen.*

The brain is usually convoluted, and the corpus callosum, though small, is not absent.

The testes are in a scrotum which hangs in front of the penis. There are no vesiculæ seminales, and the glans is often bifid.

The uteri are quite distinct and the vaginæ more or less so. There is no placenta, but a large umbilical vesicle (vitelline sac), and the fœtus being extruded very early, is transferred to the mother's teats, which are placed in the pouch.

Distr.—All the Marsupials are confined to the Australian region, except the opposums (genus *Didelphys*) of America.

In former times, while extinct Marsupials inhabited Australia, others lived in Europe as far back as the Mesozoic period (Oolite).

Class.—The Marsupial genera may be arranged in the following groups, several of which correspond, functionally at least, to Orders of Placental Mammals.

1. *Pedimana* v. *Didelphidae*, corresponding to Monkeys or Lemurs; insectivorous. Opossums.
2. *Entomophaga* v. *Peramelidae*, answering to placental Insectivora. *Tarsipes*, *Chœropus*, Bandicoots.
3. *Sarcophaga* v. *Dasyuridae*, answering to Carnivora. *Thylacinus*.
4. *Carpophaga*, fruit and leaf-eaters, Koala (*Phascolarctos*), answering to the Sloths, *Petaurus*, Phalangers.
5. *Rhizophaga*, answering to Rodents. Wombat.
6. *Poëphaga*, *Salientia* v. *Macropodidae*, answering to ungulate Herbivora. Kangaroos.

Waterhouse: "Nat. Hist. of Mammalia," vol. j. 1846.
Gould: "Mammals of Australia," 3 vols. pl. 1863.

---

* In all the Marsupial families but that of the Kangaroos, the tibia is capable of more or less rotation on the fibula, and the hallux is more or less opposable.

214. Skeleton of Great Kangaroo (*Macropus gigas*). Australia.

Ribs thirteen. Notice the marsupial bones, incurved lower jaw, the enormous posterior extremities, and large caudal vertebræ, with chevron or V-shaped bones. The hind foot is plantigrade, with a long metacarpus, large iv digit, smaller v and very slender iii; and the hallux absent.

214^{1-7}. Cervical vertebræ.

Notice that the atlas is incomplete in front, and that the centrum of each vertebræ incloses that of the one in front by two lateral processes.

214^{8-20}. Dorsal vertebræ.

All have facets for the ribs on the trans. prs. D.xii and xiii have metapophyses and small anapophyses. All the sp. prs. slope backwards.

214^{21-27}. Lumbar vertebræ.

The centra are imperfectly ossified, most so under the posterior common ligament.

214^{28-29}. Sacrum of two vertebræ.

214^{30}. Caudal vertebræ, about twenty-five.

The anterior have metapophyses, zygapophyses and tr. prs. pointing backwards, but no sp. prs. Then the neural canal disappears, the tr. pr. moves backwards, a second one comes in a line with it in front, and a double hypapophyses below. Lastly the centrum is of a dicebox shape without any processes.

214^{35}. Sternum of six pieces.

214^{40}. Scapula, R. and L.

Acromion; no caracoid.

214^{45}. Humerus, R. and L.

Supra-condylar foramen as in Carnivora.

214^{50}. Radius and Ulna, R. and L.

The latter large in proportion: both smooth and slender.

214^{55}. Ossa Innominata, R. and L.

$214^{60,61}$. Two pelves.

214^{65}. Femur, R. and L.

214^{70}. Tibia and Fibula, R. and L.

The latter is complete; both very long.

214^{75}. Os calcis, astragalus and cuboid.

214[80]. Metatarsus and phalanges.

See also preps. 548, 674, 737, 757, 835—838, 1197, 1198.

215. Skeleton of Little Kangaroo, or Wallaby (*Halmaturus*, sp.) Australia.

216. Skeleton of Kangaroo-Rat—the Potoroo or Bettong (*Hypsiprymnus murinus*). Australia.

Dental formula, i. $\frac{3-3}{1-1}$ c. $\frac{1-1}{0-0}$ m. $\frac{5-5}{5-5}$. The fourth true molar has not appeared. Notice the large tympanic bulla.

217. Skeleton of Phalanger (*Phalangista*). Australia.

218. Skull of a Phalanger (*P. cinereus*).

219. Skull of Opossum (*Didelphis*). North America.

See also prep. 839.

Order Monotremata.

Syn.—Ornithodelphia, as a Sub-class.

Chars.—The coracoid reaches the sternum, as in Sauropsida. Both genera have clavicles, and also epicoracoids and an azygos interclavicle. The "marsupial" bones are present, as in Marsupiata, but there is no pouch.

Both the genera are edentate.

The testes are abdominal. There is no complete urethra, the canal of the penis, the bladder and the ureters opening into a cloaca as in Sauroida.

The uteri (which are quite distinct) open into the cloaca.

There is no placenta.

The mamma is without a nipple. The brain is slightly convoluted, with a small corpus callosum.

In the Males the hind foot has a perforated spur.

Distr.—Both genera of Monotremata are only found in the Australian region.

No fossil specimens of this Order have been discovered.

220. Skeleton of Duck-billed Platypus (*Ornithorhynchus paradoxus*). Australia.

Notice, beside the ordinal characters mentioned above, the generic peculiarity of the long slender præmaxilla forming the edges of the horny beak, with a small central ossification also. Likewise the large infraorbital and inferior dental foramina, through which the superior and inferior maxillary branches of the v pass to supply the sensitive edges of the beak. The bone supporting the tarsal spur is a secondary sexual character.

221. Vertebral column, skull, upper and lower extremities, and sternum, with episternum and clavicles, of a Male Ornithorhyncus.

Notice the separate odontoid process of the axis, the cervical hypapophyses, large cervical ribs or transverse processes, and broad transverse processes of the caudal vertebræ, to form the flat swimming tail. In front of the manubrium is seen a large median bone, the *interclavicle*, with two transverse processes, making it T-shaped, and on these the slender true clavicles lie.

222, 223. Stuffed Platypi, both Female.

See also preps. 475, 840, 1199.

224. Skeleton of the Spiny Anteater (*Echidna hystrix*). Australia.

Notice the smooth, globular, bird-like cranium, even more so than in *Ornithorhyncus;* also the rudimentary ascending ramus and angle of the mandible.

The ribs, as in the allied genus, only articulate with the bodies of the dorsal vertebræ. The tail has two chevron bones.

The scapula is sickle-shaped and has no apparent acromion. Its anterior border, however, appears to answer to the spine in other animals (see Flower: "Osteology of Mammalia," p. 236). The humerus is strongly marked by muscular impressions, as in the Armadillo, Mole, and other burrowing animals; and the broad pentadactylous forefeet, with large claws, have the same meaning.

The ilium is trihedral, the femur short, and the fibula has a large expanded upper end, which answers to the olecranon of its homologue, the ulna. As in the allied genus, there is an extra spur bone in the Male.

Class AVES.

Characters.—Abranchiate, amniotic Vertebrata, with warm blood, and more or less covered with feathers.

One condyle. Os quadratum. Short coccyx (except in *Archæopteryx*). Anterior extremities modified to form wings. Three digits, i, ii, and iii, except in *Apteryx* and *Casuarius*, which have only one. Ankle joint between the two rows of tarsal bones, which are ancylosed to the tibia and the metatarsus respectively. Digits of pes i, ii, iii, and iv, or fewer. For further characters of the skeleton, see prep. 230.

Edentulous. Horny mandibles. Blood corpuscles oval and nucleated. Heart with four cavities, single right aorta, with no direct communication between it and pulmonary artery. Respiration by lungs and air sacs.

Oviparous. Eggs with albumen and calcareous shell.

The embryo has an amnion, and a large respiratory allantois. The yelksac is also large.

Affinities.—Birds are structurally closely related to Reptiles, so that they have been united with that class under the name *Sauropsida.* Functionally they much more nearly resemble Mammals. Their nearest allies among Reptiles are certain extinct Dinosauria, especially *Compsognathus*, with large posterior extremities alone used for support. To fit an animal of this type of structure for flight, the anterior extremities must be turned into wings, instead of hands or forefeet, and both the endo-skeleton and the dermal appendages (pinions) of birds are modified for this purpose. This necessitates the hind limbs being altered, so as to support the body alone, and a corresponding adjustment of the centre of gravity. The caudal vertebræ are suppressed, and functionally represented by the lighter and expansible tail feathers. The absence of hands necessitates a long neck; and efficient grinding teeth, being precluded from their weight, are replaced by a stomach thickened to form a gizzard; while the lighter, horny mandibles supply the place of prehensile and tearing teeth. To move the body through so thin a medium as the air, great muscular power is necessary, and the sternum acquires its keel to afford the requisite attachment to the pectorals; while the ribs are very much fixed, and the dorsal and lumbar vertebræ consolidated so as to afford a sufficiently firm fulcrum. The consequent activity of muscular metamorphosis necessitates a highly organised circulation to convey abundant nutritive material and oxygen, fully developed respiration to provide the necessary interchange of gases, and a non-conducting covering so as to maintain the high temperature thus produced without materially adding to the weight to be moved. These ends are obtained by the obliteration of the *ductus arteriosus*, the addition of air sacs and pneumatic bones to make up for the deficient movements of the lungs, and the modification of the horny out-growths of the cutaneous papillæ so as to form feathers. Lastly, the necessity of perfect balance in flight has led to a more complete bilateral symmetry of the internal organs in Birds than in any other vertebrate class.

Classification.—Birds form such a compact, uniform, and numerous class, that it is difficult to divide them into natural orders.

1. The great majority agree in having a keeled sternum for attachment of the great pectoral muscles which depress the wings in flight, and these may be called AVES CARINATÆ. The following groups, made by Linnæus, and substantially accepted by Cuvier, depend chiefly upon adaptive characters of the beak and legs, but are useful for descriptive purposes.

Accipitres v. Raptores	Birds of prey (falcons, vultures, owls).
Pici v. Scansores	Climbing birds (woodpeckers, parrots).
Passeres v. Insessores ..	Perching and singing birds (crows, finches, swallows).
Gallinæ v. Rasores	Scratching birds (fowls, pheasants, grouse).
Grallæ..	Wading birds (snipes, herons, storks).
Anseres, Palmipedes v. Natatores	Swimming birds (ducks, gulls, pelicans).

Other proposed classifications depend on the habitat (Ray, &c.), on the maturity of the young when hatched, on the arrangement of the feathers (Nitsch), on the sternum, or on the structure of the base of the skull (Huxley).

In this museum the several families are simply arranged in tolerably natural sequence, without any attempt to group them into larger sections.

Carinate birds are found in all regions of the world. Fossil remains occur in the secondary period (chalk) and throughout the tertiary strata, but they are neither numerous nor important. The most remarkable extinct form of this order is the Dodo, a large terrestrial bird belonging to the family of pigeons, which inhabited Mauritius, and has become extinct within historical times. See Strickland and Melville: "The Dodo and its Kindred," 1848.

2. There is one family of birds so distinct from the rest, that it is rightly regarded as a primary division of the class. These are the *Cursores*, or running birds of Linnæus (*Brevipennes*, or short-winged of Cuvier; *Proceri*, as Illiger named them from their usually large size) which cannot fly, and have no keel to the sternum. Hence they have been called RATITÆ (*ratis*, a raft or punt) in distinction from Carinatæ. Their feathers are also loose and more hairlike; they have a more developed diaphragm, and in all respects show less differentiation of structure than other birds, approaching in some respects the Dinosauria, in others the Mammalia.

The few existing members of the order Ratitæ are distributed as follows:—The true Ostrich (*Struthio camelus*) is confined to the deserts of Africa and Arabia. The "American Ostrich" (*Rhea*) inhabits the Neotropical Region. The genus *Casuarius* is found in New Guinea and other islands of the Australian region, and the nearly allied Emeu (*Dromæus*) the continent of Australia. Lastly, the *Apteryx* is found only in New Zealand.

Numerous extinct genera belonged to this order, some of gigantic size; *Dinornis* lived in New Zealand, and *Æpiornis* in Mauritius, till comparatively recent times.

3. The only other fossil bird of importance is the *Archæopteryx*, which differed from all existing forms and resembled a lizard in

having a long tail. It was discovered in the Solenhofen slate of the Upper Oolite formation. A third primary division of the class has been made for its reception, SAURURÆ.*

Refs.—Willoughby: "Ornithologia" (plates), a posthumous work, edited by Ray, 1676. Ray: "Synopsis Avium," 1713. Temminck: "Manuel d'Ornithologie," 1820—40. Gould: "Birds of Europe" (plates), 1837. Sharpe and Dresser: "Birds of Europe" (publishing). Yarrell: "British Birds," 3rd edit., 1856 † (figures of all the species). Morrell: "Student's Man. of Comp. Anat. and Guide to Dissection," part ii. sect. 1, Aves. 1870.

Fam. *Falconidæ.*

225. Skeleton of Golden Eagle (*Aquila chrysaëtos*) ‡.

See also prep. 1051.

Beside the general avine characters of the skeleton (mentioned under 530, 530[5]), notice the family peculiarities of the beak, feet, and sternum, which is broad, with a deep carina, and entire behind.

226. Skeleton of Peregrine Falcon (*Falco peregrinus*).

227. Skeleton of Sparrow Hawk (*Accipiter nisus*).

227[5]. Skull of Sparrow Hawk.

228. Skull of Buzzard (*Buteo vulgaris*) ♀

228[5]. Skeleton of Harrier (*Circus*).

See also prep. 843.

229. Stuffed Marsh Harrier (*Circus æruginosus*) with a Snipe (*Scolopax gallinago*).

230. Skeleton of the Secretary-bird (*Gypogeranus serpentarius*). South Africa.

230[5]. Skull, trunk, and extremities of the same.

As convenient examples of a carinate bird's osteology, notice in these two specimens:—

(*a*) The globular cranium with the sutures all obliterated. The large orbits, slender jugals, edentulous jaws, and *quadrata* attaching

* Since writing the above, a new genus (*Odontornis*) has been described, from secondary rocks in North America, with numerous teeth and biconcave vertebræ.

† A fresh edition, by Prof. Newton, is now being published.

‡ This, and all birds whose habitat is not otherwise given, are found in the British Isles.

the mandible to the squamosal. The base of the skull is desmognathous, a family character.

See Huxley: Anat. Vert. An. fig. 84.

(*b*) The long neck, with above seven vertebræ and cervical ribs, the sacrum formed by ancylosis, with lumbar and caudal as well as true sacral bones, the short coccyx ending in a "ploughshare-bone." The vertebral ribs, with tubercular and capitular articulation. *Processus uncinati:* ossified sternal ribs: the broad sternum with its *carina*.

(*c*) The *furcula*, of clavicles and interclavicle, strong coracoids behind it, reaching the sternum and forming the glenoid cavity with the narrow scapula. The slender humerus, with its strong pectoral ridge, complete and long ulna, pronated radius, and abducted manus. The carpal bones are seen to be reduced to two, radiale, and cuneiform (ulnare), and the metacarpals to three (i, ii and iii) with few phalanges and ii and iii ancylosed.

(*d*) The long ilia, perforated acetabulum, ossified great ilio-ischiatic ligaments, slender pubes without a symphysis. The rudimentary fibula, tibia united below with the astragalus, and *tarsometatarsus* made up of the cuneiform bones (?), ancylosed with the ii, iii and iv metatarsals. Lastly, the hallux turned back and ii, iii and iv digits turned forward, with 2, 3, 4 and 5 phalanges respectively.

Vulturidæ.

231. Skeleton of Vulture (*Vultur*). Europe, Asia, and N. Africa.

Beak longer than in the Hawks and Eagles.

See also prep. 842.

Nocturnae.

233. Skull of Horned Owl (*Bubo maximus*).

The cleft on each side of the vomer is much narrowed by the tumid maxillo-palatines. The lacrymal is distinct.

234. Feet of Common Barn-Owl (*Strix flammea*).

The tarsi (from ankle to toes) and toes are feathered, and the iv digit is capable of being turned back, as in the following family it always is.

235. Stuffed Wood-Owl (*Syrnium cinereum*). North America.

An allied species, *S. aluco*, is found in England and other parts of Europe.

Psittacidae.

236. Skeleton of Parrot (*Psittacus*). India, Malaya, Australia, less abundantly in America and Africa.

Notice the joint between the ethmoid and nasal bones, allowing of movement of the upper jaw. The sternum is entire behind. The tarsometatarsus short. The iv toe, as well as the hallux, is turned back. Clavicle absent.

See prep. 844.

236[3]. Skeleton of Parrot.

The clavicle is small.

236[5]. Skull of Grey Parrot (*Psittacus erythacus*). Guinea.

236[10]. Skull of Green Parrot.

236[15]. Skull of Lovebird (*Agapornis pullaria*). Guinea.

236[20]. Skull of Blue-faced Lorry (*Trichoglossus haematodes*). Timor.

Rhamphastidæ.

237. Stuffed Toucan. Tropical America.

See also preps. 482.

Picariæ.

238. Stuffed Green Woodpecker (*Picus viridis*).

See also prep. 608

Trochilidae.

239. Skeleton of Humming-bird (*Trochilus sp.*)

Neotropical Region.

Notice the enormous keel to the sternum, which is without posterior notches, and the relatively large cranium. Also the short humerus and long manus. Cf. 298.

Laniadae.

240. Skull of Redbacked Shrike (*Lanius collurio*)

Merulidae.

241. Skull of Missel Thrush (*Turdus viscivorus*).

241[5]. Skull of Fieldfare (*T. pilaris*).

241[10]. Skull of Thrush (*T. musicus*).

241[15]. Skull of Redwing (*T. iliacus*).

241[20]. Skull of Blackbird (*Merula vulgaris*).

Sylviadae.

242. Skull of Redbreast (*Erythaca rubecula*).

242[5]. Skull of Furzechat or Whinchat (*Saxicola rubetra*).

242[10]. Skull of Hedge Warbler, often called the Hedge Sparrow (*Accentor modularis*)

242^{15}. Skull of Reed Warbler (*Salicaria arundinacea*).

242^{20}. Skull of lesser Whitethroat (*Curruca sylviella*).

Paridæ.

243. Skull of Great Tit (*Parus major*).

243^{5}. Skull of Blue Tit (*P. cæruleus*).

243^{10}. Skull of Longtailed Tit (*Mecistura caudata*).

Motacillidæ.

244. Skull of Common or Pied Wagtail (*Motacilla Yarellii*).

244^{5}. Skull of Yellow Wagtail (*M. Raii*).

Alaudidæ.

245. Skull of Skylark (*Alauda arvensis*).

245^{5}. Skull of Woodlark (*A. arborea*).

245^{10}. Skull of Titlark or Meadow Pipit (*Anthus pratensis*).

Emberizidæ.

246. Skull of Common Bunting (*Emberiza miliaria*).

246^{5}. Skull of Yellow Ammer (*E. citrinella*).

Fringillidæ.

247. Skull of Chaffinch (*Fringilla cœlebs*).

247^{5}. Skull of Brambling or Mountain Finch (*F. montifringilla*).

247^{10}. Skull of Sparrow (*Passer domesticus*)

247^{15}. Skull of Tree Sparrow (*P. montanus*)

247^{20}. Skull of Greenfinch (*Coccothraustes chloris*)

247^{25}. Skull of Goldfinch (*Carduelis elegans*).

247^{26}. Skeleton of Linnet (*Linota cannabina*).

247^{27}. Skulls of Linnet ♂ and ♀

247^{30}. Skull of Lesser Redpole (*L. linaria*) ♂

247^{35}. Skull of Bullfinch (*Pyrrhula vulgaris*) ♂ and ♀

247^{40}. Skull of Canary (*Crithagra canaria*). Canary Islands.

247[45]. Skull of Hybrid between Goldfinch and Canary.

Sturnidæ.

248. Skull of Starling (*Sturnus vulgaris*).

Corvidæ.

249. Skull of Raven (*Corvus corax*).

See also preps. 845, 846, 846[5].

249[5]. Skull of Rook (*C. frugilegus*).

249[10]. Skull of Jay (*Garrulus glandarius*).

249[15]. Skull of Magpie (*Pica caudata*).

Certhiadæ.

250. Skull of Creeper (*Certhia familiaris*).

251. Skull of Wren (*Troglodytes vulgaris*).

Hirundinidæ.

252. Skull of Swallow (*Hirundo rustica*).

Halcyonidæ.

253. Skull of Kingfisher (*Alcedo ispida*).

Columbidæ.

254. Skull of Common Blue-rock Pigeon (*Columba livia*).

Cf. preps. 738[5], 847. For the anatomy of this bird, which is a good example of the class, see Morrell, loc. cit. p. 66, and Rolleston, loc. cit. p. 12 and pl. ii.

255. Skull of Green Samoan Pigeon (*Ptilopus*, improperly *Ptilonopus*, *Mariæ*). Australian region.

256. Skeleton of *Didunculus dentirostris* v. *Gnathodon strigirostris*. Samoa.

Tetraonidæ.

257. Skeleton of the Cock of the Woods, or Capercailzie (*Tetrao urogallus*).

This bird, still common on the Continent, became extinct in Scotland and Ireland during the last century, but of late years has been re-introduced into the Highlands.

258. Stuffed Blackcock and Grey Hen (*Tetrao tetrix* ♂ and ♀).

259. Skeleton of Partridge (*Perdix cinerea*).

259[5]. Skull of Partridge.

260. Sternum and shoulder girdle of Ptarmigan (*Lagopus mutus*).

The manubrium is small, the carina moderate, and, beside the central xyphoid or ensiform process, the metosteon divides into an internal and external additional xyphoid process on each side, the outer one of which is short and broad at the ends. Compare the sternum in 230[5] and 270.

261. Skull of Red Grouse (*Lagopus britannicus*).

Found only in England, Wales, Ireland, Scotland, the Hebrides, and the Orkneys.

Phasianidæ.

262. Skull of Pheasant (*Phasianus colchicus*) ♂ and ♀.

Asia Minor.

263. Skull of Peacock (*Pavo cristatus*).

264. Skull of Turkey (*Meleagris gallopavo*). North America.

See also prep. 850.

265. Skeleton of Common Cock (*Gallus bankiva*).

Introduced from East India Islands.

266. Skull of Black Spanish Cock.

266[5]. Skull of common Dunghill Cock and Hen.

267. Feet of Common Fowl, with spurs.

This is an osseo-corneous structure, like the horn of a ruminant. It is ancylosed to the ii metatarsal.

268. Feet of Dorking Fowl, showing the additional fifth toe: two specimens dried and two showing the bones articulated.

269. Sternum of Fowl.

Notice the rostrum, carina, and external and internal lateral processes. See Huxley: Anat. Vert. An., fig. 81.

270. Shoulder-bones of Fowl.

271. Pelvis of Fowl.

See also preps. 677, 731, 851, 990, 1201—1246.

Struthionidæ.

272. Skeleton of Ostrich (*Struthio camelus**).

North Africa and Arabia.

---

* Στρουθοκάμηλος, the Camel-bird, *Avis struthio*, whence Autruche and Ostrich.

Notice the flat sternum, the small wing bones, but relatively long humerus, the pubes forming a symphysis, the ischia ununited, and the absence of i, ii, and v digits in the hind limb, having the large iii with four and iv with five phalanges. Also the double patella and great cnemial ridge. For the skull see Huxley, Elements of Comparative Anatomy (A), in figs. 88, 92, 95.

See also preps. 676, 856.

Casuariidæ.

273. Skeleton of Emeu (*Dromæus novæ-hollandiæ*).

New South Wales.

Notice the flat sternum, short humerus, symphysis of ischia but not of pubes, and the tridactyle foot, the digits being ii, iii, and iv with three, four and five phalanges respectively. Uncinate processes absent.

See also preps. 606, 680, 688, 857, 919, 920, 1073.

Otidæ.

274. Skeleton of Great Bustard (*Otis tarda*).

Hab. Europe; only lately extinct in England.

Charadriadæ.

275. Skull of Golden Plover (*Charadrius pluvialis*).

275[5]. Skull of Oyster-catcher (*Hæmatopus ostralegus*).

Scolopacidæ.

276. Skull of Curlew (*Numenius arquatus*).

277. Skeleton of Jacksnipe, or Judcock (*Scolopax gallinula*).

Notice the rudimentary hallux and long, narrow beak.

277[5]. Skull of Jacksnipe.

277[10]. Skull of Woodcock (*Scolopax rusticola*).

278. Skeleton of Ruff (*Machetes pugnax*).

279. Skeleton of Common or Bartailed Godwit (*Limosa lapponica* v. *rufa*.

279[5]. Skull of Red or Blacktailed Godwit (*L. melanura*).

Rallidæ.

280. Stuffed Corncrake or Landrail (*Crex pratensis*).

280[5]. Skull of Corncrake.

280[10]. Skull of Water-rail (*Rallus aquaticus*).

280^{15}. Skull of Moorhen or Waterhen (*Gallinula chloropus*).

280^{20}. Skull of Coot (*Fulica atra*).

Ardeidæ.

281. Skeleton of Heron (*Ardea cinerea*).

281^{5}. Another specimen.

281^{10}. Skull of Heron.

See also preps. 860, 917, 988.

282. Skeleton of Little Bittern (*Ardetta minuta*).

282^{5}. Stuffed Bittern (*Botaurus stellaris*).

283. Skeleton of Adjutant (*Leptoptilus argala*). India.

283^{5}. Another specimen.

Notice the marks on the ulna, made by the follicles of insertion of the great secondary wing feathers. The best Mariboo feathers come from this species, not from that of West Africa (*L. mariboo*).

284. Skeleton of Stork (*Ciconia alba*). Europe.

Cerv. vert. 16. Only 4 thoracic distinguishable from the sacrum.

285. Skull of Stork.

285^{5}. Leg of Stork.

285^{50}. Mandible and os quadratum of Stork.

Gruidæ.

286. Skeleton of Crowned Crane (*Balearica pavonina*). Africa.

287. Skeleton of Sahras Crane (*Grus antigone*). N. India.

The sternum has been opened to show the convoluted trachea. See also prep. 859.

Hemiciconiæ.

288. Skeleton of Flamingo (*Phœnicopterus antiquorum*). Africa.

Notice the peculiar form of beak, the long metatarsus and absence of hallux. The left humerus has been broken.

Anatidæ.

289. Skeleton of Common Duck (domestic variety of *Anas Boschas*).

289^{1}. Skull of Wild Duck.

289^{2}. Skull of Common Duck.

See also preps. 862, 902.

289^{5}. Skull of Teal (*Anas* v. *Querquedula crecca*).

289[10]. Skull of Widgeon (*Mareca penelope*).

290. Skeleton of Goosander (*Mergus merganser*).

291. Skull of Goose, domestic variety of the Greylag Goose (*Anser palustris* v. *ferus*).

291[5]. Feet of Goose.

Notice the very small fourth toe. See also preps. 861, 1081[5], 1206.

291[10]. Skull of Canada or Cravat Goose (*A. canadensis*).

292. Skeleton of Tame or Mute Swan (*Cygnus olor*).

292[5]. Skull of Tame Swan.

293. Skeleton of Wild or Whistling Swan (*Cygnus ferus*).

293[5]. Skull of Wild Swan.

This is desmognathous. Notice also the long angle of the lower jaw.

294. Limb bones of Swan.

295. Skull, and other detached Bones of Swan.

Compare with account of 230[5]. The sternum, as in the rest of the family, is broad, and has one notch on each side behind, closed by membrane. The carina is hollow to receive the trachea.

See also preps. 607, 683, 684, 689, 863, 902[5], 921, 1074.

Colymbidæ.

296. Stuffed Northern Diver (*Colymbus glacialis*).

See also prep. 867.

Procellaridæ.

297. Skeleton of Fulmar Petrel (*Procellaria glacialis*).

297[5]. Head of Petrel.

298. Skeleton of Albatross (*Diomedea exulans*). Pacific Ocean.

Notice the great length of the wing-bones, especially of the humerus, and the curious upward prolongation of the crest of the tibia, simulating an ancylosed patella.

298[10, 15]. Two Skulls of Albatross.

Notice the compressed and hooked rostrum, as in *Laridæ*, also the swollen maxillo-palatines, which almost touch the vomer, and the imperfectly ossified orbits.

298[20]. Head and Feet of Black Albatross (*D. fuliginosa*). Ind. Ocean.

Laridæ.

299. Skeleton of Gull (*Larus*, sp.)

Notice the schizognathous skull (better in 300), and groove in roof of orbit which lodges a gland. Also the webbed feet without a hallux.

299[5]. Skeleton of Gull.

299[10]. Skeleton of Gull.

300. Skull of great Blackbacked Gull (*Larus marinus*).

303. Skull of lessor Blackbacked Gull (*L. fuscus*).

304. Skull of Laughing Gull (*L. atricilla*). America.

305. Skull of Tern (*Sterna hirundo*).

Pelicanidæ.

306. Skeleton of Cormorant (*Phalacrocorax carbo*).

Notice that the sternum in this family is truncated, and its posterior edge entire, or nearly so. See also preps. 681, 866.

306[5]. Skull of Cormorant.

307. Skeleton of Solon, or Soland Goose, or Gannet (*Sula bassana*).

307[5]. Skull of Gannet.

308. Skeleton of Pelican (*P. onocrotalus*). S. Europe & N. Africa.

Notice the enormous length of the wing bone, especially of the humerus, and the very narrow symphysis of the two rami of the lower jaw, which support between them the great pouch of skin and mucous membrane. The left ulna has been broken. See prep. 681.

Alcidæ.

309. Skull of Puffin, or Sea-parrot (*Fratercula arctica*).

Notice the laterally compressed beak.

Spheniscidæ.

309[5]. Wing and Foot of Penguin (*Aptenodytes Pennantii*). Patagonia and Falkland Islands.

The short wing is used for swimming not flying. Compare it with the flipper of the hawkbill turtle (348). See also prep. 864.

310. Skulls illustrating some of the principal varieties in the structure of the base of the skull, on which Prof. Huxley's classification of Carinate Birds is founded.

I. Skulls of Common Hen (*Gallus bankiva* ♀) and Albatross (*Diomedea exulans*), belonging to the suborders Alectoromorphæ and Cecomorphæ respectively, illustrating the Schizognathous form of skull.

Notice that the vomer (coloured green) is narrow in front, and embraces the rostrum of the præsphenoid behind, and that the maxillo-palatines (yellow), and pterygoid (red), articulate directly, but that the maxillo-palatines do not meet each other, so that there is a fissure between them and the vomer.

II. Skulls of Swan (*Cygnus olor*) and Parrot (*Psittacus*), belonging to the suborders Chenomorphæ and Psittacomorphæ respectively, illustrating the Desmognathous form of skull.

Notice that the vomer is wholly or nearly absent, and that the right and left maxillo-palatines (yellow) unite in the middle line. These are spongy in the parrots, but not in Anatidæ. This form of skull approaches in some respects nearest to that of reptiles.

III. Skull of Raven (*Corvus corax*), belonging to the suborder Coracomorphæ, illustrating the Ægithognathous form of skull.

Notice that the vomer is broad in front, and has a deep notch behind, the processes on each side of which embrace the rostrum of the præsphenoid. The maxillo-palatines do not unite.

The fourth form of skull in Aves Carinatæ, which is very nearly that of the Ratitæ, is only found in the South American Tinamou (*Tinamus*), which genus forms the order Dromæognathæ.

310^{5}. Cervical vertebræ of a bird.

Notice the saddle-shaped articulating surfaces of the elongated centra, also the small backward-pointing transverse and rudimentary spinous processes.

310^{10}. Rib of a Bird, showing the capitular and tubercular facets, the uncinate process, and sternal segment.

For sternum see 230^{5}, 260, 269, and 295.

310^{15}. Scapula, coracoid, and humerus articulated, and furcula without an interclavicle. (Cf. 270.)

310^{17}. Ulna, radius, and metacarpus of ii and iii.

310^{20}. Pelvis, showing the characteristic long sacrum, large ancylosed ilia, slender pubes without a symphysis, perforated acetabulum, and large ischia joining the ilia. (Cf. 271.)

310^{25}. Bones of lower extremity.

Short femur, with a single trochanter, long tibia with cnemial crest and rudimentary fibula (cf. 120), and tarsometatarsus with three facets and grooves for flexor tendons. (Cf. 158.)

Class REPTILIA.

Synonyms.—Pholidota; Haplopnoa, or Monopnoa; Amphibia of Linnæus, including the Batrachia, to which the term is now confined.

Characters.—Abranchiate, amniotic Vertebrata, with cold and partially mixed blood.

Covered with horny, epidermic scales.

One condyle to skull. Quadrate bone to lower jaw. Ankle joint between the two rows of the tarsus.

Teeth alveolar, or without sockets; sometimes absent.

Heart with three or four cavities; double aorta, communicating with the pulmonary artery by a patent ductus arteriosus, during the whole of life. Blood corpuscles oval and nucleated. Respiration only by lungs. Corpora Wolfiana replaced by permanent kidneys.

Oviparous; egg has albumen and shell; ova fertilised within the body; embryo provided with amnion; allantois large and respiratory; yelk sac large.

Distribution.—Reptiles are at present scantily represented both in species or individuals, except in tropical climates. They are found in each of the Zoological Regions. For details see under each of the orders.

Palæontology.—The existing species of this class form only the remains of a much larger and more varied group of Vertebrata. Beside representatives of the four orders still existing, numerous species abound, chiefly in the Secondary strata, which cannot be referred to any of them. Accordingly, these have been arranged in the following orders:—

1. *Ichthyosauria.*—Huge, whale-like reptiles, without necks; long jaws armed with teeth not implanted in sockets; four paddles. Vertebræ biconcave. Carnivorous. Found in the Lias and Cretaceous formations.

   See prep. 579.

2. *Plesiosauria.*—Like the last order, marine, with four paddles, and no sternum. Neck very long and head small; thecodont; scapulæ peculiar. Carnivorous. Found in all the secondary or mesozoic strata.

3. *Anomodontia.*—Large land animals, some edentate like tortoises (*Oudenodon*), others with two tusks in the upper jaw (*Dicynodon*). Found in the Trias.
4. *Pterosauria.*—Winged reptiles, with skulls resembling a bird's, and also keeled sterna and pneumatic cavities in many bones; but armed with teeth, and flying like Bats by means of a patagium supported on a single enormously lengthened digit (no. iv, v being absent). Insectivorous? The Pterodactyles are found abundantly in the chalk, oolite and other secondary strata.
5. *Dinosauria* v. *Ornithoscelida.*—Huge land animals, with four feet. They are the highest known reptiles, and, in the structure of the pelvis and some other points, resemble Birds. The *Iguanodon* (herbivorous), *Megalosaurus* (carnivorous), *Compsognathus*, and other members of this Order, are found throughout the Mesozoic strata.

Classification.—Existing Reptiles belong to the following very natural Orders: — Crocodilia, Chelonia (Turtles), Lacertilia (Lizards), and Ophidia (Snakes).

Lit.—Lacepède: "Hist. nat. des Quadr. ovip. et des serpens," 1789. Duméril et Bibron: "Erpétologie générale," 1834—54. Gervais: "Rept. vivants et fossiles," 1869. Bell: "British Reptiles," 1839. Günther: "Reptiles of British India," 1864. Fayrer: "Thanatophidia," 1871.

Order Crocodilia.

Syn.—Loricata, Emydosauria.

Char.—Covered with epidermic, horny plates, and also dermal ossifications.

Vertebræ procœlous, i.e. concave in front and convex behind. Beside true vertebral ribs in the abdomen, the *linea alba* and *lineæ transversæ* are ossified. No clavicles. Forefoot five-toed, hind four-toed. Teeth thecodont, homodont, indefinite in succession. Heart four-chambered.

CROCODILIA.

These Reptiles inhabit the large rivers of warm countries, where they feed on carrion, fish, &c.

Distr.—The true Crocodiles are found very extensively in Africa, India, America, and Australia. The Alligators and Caymans are confined to America, and the Gavials to the East Indies.

There are many fossil forms of this Order, as *Teleosaurus*. Some of these are procœlous, but others amphi- or opisthocœlous.

311. Skeleton of Young Alligator (*Alligator lucius* v. *Missisipiensis*). North America.

Notice the separate odontoid process of the axis. Cervical vertebræ, each with a pair of ribs; and these, like the anterior thoracic ones, articulate by head and tubercle also. Thoracic vert. 13; Lumbar 4, with long transverse processes; Sacral 2, with ribs; Caudal numerous, with chevron bones. Notice also the uncinate processes of the ribs, as in birds; and the false abdominal ribs (placed below the skeleton). There is no clavicle, but a strong simple coracoid. Scaphoid and lunar long, trapezium absent. The pollex has only 2 phalanges, the following digits 3, 4, 4 and 3 respectively. The two ischia are seen to unite; the pubic symphysis is completed by cartilage. There is a calcaneal tubercle to the os calcis, as in Mammals (peculiar to them and to this Order). The hallux has 2 phalanges, the other toes 3, 4 and 4, the v. digit being absent. Notice that the bend of elbow and knee is outward, and the radius and pollex correspond to the tibia and hallux.

See preps. 485, 573—575, 610, 706, 869, 925, 941, 1075, 1262, 1263.

312. Stuffed Crocodile.

There are only dorsal scuta, whereas in the American Cayman they also form an armour for the belly. Five digits in fore-feet, four in hind, v. 314.

313. Skull of Crocodile (*Crocodilus vulgaris*). West Africa.

Notice that the bones are firmly ancylosed, including the quadrate. The two frontals cannot be distinguished (as in man), but behind them are seen the fused parietals, and then the occipital with its single condyle. The hole behind the orbit is filled by membrane, as are those in the hard palate. The orbit is completed by præ- and post-frontals, as well as by the jugal (= malar). The nasals are very long; the anterior nares look upward. The præmaxilla, maxilla, and dentary piece of the mandible alone bear teeth. The palate is very long, the pterygoids, as well as the maxillæ and palatines, helping to form it, and bounding the single opening of the posterior nares. The bone between the pterygoid and maxilla is called os transversum. Cf. Rymer Jones, fig. 246, Huxley El. Comp. Anat. Lect. xii.

314. Foetal Crocodile.

The vitelline duct is unclosed.

Order Lacertilia.

Syn.—Squamata; Sauria.

Chars.—Covered with epidermic scales. Have usually four limbs, but some have only two, and others none. Vertebræ usually procœlous. Clavicles. Teeth not implanted in distinct sockets. Heart three-chambered, the ventricle being only partially divided.

Class. and Distr.—The natural affinities of the genera composing this Order have not yet been satisfactorily determined. The following are some of the principle families:—

1. Iguanidæ, or Eunota .. .. S. America and the Old World.
2. Chamæleonidæ } Akionocrania* { Africa, Madagascar, Spain,
3. Amphisbænidæ } Akionocrania* { South America and Africa.
4. Ascalobota, or Geckonidæ (amphicœlous) .. .. Old and New World.
5. Lacertina, including the Lacertidæ of the Old, and the Ameividæ of the New World.
6. Platynota, Varanidæ, or Monitors .. .. Asia and Africa.
7. Scincidæ .. .. Cosmopolitan.
8. Rhynchocephala (amphicœlous), including a single genus *Sphenodon*, the Hatteria Lizard of New Zealand.

Iguanidæ.

315. Skeleton of Iguana (*Iguana*, sp.) South America.

Cervical vertebræ 7, trunk 17, with ribs; sacral 2; caudal, 56, with chevron bones. Unossified gaps in skull. Ischial as well as pubic symphysis. Scapula, clavicle and coracoid. Five digits in manus and pes. Cf. 311.

316. Skeletons of a small Iguana, a Gecko, and one of the Lacertidæ, in one case.

317. Stuffed Iguana (*I. tuberculata*). West Indies.

Notice the characteristic dorsal crest and gular pouch, the scales, and the ear without an auricle.

317[5]. Head and Neck of Iguana, dried.

See also preps. 486, 708, 709, 926, 943.

---

* I.e. without a columella. Distinguish this vertical splint-bone, uniting the parietal with the pterygoid, from the ear-bone, which corresponds to the stapes of human anatomy, and is also known as *Columella auris*.

LACERTILIA.

317[10]. *Anolis principalis.* America.

This genus, though allied to *Iguana*, has palmate toes like those of the Geckos of the Old World.

317[15]. *Polychrus marmoratus.* Brazil.

Agamidæ.

318. The Flying Lizard (*Draco volans*). East Indies.

This singular genus is distinguished by the 6 hinder ribs being spread out laterally to support a fold of skin, which acts as a parachute. They are remarkably active, and show iridescent colours which disappear after death.

319. *Moloch horridus*: two specimens. Australia.

319[5]. Ground Iguana (*Agama* sp.) Africa.

Chamæleonidæ.

320. Stuffed Chameleon (*Chamæleo vulgaris*). Africa.

321. Chameleon. In spirit.

Notice the thick skin covering the eye almost entirely, the prehensile tail, and the curious way in which the toes are arranged, the thumb and two next fingers being turned inwards and the other two outwards, while in the foot three toes turn outwards and only the hallux and ii inwards. Integument tubercular. Vent transverse.

323. Chameleon dissected. From Mr. Bryant's Museum.

The tongue, heart and lungs, stomach and liver, kidneys and testes are seen.

324. *Chamæleo pusillus.* S. Africa.

See also preps. 611, 707, 946, 997, 1269, and a microscopical preparation 324_5 of the fæces of this animal, showing the spines, scales, and other chitinous fragments of the insects on which it lives.

Ascalobata.—This family of Wall Lizards is distinguished by the absence of eyelids.

325. The common Gecko (*Platydactylus* v. *Gecco verus*). India.

The generic name is from Keko, the native name, in imitation of its cry.

Notice its smooth skin, and the pads at the end of each digit by which it is enabled to run on walls. See the skeleton of a Gecko in same case as 316.

325[10]. *Cyrtodactylus* v. *Gymnodactylus pulchellus.* Singapore.

Lacertidæ.

326. Variable Lizard (*Eremias variabilis*). Crimea.

326[5]. The Green Lizard (*Lacerta viridis v. ocellata*).

Europe, but not found in Britain.

Notice the five-toed limbs, the bifid tongue, scuta on the abdomen and head, and cylindrical tail. This specimen was brought from Pompeii.

326[10]. The English Sand Lizard (*Lacerta agilis*).

327. The Common English Lizard *(Zootoca vivipara.)*

This is often erroneously named *Lacerta agilis*, the Linnæan title for the larger British species, called the "Sand Lizard." Both vary greatly with the locality, age, &c., as to their marking and colour. See Bell, loc. cit.

328. The Wall-lizard (*L. muralis.*) France and Italy.

329. Skeleton of Lizard.

330. Transverse section of a Lizard.

Cf. Mivart, fig. 390. See also Preps. 942, 1270, 1271.

Varanidæ.—Water Lizards v. *Platynota.*

334. Skeleton of a Monitor. Egypt, India, &c.

Compare the skull with figs. 69 and 70 (Huxley: C. Anat. Vert. An.) of *Cyclodus*, one of the Scincidæ. The complicated shoulder-girdle has scapula and suprascapula, coracoid, clavicle and interclavicle. The sternum is short and broad (Parker, loc. cit., pl. x.) In the tarsus, the astragalus and calcaneum are united, and there are only two distal bones (cuboid and ectocuneiform). The number of phalanges in the toes is 2, 3, 4, 5, 4.

Scincidæ.

335. Longitudinally Striped Lizard (*Scincus*, sp).

335[5]. Small Skink (*Eumeces*, v. *Riopa*, *Hardwickii*). India.

336. Blind, or Slow, Worm (*Anguis fragilis*).

This common English lizard has no external limbs, but differs from snakes in the tongue being not exsertile, in having a clavicle and scapula, and being furnished with eyelids.

Order Chelonia.

Chars.—Epidermic scales and horny plates, and also large dermal ossifications. Ribs with dermal bones make up a dorsal carapace. Other dermal bones form a ventral plastron, in the formation of which the sternum takes no part, this bone being entirely absent. Clavicles absent, or perhaps represented by the epiplastra: the entoplastron would then correspond to an interclavicle—see No. 493[5]. Teeth absent; horny mandibles, forming a bill.

Distr.—This Order is confined to tropical and warmer temperate climates. The Land Tortoises are best represented in Africa, the fresh-water species in America. Tortoises only appear in the later secondary (Lias), and tertiary periods. The most remarkable fossil genus is the pliocaene genus, *Colossochelys*, found in Hindoostan.

Class.—The following principal families are recognized :—

1. Testudinidæ, Land Tortoises with clubbed feet.
2. Emydidæ, Pond and Marsh Tortoises, with webbed feet; "Terrapins."
3. Trionychidæ, River Turtles or Mud Tortoises, with webbed feet, but no horny plates.
4. Chelonidæ *v.* Euereta, Marine Turtles, with fins.

This Order is only placed for convenience between Lizards and Snakes. Its true affinities are on the one hand with Crocodiles, and on the other with Amphibia.

339. Skeleton of Freshwater Tortoise (*Emys Europæa* v. *flava*). South of Europe.

Plastron removed. Compare skull, pelvis, &c., with 341, 346.

339[5]. Carapace and plastron of a large male Tortoise (*Testudo tabulata*) with the scuta completely removed to show the subjacent bones. Brazil.

The nuchal and pygal bones, 8 vertebræ and 8 costal bones, R. and L., with marginal dermal bones, correspond with those of the Turtle (342); but they are sutured to each other and to the plastron, which consists of large lateral dermal bones, R. and L., 2 "clavicles," and an "interclavicle" in front, and 2 xyphoplastra behind, all firmly united by serrated sutures. The concave plastron is a sign of sex. Monograph.—Bojanus: "Anat. Testudinis Europææ, 1821."

340. Skeleton of Edible or Green Turtle (*Chelone midas*). Atlantic Ocean.

Notice the larger anterior limbs, with long digits for swimming. C 8. D 10. S 2. Cd. short.

341. Skulls of Turtle.

The condyle shows its tripartite formation of basi- and exoccipitals. The long backward spine from the supra-occipital is like that in the Cod (No. 427).

Notice the double roof to the skull formed by a dorsal expanded crest from the parietals: also the inclosure of the temporal fossæ by ossification of the deep temporal fascia, and the general consolidation of the craniofacial bones. The quadrate especially is entirely ancylosed.

Notice also the forward position of the posterior nares by the non-union of the pterygoids (cf. 313.)

342. Carapace of Turtle. For plastron, see 491.

The carapace is made up of the dorsal vertebræ (D. ii—ix), which, by an expanded ridge like that of the skull, articulate with great "costal plates," and by their centra only with the true vertebral ribs. It is completed in front and behind by "Nuchal" and "Pygal," and along the edges by "Marginal" dermal plates.

343. Shoulder girdle of Turtle.

The cylindrical bone is the scapula, which is nearly vertical; with it is ancylosed the "clavicle," or rather procoracoid, while the third bone, helping to form the glenoid fossæ, and flat and broad at the other end, is the true coracoid.

344. Two fore-limbs of Tortoise (*Testudo*, sp).

Notice that the carpus contains the full number of bones, 9 (cf. p. 27), and that the five digits contain only two phalanges each. Longer scapula and smaller coracoid than in 343.

345. Pelvis of Tortoise, articulated. Two specimens.

The broad notched bone is the os pubis, the cylindrical one the ilium, and the posterior and inferior the ischium; all three contribute to the acetabulum.

346. Pelvis and hind limbs of Turtle.

Six tarsal bones. The astragalus unites with the navicular bone.

346[5]. Separate vertebral rib of Turtle, showing the broad expansion which helps to form the carapace.

Notice also that it has only a capitular facet, and no sternal segment.

347. Hawk-billed Turtle (*Chelone* v. *Caretta imbricata*). Indian Seas.

This species furnishes the best tortoiseshell.

348. Young specimen of the same species.

349. Young River Tortoise (*Emys ornata*). Honduras.

350. Two other specimens.

351. *Emys concinna*, dissected. Honduras.

352. Three small Turtles, one partly dissected, with an egg.

353. Young Tortoise (*Testudo græca*). Europe.

354. Another specimen.

For other preparations from Chelonia see Nos. 491—496, 690—705, 739, 758, 871—874, 903, 904^{50}—904^{88}, 923, 935, 936—938, 993—996, 1052—1054, 1067, 1115, 1116, 1264—1267.

Order Ophidia.

Chars.—Clothed with epidermic scales.

Limbs absent, or quite rudimentary. No sternum: procœlous vertebrae. Skull very loosely articulated, especially the mandibles, which are only united with each other by an elastic ligament.

Teeth ancylosed: usually palatine.

Eyelids absent, the skin over the cornea being transparent, and called the Antocular Membrane.

Distr.—This Order is abundant only in the tropics, and is absent in cold climates. Thus, in England we have only two species, the harmless common Snake (*Tropidonotus natrix*), and the Adder (*Vipera berus*). There are comparatively few snakes in Africa, and they are absent in many islands, especially in Polynesia.

Ophidia are first met with in Eocæne strata.

Class.—This Order may be divided as follows:—

1. Aglyphodontia (innocua), the teeth not grooved. *Pythonina*, *Colubrina* and *Rhinophidia* v. *Tortricidæ*.
2. Opisthoglypha (suspecta), back teeth grooved. *Psammophididæ*.
3. Proteroglypha (venenosa), front maxillary teeth grooved. *Hydrophidia* and *Elapidæ*.
4. Solenoglypha (venenosa), teeth grooved into a complete tube. *Viperidæ* and *Crotalidæ*.

Two small families of innocuous snakes, with narrow mouths and few and ungrooved teeth, remain; the *Uropeltidæ*, and the *Typhlopidæ*, the latter differing from the rest of the order in the structure of their jaws.

Pythonina.

355. Skeleton of a *Boa constrictor*. South America.

A few smaller species of Boa are found in the East Indian Islands. Notice the cervical ribs which, with the absence of sternum and pelvis, makes the vertebræ divisible only into atlas, præ-caudal, and caudal, the latter being behind the anus and bearing no ribs.

356. Stuffed Rock Snake (*Python reticulatus*), with a chevrotain (*Tragulus*); presented by Mr. Morgan. East Indian Islands.

Other species of this genus are found in Africa, but none in the New World.

356[5]. Section of a Boa, showing the nails of the rudimentary posterior extremities, in the shape of horny "spurs."

See also Preps. 710, 711, 875, 947--949[5], 998, 1076, 1116[2], 1272.

Colubridæ.

357. Vertebral column of Snake.

Notice its extreme flexibility, its short transverse processes, and the additional articulating processes, the "zygosphene" at the front of the neural arch, and the "zygantrum" behind.

Cf. Rymer Jones, fig. 249.

357[5]. Vertebræ of Colubrine Snake.

Showing the spinous processes directed somewhat backward, the procœlous body forming with the next in front a ball and socket joint, præ- and post- zygapophyses, the inferior median hyapophysis, the deeply excavated zygantrum in the posterior surface of the lamina, and the corresponding triangular zygosphene in front. See Mivart, fig. 59.

358. Skeleton of common Snake.

There are 222 vertebræ. As in fishes, they can only be divided into trunk vertebræ in front of the anus and caudal vertebræ behind it. Tho latter are distinguished by chevron bones which form a canal for the aorta.

359. Common Ringed Snake (*Tropidonotus natrix* v. *torquatus*).

Notice the large flat scales (scuta) on the head. The tail, behind the anus, is a fifth of the length of the body. Head oval; scales keeled.

361. River Snake (*T. quincunciatus*). India.

362, 363. *T. stolatus* (sub-genus *Amphicsma*). India.

This is one of tho commonest Indian species, and varies much in coloration.

OPHIDIA.

366. *Heterodon*, sp. Presented by Mr. Johnston. America.

366[5]. *Coronella doliata.* Guatemala.
An allied sp., *C. levis*, is found in the south of Europe.

367. All-green Tree-Snake (*Philodryas viridissimus*). South America.

368. Tree-Snake (*Dendrophis picta*). East Indies.

370. The beautiful Tree-Snake (*Chrysopelea ornata*). Sumatra.

371. *Dromicus melanotus.* America.

371[5]. Tree-Snake (*Herpetodryas fuscus*). Brazil.

372. *Lycodon aulicus*: two specimens. India and Ceylon.

Oligodontes.

373. *Simotes coccineus.* Mexico.

374. The Katla tutta (*S. Russellii*). Coromandel.

Tortricidæ.

375. Short-tailed Snake (*Ilysia scytale*). Surinam.
The genus was formerly called *Tortrix*, but this name having been previously applied to a genus of moths, has been changed to *Ilysia*. Notice the "spurs" (356[5]), the small abdominal scuta, and the short tail.

Psammophididæ.

376. *Erythrolamprus venustissimus.* Brazil.

377. Desert Snake (*Psammophis sibilans*). South Africa.
Tail more than half as long as the trunk.

Dryiophididæ.

379. *Passerita mycterizans.* Ceylon.
Notice the produced lower jaw and long tail, whence this family is known as "Whip-Snakes."

Hydrophididæ.

380. Sea-Snake (*Hydrophis*, sp.)
Notice the small hexagonal scales, and compressed tail for swimming, in this and the following specimen. Also, the absence of abdominal scuta and the position of the nostrils at the top instead of the end of the snout, as in Crocodiles.

381. *H. Hardwickii.* Penang.
It inhabits the mouths of rivers in the Indian Sea.

Elapidæ.

384. The Bungarum (*Bungarus fasciatus*). Coromandal, &c.

385. The Cobra di Capello (*Naja tripudians*). Bengal.

Notice the "hood" formed by the first twenty ribs, which is capable of erection at will. This is a generic character, but the curious mark on the hood from which the Cobra is known as the Spectacle Snake is peculiar to the species. An allied species, *Naja haje*, is the sacred serpent of Egypt.

This specimen was presented by Mr. A. Cheek. One of his servants who was bitten by it died in three hours.

386. *Elaps lemniscatus.* South America.

Viperidæ.

387. Common Adder (*Vipera berus*).

Notice the triangular head, covered with small scales.

388. Indian Viper (*Daboia elegans* v. *Russellii*). India.

A venomous nocturnal Snake; known as "Cobra monil."

389. Rattle-Snake (*Crotalus durissus*). America.

The "rattle," seen at the end of the tail, consists of coalesced caudal vertebra, covered with dry, horny rings, which are loosely jointed together, and rattle when the proximal one is shaken. These rings are not present in the young animal, and increase in number with age.

For other preparations from Ophidia, beside those given under 356^5, see Nos. 486^{50}—490, 712.

Uropeltidæ.

389^5. Rough-tailed Snake (*Rhinophis melanogaster* v. *Blythii*). Ceylon.

The head is continuous with the neck, the tail very short and truncated, ending in a disk (whence the family name). The mouth is but little dilatable. They are all harmless.

Typhlopidæ.

389^{10}. Blind Snake (*Typhlops*, sp.) East Indies.

Head and tail as in *Rhinophis*, but not truncated, and mouth very small. The species are all burrowers and have only rudimentary eyes. There are traces of hind limbs concealed under the skin.

Class AMPHIBIA.

Syn.—Placed by Cuvier as an Order of Reptiles, under the name Batrachia, by which the class is still often denoted. They have also been called Psiloderma and Diplopnoa, from their naked skin and double respiration.

Char.—Skin naked. Two condyles. Sternum well developed. Ribs rudimentary or absent. Shoulder girdle, pelvis, and extremities readily comparable with those of abranchiate Vertebrata. No azygos fins, and no fin rays in limbs. Ankle joint between tibia and tarsus.

Heart with two auricles, one pulmonary, the other systemic. Double aorta. Respiration by gills when young, by lungs or both when adult. Blood cold, with large, oval, nucleated corpuscles. Kidneys (= *C. Wolfiana*) are never replaced by permanent ones.

Oviparous—ova fertilised outside the body. The embryo has no amnion, and the allantois is only developed in its proximal part.

Distr.—Amphibia are found in all regions of the globe, and are more abundant than Reptiles in the colder temperate climates.

Pal.—One Order, Labyrinthodontia, is entirely extinct. It belongs to both Palæozoic and Mesozoic ages, being found in the Coal Measures and in the Trias. The remaining Amphibia are comparatively modern, having been as yet only found in Tertiary formations. One of them, a large Salamander, was supposed when first discovered to be a human skeleton, and named *Homo diluvii testis.*

Lit.—Günther: "Reptiles of British India," 1864. Mivart: "Axial Skeleton of Urodela." Proc. Zool. Soc., 1870.

Classification.—The Class Amphibia may be divided into the following Orders:—

- Anura v. Theriomorpha—the adult without a tail and breathing entirely by lungs—Frogs and Toads.
- Labyrinthodontia—dermal skeleton and complicated teeth.
- Urodela v. Saurobatrachia—the tail persistent in the adult, the gills persistent or not*—Newts, Salamanders, *Siren*, *Amphiuma*, *Cryptobranchus*, &c.

* This character, according to which the Amphibia have been divided into Perennibranchiata and Caducibranchiata, is very variable. Even the same species may, under some conditions, breed with its gills persisting, and, under others, lose them when adult, as the Mexican Axolotl, *Siredon pisciforme.*

Gymnophiona v. Ophiomorpha—a small group of tropical animals, including the Genus *Cæcilia* and its allies, without limbs or tail, with inconspicuous scales and labial tentacles.

Anura.

390. Common Frog (*Rana temporaria*).

See figures and description of this species (of greater physiological than zoological importance) in Rolleston: "Forms of Animal Life," plate iii. and letterpress, and Ecker's "Icones Physiologicæ," plates xxiii., xxiv.

391. Skeleton of a Frog ♂

Notice the absence of ribs, the small number of vertebræ (only ten for cervical, dorsal, and lumbar regions, and one sacral), and the "uro-style" into which those of the caudal region are consolidated. Also the large suprascapula and coracoid, with the foramen between the latter and the conjoined clavicle and procoracoid, and the anterior prolongation of the sternum (omosternum). In the pelvis the ilia and united ischia are seen; the pubes is absent. The tibia and fibula, like the radius and ulna, are ancylosed; the os calcis and astragalus much elongated. See 395.

391[5]. Another specimen ♀

Notice the smooth humerus contrasted with that of 391, a sexual peculiarity.

392. Skull of a Frog.

Notice that the upper jaw only has teeth. On the under surface is seen the parasphenoid bone, and between the orbits the "girdle-bone" of Cuvier. See Huxley: Anat. Vert. An., figs. 54, 55.

393. Frog dissected, showing lungs, liver, gall-bladder, &c.

393[5]. Tadpole of *Rana temporaria*, showing the external gills, hind and fore limbs, and tail.

393[10]. Three Tadpoles in successive stages of development.

Notice that the hind legs appear before tho front ones, and that the external gills fall off before the tail is absorbed.

See also preps. 713, 740, 877, 878, 950, 951, 999, 1055.

394. Edible or Green Frog, (*R. esculenta*). Europe and parts of England.

395. Skeleton of a Bull Frog (*Rana mugiens*). N. America.

The number of phalanges in the hind digits run 2, 2, 3, 4, 3, as in the common Frog. The manus is tetradactyle.

395[5]. Two stuffed Bull Frogs.

395[10]. Disarticulated bones of Bull Frog.

396. *Pseudis paradoxa*. South America.

This amphibian retains its large tail for a long time. Notice the forward position of the hind feet. It inhabits Surinam. The fore feet have not yet appeared.

396[5] *Pseudis paradoxa*. Another specimen from Berbice.

An earlier stage. See also prep. 719.

397. Common Toad, dissected (*Bufo vulga·is*).

397[5]. Large Toad from Guernsey, lungs &c. injected.

See also preps. 714, 717, 718, 1116[5], 1116[15], 1274—1280.

402. Tree Frog (*Hyla*, sp.), dissected. Berbice.

Notice the tongue, transparent lungs, dark liver, ovary and oviduct, with bristle passed from it into the cloaca.

One species of this genus (*H. viridis*) is found on the Continent, others in the East Indies and Australia. The toes are provided with suckers for climbing. See also prep. 716.

Urodela.

403. Common Newt, or Eft (*Triton cristatus* ♂ and ♀).

404. Smooth Newt (*T. tæniatus*).

405. Newt, showing reproduction of hind limb.

See also prep. 721.

406. Land Salamander (*Salamandra maculata*) from the Pyrennees.

406[5]. Skeleton of the same species.

Notice the presence of ribs, the numerous, unconsolidated caudal vertebræ, and the normal calcaneum and astragalus, in contrast with the skeleton of the Bull Frog, or Common Frog. The numbers of phalanges in the hind digits (beginning with the hallux) are 1, 2, 3, 3, 2.

406[10] *Menobranchus lateralis* ♂. N. America.

Notice its persistent gills, depressed head, compressed tail for swimming (cf. 403 and 406), and tetradactyle feet. See Rymer Jones, fig 254, of an allied genus *Proteus*. Further description will be found under 952 and 1116[20].

Class PISCES.

Characters.—Vertebrate animals, breathing by gills, and usually covered with dermal scales. Their limbs, when present, are modified to form fins, the anterior pair being called pectoral, and the posterior ventral or abdominal; but they have in addition azygos fins—dorsal (one or two), anal, and caudal. The whole of these, as well as the rays of the paired fins, are dermal structures. The vertebræ are amphicœlous, and are divisible into abdominal (or trunk-vertebræ) bearing ribs, and caudal without. There is no sternum. The skull is provided with ossified gill-covers (*opercula*), and a complicated hyoid apparatus, connected with the branchial arches and the lower jaw. The teeth are not confined to the jaws. All except *Amphioxus* breathe by gills, and have a branchial heart with an auricle* and ventricle, and a *bulbus arteriosus*. The red blood corpuscles are oval† and nucleated. The nostrils do not communicate with the pharynx except in the Dipnoi and *Myxine*. There is no amnion or allantois. Impregnation usually takes place outside the body. A few species are viviparous; the rest lay eggs.

All fishes live in the water. A few like the Hag (*Myxine*) are ectoparasitic, and some are commensal with Medusæ, &c. Most of them are carnivorous.

Geographical distribution.—The marine or freshwater habitat is noted under each Order or Sub-order. As in the preceding classes, all not otherwise described are British species.

Palæontology.—Fishes are the oldest group of Vertebrata, first appearing in the Upper Silurian strata (*Pteraspis*), and becoming very abundant in the old red sandstone, and succeeding primary formations. These Palæozoic fishes are Ganoid or Placoid. The osseous fishes have not been found earlier than the chalk; but during the rest of the Secondary and the Tertiary period they have gradually

* The Dipnoi (Lepidosiren and its allies) have lungs in addition to gills, and two auricles.

† Circular in the Lampreys, and absent in the Lancelet, which has only colourless blood corpuscles (leucocytes).

taken the place of the two older Orders (*Palæichthyes* of Günther), of which only scanty relics now survive. Nothing is known of the former history of the Cyclostomi or the Leptocardii.

Classification.—The distinction between Cartilaginous and Osseous fishes was recognised by Aristotle, and made the basis of his classification by Ray. The subdivisions of the former numerous group made by Cuvier, were afterwards modified by Joh. Müller, and, as given below, are now generally admitted. The researches of Müller on the Lampreys, and Rathke on the Amphioxus, showed the wide separation of each of these forms from each other and from the rest of the class. Of the remaining cartilaginous families, the Sharks and Rays form a natural group of Placoid fishes, while the Holocephali, Ganoids proper, *Ceratodus* and *Lepidosiren* carry on a continuous gradation from the lowest Placoidei to the Amphibia.

Willoughby and Ray: "Historia Piscium," 1686, and Ray: "Synopsis Piscium," 1713. Cuvier and Valenciennes: "Hist. Nat. des Poissons," 1828—1849. Joh. Müller: "Ganoiden u. das Natürliche System der Fische," 1846. Agassiz: "Poissons fossiles," 1833—1844. Günther: "Cat. of Fishes in the Brit. Mus.," 1859—70. "Yarrell's British Fishes," 1836—59. Couch: "Hist. Fishes Brit. Islands," 4 vols., 1862—4.

Order Teleostei.

Syn.—Pisces Ossei.

Char.—Bony endoskeleton: four pair of gills with operculum: bulbus aortæ not contractile, with only two valves; no chiasma.

Sub-orders.—(1.) *Acanthopterygii* v. *Acanthopteri:* fishes, with mostly ctenoid scales, and inflexible fin-rays, without a ductus pneumaticus to the air-bladder, and with pectinate gills: ventral fins forward. This large sub-order is for the most part marine.*

---

* Those Acanthopterous fishes which have the inferior pharyngeal bones more or less completely united, are distinguished from the rest as *Pharyngognathi.* Some of them have cycloid scales; and with these may be associated a *Malacopterous* family (*Scomberesocidæ*) with cycloid scales and united pharyngeal bones.

(2.) *Anacanthini* (*Malacopterygii sub-brachii*). Scales ctenoid or cycloid: flexible finrays: air-bladder, when present, without a duct: pectinate gills: ventral fins forward or absent. Marine: includes the "flat-fishes."

(3.) *Physostomi* (*Malacopterygii abdominales* and *M. apodes*). Scales mostly cycloid: flexible fin-rays: air-bladder provided with a duct: pectinate gills: ventral fins behind pectorals or absent. These fishes, except the *Clupeidæ*, for the most part inhabit fresh water.

(4.) *Lophobranchii.* Exoskeleton tesselated: pneumatic duct absent: gills tufted, with operculum largely adherent; ribs absent. In this small order of marine fishes, the males carry the eggs in a pouch.

(5.) *Plectognathi* (more correctly Pectognathi). Exoskeleton tesselated or spiny: swimming bladder without a duct: pectinate gills: consolidation of maxillæ, præmaxillæ and palatine arch: ventrals commonly absent. This small order is marine.

Sub-Order Acanthopteri.—*Fam. Percidæ.*

407. Skeleton of Perch (*Perca fluviatilis*).

Beside the general piscine characters, notice the forward position of the ventrals (family char.), the strong, undivided rays of the first dorsal fin (subordinal do.), the homocercal tail, well ossified skeleton, and opercula (ordinal do.)

Cf. Rymer Jones, fig. 221.

408. Another specimen.

408[5]. Perch in spirit.

See also preps. 725, 954, 962, 1005.

Skull of Perch-pike (*Sphyræna barracuda*). W. Indies.

See prep. 586.

408[10]. Red Mullet (*Mullus barbatus*).

409. Stickleback (*Gasterosteus aculeatus*).

Cataphracti.

410. Skeleton of Gurnard (*Trigla*, sp.)

411. Bullhead (*Cottus gobio*).

412. Skeleton of *Scorpæna.* Atlantic and Mediterranean.

412^{5}. Flying Gurnard (*Dactylopterus volitans*). Mediterranean.

An allied species (*D. orientalis*), larger and of brilliant colours, inhabits the Indian seas.

412^{10}. Three Gurnards dried.

In one the upper lobe of the caudal fin is produced into a long filament.

Mugilidæ.

412^{15}. Grey Mullet (*Mugil capito*).

Sciænidæ.

412^{20}. Umbre Fish (*Sciæna*).

The lateral line shows very plainly.

Sparidæ.

Sargus. See prep. 583. Mediterranean.

Squamipennes.

413. Skeleton of Grey Snapper (*Ephippus gigas*). N. America.

Notice the curious bony appendage on the head, like the Cassowary's crest. It is an outgrowth of the supraoccipital.

413^{5}. *Pomacanthus paru.* West Indies.

Lepidopodidæ.

414. Silver-hair-tail (*Trichiurus lepturus*).

Notice the mandible produced beyond the upper jaw, the long dorsal fin, and absence of ventral, caudal, and anal fins.

Scomberidæ.

414^{5}. John Dorey (*Zeus faber*).

The trivial name of this fish is a corruption of *Jean doré*, which again is from the Italian *il gianitore, i.e.*, St. Peter's fish, from the dark mark on each side.

415. Skeleton of Mackerel (*Scomber scombrus*).

415^{5}. Tail of Mackerel.

Showing the large and deeply lobed caudal fin, and the five extra finlets (*pinnæ accessoriæ*) behind the dorsal and anal fins.

See also preps. 732,960.

415^{10}. Rostrum of Sword Fish (*Xiphias gladius*).

Atlantic and Mediterranean.

Formed of the præmaxillæ and vomer.

Carangidæ.

415^{20}. Silver Fish (*Argyriosus vomer*). E. American coast.

Notice the lateral line curving upwards, and then taking its ordinary straight course. Also the long filaments of the dorsal and ventral fins.

Gobiadæ.

416. Sucking Fish (*Echineis remora*). Mediterranean.

Lower jaw produced, scales minute. The curious appendage on the head, well known to the ancients (Plin. xxxii. 1), has dermal bones connecting its serrated transverse plates with the cranium and anterior vertebræ. It has been supposed to represent an anterior dorsal fin. In this species there are eighteen plates.

416[5]. A smaller specimen of the same species.

Acronuridæ.

417. The Surgeon Fish (*Acanthurus velifer*). Pacific.

Blenniadæ.

418. Skeleton of Wolf Fish, or Sea Cat (*Anarrhichas lupus*).

See also preps. 587, 728, 729, 881, 1291.

419. Eelpout, or viviparous blenny (*Zoarces viviparus*).

The belly has been opened to show the young in the ovary, where the ova are hatched after impregnation.

See also preps. 1292, 1293.

Halibatrachi v. *Chironectidæ.*

420. Skull of the Angler (*Lophius piscatorius*).

Notice the enormous mouth. This fish lives in the mud and is found on the shallow coasts of the North Sea, as well as the Mediterranean.

See also prep. 727.

421. Skull of the Frog Fish (*Batrachus trispinosus*). Bombay.

Notice the two backward pointing spinous processes on each operculum, and one on the suboperculum, from which it takes its specific name.

Labridæ (Acanthopteri pharyngognathi).

Parrot Fish (*Scarus*). See prep. 581. Molucca seas.

Malacopteri Anacanthini.—*Pleuronectidæ.* In this family of the "flat-fishes," the cranial bones become distorted after hatching, so as to bring both eyes to the right or left side; this is always coloured, and they swim with it uppermost.

423. Skeleton of Sole (*Solea vulgaris*).

Notice the curious twisting of both orbits over to the right side, the very small pectoral and ventral fins, the short trunk, and long, flat tail, with its continuous dorsal and anal fin, and long hæmal spines.

424. Flounder (*Platessa flesus*).

424^5. Another specimen, reversed or sinistral; the dark side, on which both the eyes are, being left instead of right.

Such exceptions, which are found throughout this family, may be compared with the transposition of viscera occasionally met with in man (Guy's Hosp. Rep., 3rd series, vol. xvi.) and the reversed coil of shells in Gasteropoda.

424^{10}. Head of Turbot (*Rhombus maximus*).

As in the Brill (*R. vulgaris*) both eyes are sinistral.

Gadidæ.

425. Skeleton of Cod (*Gadus morrhua*).

Notice the numerous small conical teeth on the præmaxillæ, mandible, vomer, and phalangeal bones. The maxillæ are edentate, as usual in the class. Notice the row of suborbital bones, the great gill cover, with operculum, præ-, sub-, and inter-operculum, the hyoid bone with the 7 branchiostegal rays on its cornua and the hyomandibular and quadrate bones which make up the *suspensorium* of the mandible. Cf. 427.

There are 18 trunk vertebræ with thick, spongy ribs, and characteristic "dagger-bones," like the uncinate processes of birds and crocodiles; about 33 caudal vertebræ, with hæmal arches and spines, which are seen to be serially continuous with the ribs.

The pectoral fins are large, the ventral smaller, and placed in front of them, from which Linnæus described the Cod as one of the Pisces jugulares.

There are 3 dorsal fins, 2 anal with interspinous bones; also a homocercal triangular caudal fin.

426. Disarticulated bones of Cod.

427. Skull of Cod.

Beside the points mentioned under 425, notice the united frontals, the large backward spine of the supra-occipital, the single condyle of the basi-occipital, the long straight parasphenoid running under the cranial axis and meeting the vomer in front.

See also preps. 730, 733, 733^5, 881, 882, 956, 957, 1004, 1075^5, 1068.

428. Whiting (*Gadus merlangus*).

See also prep. 1057.

Malacopteri Physostomi abdominales.—*Clupeidæ.*

429. Herring (*Clupea harengus*).

430. Whitebait.

This is only the young of the Herring, though improperly named *Rogenia alba*.

431. Anchovy (*Engraulis encrasicholus*).

432. Sprat (*Clupea sprattus*).

433. Sardine (*Clupea sardinella*).

Esocidæ.

434. Skeleton of Pike, Jack, or Luce (*Esox lucius*).

Salmonidæ.

435. Common River Trout (*Salmo fario*).

See also prep. 884.

Cyprinidæ.

436. Skeleton of Bream (*Abramis brama*).

437. Golden Carp (*Carassius auratus*). Introduced from China.

See also preps. 953, 961, 1289.

438. Roach (*Leuciscus rutilus*).

438^{5}. Minnow (*L. phoxinus*).

438^{10}. Dace (*L. vulgaris*).

439. Loach (*Nemachilus barbatulus*).

440. Gudgeon (*Gobio fluviatilis*).

MALACOPTERI PHYSOSTOMI APODES.—*Murænidæ.*

441. Common Eel (*Anguilla vulgaris*).

Beside the absence of ventral fins, observe that there is no distinct caudal, the dorsal and anal simply meeting as in the lamprey.

See also preps. 726, 1007, 1117, 1294.

MALOCOPTERI PHARYNGOGNATHI.—*Scombcresocidæ.*

442. Two Flying Fish (*Exocœtus volitans*).

Notice the characteristic pectorals, the forked caudal with the lower lobe the longer, and the large scales. The genus is widely distributed.

443. Another specimen, in spirit.

443^{5}. Pectoral fin of Flying Fish.

444. Garr Fish, or Pioneer Mackerel (*Belone vulgaris*).

LOPHOBRANCHII.—*Syngnathidæ.*

446. Pipe Fish (*Syngnathus*).

Notice the absence of pectoral and ventral fins, the dorsal alone is present.

447. Two other specimens, dry.

448. Sea Horse (*Hippocampus antiquorum*). Mediterranean, &c.

Seven dried specimens. Notice the absence of caudal fin, and the curious prehensile tail. An anal fin is present in the female only.

449. Another specimen, in spirit.

PECTOGNATHI.—*Gymnodontes.*

450. Skeleton of Four-toothed Urchin Fish (*Tetrodon*). China Seas.

451. Stuffed Porcupine Fish (*Diodon aculeatus* v. *hystrix*). India.

452. Trunk Fish (*Ostracion*). Indian Seas.

Notice the small mouth, absence of ventral fins, and hexagonal scuta. This genus has the smallest number of vertebræ known, 15.

453. Another cut open to show the endoskeleton.

454. Two other small specimens, dried.

Order Placoidei.

Syn.—Elasmobranchii.

Char.—Endoskeleton chiefly cartilaginous, no cranial membrane bones. Exoskeleton, calcareous bosses or spines. Tail heterocercal. Heart with a contractile aortic bulb and several rows of valves. Gills more than four, no opercular bones; no air bladder. Spiral valve in intestine. Chiasma of optic nerves.

Distr.—This Order is exclusively marine, and was abundant in the Palæozoic and Mesozoic periods.

Beside the Sharks and Rays (Plagiostomi, Desmobranchii, Pentabranchii), this Order includes the genus *Chimæra* (Holocephali), which differs from them chiefly in the gills not opening by five separate apertures but by a single one covered with an opercular membrane, and in the mouth being terminal as in other fishes instead of ventral. It thus forms a transition from the Plagiostomi to the next Order, with which it was united by Cuvier.

Joh. Müller u. Henle: "Syst. Beschr. d. Plagiostomen," 60 pl., 1841.

Squalidæ.

455. Stuffed Shark (*Carcharias lamia*). Atlantic.

Notice the placoid skin, with no scales but rough tubercles. It makes the kind of leather called "shagreen." Also, the mouth placed below the muzzle, instead of at its extremity, as in bony fishes, and the heterocercal tail.

456. Vertebræ of Shark.

These are deeply amphicœlous, the concavities being occupied by a soft gelatinous substance, which is the remains of the notochord. In the longitudinal sections this is well seen. Cf. Rymer Jones, fig. 220.

457. Jaws of Shark (*Carcharias lamia*).

The upper is the palato-quadrate arch, the lower Meckel's cartilage.

458. Another species (*Odontaspis ferox ?*). Mediterranean.

459. Stuffed Dog Fish (*Scyllium canicula*).

Beside the general characters mentioned under 455, notice the five separate branchial apertures on each side of the neck, without any gill cover, whence the names Desmobranchii and Pentabranchii applied to the Order. Pectoral and ventral, two dorsal, and an anal fin.

460. Another specimen, in spirit.

460[5]. Picked Shark (*Acanthias vulgaris* v. *Spinax acanthias*).

Notice that there is no anal fin, and a spine in front of each dorsal. The placoid tubercles of the skin are rough and shining.

See also preps. 589, 879, 1002, 1003, 1285—1288.

Batides.

460[50]. Stuffed Saw-fish (*Pristis antiquorum*). Mediterranean.

This genus forms a connecting link between the *Raidæ* and Sharks. There are large pectoral, smaller ventral, two dorsal, and a heterocercal anal fin: minute scales.

460[60]. Saw-fish, in spirit.

See also prep. 589.

461. Skeleton of Skate (*Raia batis*).

Notice the cartilaginous spinal column, with the greatest number of vertebræ known (365), and the long tail with a small heterocercal fin. The skull has a rostrum in front, and is incomplete above, leaving two large fontanelles. Below is seen the upper "jaw" with its teeth, which is made up not of the maxillary arch, but the palatal, and below it the lower jaw of Meckel's cartilage, with a cartilaginous suspensorium.

On each side are the huge anterior extremities which do not form detached pectoral fins as in other fishes, but are covered over with skin (see next prep.) The R. and L. shoulder girdle, it will be seen, meet over the vertebral column. There are no ribs or sternum. The pelvis is represented by cartilages seen under the spine, with which are connected two small ventral fins, and external to them the claspers, which serve as auxiliary organs of impregnation.

461[5]. Small Ray, in spirit, dissected.

Notice the ventral mouth, gills, liver, and transparent intestine, with its spiral valve.

See 588[10], 593—595, 723, 724, 904[99], 1000, 1001, 1068[20], 1077, 1284.

Order Ganoidei.

Syn.—Ganolepidoti, Eleutherobranchii (Cuv.), including Holocephali (cf. p. 103).

Char.—Endoskeleton cartilaginous, or bony; exoskeleton osseous, enamelled, or scaly; gills with operculum; contractile aortic bulb, with several rows of valves; chiasma of optic nerves; air-bladder with duct; ventral fins backward, caudal unsymmetrical; spiral valve in intestine.

Distr.—This small Order of fresh water fishes represents what was an extensive group in the Palæolithic period. All the species inhabit fresh water, and are distributed in the genera *Amia* and *Lepidosteus* from the lakes of North America, *Polypterus* from the African rivers, and *Acipenser*, *Spatularia*, and their allies, including about thirty species, which make up the family of Sturgeons (*Sturiones* v. *Chondrostei*).

To these must now be added the remarkable *Ceratodus Forsterii* from the rivers of Queensland, with a persistent notochord and cartilaginous cranium, cycloid scales, and lungs.

Agassiz: "A New Classification of Fishes," Edin. New Phil. Journ., 1835. Joh. Müller ü. d. Bau u. Grenzen d. Ganoiden, 1846.

The two species *Lepidosiren paradoxa* from the Amazon, and *L.* (v. *Protopterus* v. *Rhinocryptis*) *annectens* from the Gambia and East Africa, for which the Order Dipnoi or Protopteri has been formed, are so closely connected with the preceding genera, that they are probably best united with them as a family of Ganoid fishes, forming a link between this class and Amphibia. They are characterised by a persistent notochord, cycloid scales, nostrils opening behind, double air-bladder with a duct, which serves as a pair of lungs in addition to their gills, and a heart with two auricles.

Natterer: "Ann. d. Wiener Mus.," 1837. Bischoff: "*L. paradoxa*," 1840. Owen: "*L. annectens*," Linn. Tr., 1839—40; "Ann. Nat. Hist.," iii., 265. Hyrtl: "*L. paradoxa*," 1845.

Affinities.—The Ganoid Fishes, like the Sharks, are a primitive and undifferentiated group. They are intermediate between Placoidei and Teleostei, and have affinities with Amphibia on the one hand, and Cyclostomi on the other.

Sturiones v. *Chondrostei.*

462. Head of Sturgeon (*Acipenser Sturio*).

North Sea, Caspian, &c.

The rostrum is much prolonged and furnished with four tentacles, better seen in prep. 1003^{3}. The mouth is tubular, edentate, and protrusible (v. 963). The nostrils are seen to be placed far back, in front of the eyes. On each side is the large operculum and pectoral fin.

The bones here seen are not part of the true, cartilaginous endoskeleton, but dermal scutes. The two large R. and L. bones, extending back from the level of the eyes, are called frontals, the two longer ones behind them parietals, and the azygos plate next in order, supra-occipital. Behind this come the first two of the dorsal dermal scutes, corresponding with the lateral rows, of which the anterior are seen in this preparation.

462^{10}. Tail of Sturgeon, dried.

The dorsal, anal, and heterocercal caudal fin are seen, as well as the last of the rows of dermal plates.

462^{15}. Section of cartilaginous vertebral column of Sturgeon, immediately behind the skull.

Notice the spinal cord in its canal, marked by a black bristle, and the unossified notochord beneath it, surrounded by its fibrous sheath. The canal below this is for the aorta.

462^{20}. Vertebral segment of Sturgeon, taken further back.

Above is the canal for the spinal cord, then the notochord in its sheath, and below this the canal for the aorta.

462^{30}. Two vertebræ of Sturgeon.

The neural arches, with the long neural spine attached to the anterior vertebra; the transverse processes, the two centra, and the broad hypapophyses forming a hæmal canal, are shown in this preparation: all cartilaginous.

462[10]. Longitudinal section of spine of Sturgeon.

Beside the zygapophyses and transverse processes, better seen than in the last prep., notice that the notochord is undifferentiated into vertebræ, the sheath only showing segmentation externally. Behind is the neural, in front the hæmal, canal, cut lengthwise.

462[50]. Left pectoral fin of Sturgeon.

See also preps. 498, 963, 1003[3], 1003[5], 1068[10].

Ganolepidoti v. *Holostei*.

463. Bony Pike (*Lepidosteus osseus*). American lakes.

The scales are osseous, enamelled, and firmly locked together. Long, narrow jaws, the upper prolonged with small pointed teeth. Operculum. Pectoral and abdominal fins, dorsal and anal, both placed far back, and oval caudal fin. All of these are partly covered with scales.

Order Cyclostomi.

Syn.—Marsipobranchii, Monorrhina.

Char.—Endoskeleton cartilaginous, with persistent notochord, no cranial roof-bones, or mandible, or ribs; limbs absent. Continuous dorsal and ventral fin, ending in a symmetrical caudal fin without lobes, as in *Anguilla* and *Ceratodus*. Skin naked. Gills pouched, without operculum. No air-bladder Nasal sac single. Red blood-discs, nucleated but circular.

This small Order contains the Lampreys (*Petromyzon*), and Hags (*Myxine*). The species inhabit both sea and fresh water, and are widely distributed. No fossil forms are known. They form a natural link between the Placoids and Ganoids and *Amphioxus*.

Rathke: Bemerkungen ü d. innern Bau der Pricke (1825), des Querders, 1827. Joh. Müller: Vergl. Anat. der Myxinoiden, 1834—42. Gulliver, P. Z. S., 1870.

464. Transverse section of Sea Lamprey (*Petromyzon marinus*).

Above is the neural arch with the spinal chord, next the unsegmented notochord surrounded by its fibrous sheath, and below this again the ventral arch which contained the aorta and alimentary canal.

464[5]. River Lamprey (*Petromyzon fluviatilis*).

This specimen was taken in the Cherwell. Notice the five branchial openings on each side; also, the azygos nostril seen on the top of the head, and the anus in front of the rather short tail and anal fin. See also preps. 741, 964, 965, 1009, 1295.

Order Leptocardii.

Syn.—Pharyngobranchii, Acrania, Cirrhostomi.

Chars.—Endoskeleton reduced to the notochord. Mandible and limbs absent. Skin naked. No fin-rays. Heart replaced by contractile vessels, gills by a perforated pharynx. No red blood-discs.

This Order (or Class) has been formed to receive a single marine species *Amphioxus lanceolatus.* It is obviously the lowest of vertebrate forms, and has remarkable affinities to the Tunicata both in structure and development. The prehistoric characters of the group are unknown.

Yarrell: "British Fishes," 1836, vol. ii, p. 468. Goodsir: "Anat. Memoirs," 1868, vol. i., p. 371 (Paper read before R. Soc. Edin., May 3, 1841). Rathke: "Bemerkungen ü. den Bau des *A. lanceolatus*," pl., 1841. Joh. Müller: ü. den Bau u. Lebenserscheinungen des *Branchiostoma lubricum*, pl., 1842 and 1844. Kowalewsky: Mém. de l'Académie Imp. des Sc. de St. Petersbourg, 1867.

464[50]. The Lancelet (*Amphioxus lanceolatus*).

Mediterranean Sea.

This remarkable form was first discribed by Pallas as a mollusk under the name of *Limax lanceolatus.* Another generic name, given by Costa in 1834 (two years before it was called *Amphioxus* by Yarrell), and still sometimes used, is *Branchiostoma.*

It lives in the ooze of sandy shores, and is abundant in the lagunes of Venice. It is also occasionally found on the coasts of Devon and Cornwall. This specimen was given me by Mr. Ray Lankester, who brought it from Naples. A blue rod has been placed in the ventral mouth, round which fine cirri are seen; and a bristle in the anal orifice. The skin is naked and somewhat iridescent.

SERIES II.—EXOSKELETON.

In the Vertebrata two chief modes by which the integument is hardened are observed, the epidermic cells become horny or the fibrous derma ossifies. The exoskeleton is never developed from cartilage.

In *Amphioxus*, the cyclostomatous fishes, and most amphibia, the skin is "naked," the epidermis being soft and moist. In the snake-like amphibia (*Cæciliadæ*), small scales appear, and these become numerous and thick in all true reptiles, in some, as Chelonia, taking the form of tesselated plates. The same horny scales are found on the legs of birds, and on the Pangolins and Armadillos. But the characteristic covering of the highest two vertebrate classes is a number of processes of horny epidermic cells developed in special sacs, and taking, in birds the divided form of feathers, in mammals that of hair, including fur, wool, bristles, spines. In all classes, from amphibia upwards, we also find horny epidermic appendages in the form of nails, claws, talons and hoofs, and also as hollow or solid "horns," and as beaks or bills, and spurs.

Dermal ossifications are met with in many fishes—as tubercles or spines in Placoids, and enamelled plates in Ganoids. The scales of osseous fishes are not epidermic appendages, but plates of hardened derma. In the extinct Labyrinthodon there was a bony exoskeleton, and this is highly developed in some reptiles, forming the entire plastron of Chelonia and the dorsal plates of Crocodiles. There is no instance of it among birds, and in the class Mammalia it is only found in the Armadillos.

465. Epidermis of a Whale, with the opening of the duct of a cutaneous gland.

The cuticle is thin, and in the adult entirely naked, but the cutis and subcutaneous fascia (blubber), are enormously thick.

4655. Baleen, or "Whalebone."

This is the epidermis of the roof of the mouth developed into great transverse ridges, the fine edges of which are divided into long horny processes, which break up at their extremities into a fringe of bristles. Similar transverse ridges are seen on the palate of the ox and other ruminants. It must be borne in mind that the mucous membrane of the mouth, being developed as far as the fauces by involution of the skin of the face, is derived from the "serous" or "corneo-nervous" external layer of the embryo, and is, therefore, epidermic in the strict sense, not epithelial. A microscopical preparation (46510), shows the minute structure of whalebone. On transverse section it is seen to be traversed by hollow tubes surrounded by concentric fibrous rings. These represent the constituent hairs of which it is composed.

466. Skin of Porpoise, showing the thin naked cuticle, thick cutis, and subcutaneous adipose tissue known as blubber, which supplies the want of hair as a non-conductor of heat.

4665. Dorsal fin of Porpoise.

This is a mere duplication of the integuments in the middle line, but functionally answers to the bony azygos dorsal fin of a fish; the wartlike processes seen in this specimen are an individual character not uncommon in old animals.

46610. Cutis vera surrounding eye of Porpoise.

Injected to show its vascularity in contrast to the cuticle which has been removed.

467. Subcutaneous fascia of Seal, showing its lamelliform arrangement, as it passes into the deeper layer of the cutis.

4675. Three Microscopical preparations showing the imbricated structure of the hair of the Seal, and the dotted hair of the Mouse and Rabbit.

468. Skin of Hedgehog, showing its epidermic hairs and spines.

4685. Portion of skin of Porcupine, with quills attached, showing their implantation in the follicles or hair sacs of the skin.

Notice on the deep surface of the skin the *panniculus carnosus*, the subcutaneous muscular stratum represented by the Platysma myoides in man.

469. Two specimens of dorsal armour of Armadillo.

Notice the horny epidermic "scutes;" and beneath, where they have been removed, the dermic osseous plates.

470. Two specimens of tail of Beaver, showing the arrangement of its imbricated epidermic scales.

470[5]. Callosities of the Horse's legs.

There is one of these corns or "chesnuts" on the inner side of each forearm, and one on the inner side of each metatarsus. They form, with the bushy tail, a specific character, the Ass and other species of *Equus* having only the front pair slightly marked.

471. Two feet of Elephant, showing the character of its hoofs.

If a nail be defined as covering only the dorsal surface of a digit, it will be seen that Ray was justified in classing the Elephant among the unguiculate rather than the ungulate mammals.

471[5]. Foot of Camel, in section, showing the nail-like hoof and horny pad, whence the name Tylopoda (cushion-footed), applied to the family.

472. Cleft, or bisulcate, hoof of ox.

473. Hoof of Horse.

473[5]. A wet preparation of the same.

The "wall" is seen to be lined with lamellæ, which fit into corresponding grooves between the papillæ of the matrix (Cf. 117, 118, 119). The front is the "toe," the sides the "quarters," and the back the "heel." The upper edge is the *coronet*, and the lower, where the shoe is attached, the *crust*. These parts all correspond with the human nail (*unguis*), but the horny part covering the palmar surface of the digit is characteristic of the hoof (*ungula*). This portion consists of the flat "sole," seen outside, with the two "bars" coming to an angle in front, and the soft frog (i. e. *fourche*) behind them, with its median cleft. Inside, this cleft is seen as a projection.

474. Hoof of Horse with the sole and frog removed, leaving only the crust and bars.

474[5]. Other specimens.

475. Hind foot (right), of male Ornithorhynchus with spur.

This is a secondary sexual character.

476. Solid azygos horn of Rhinoceros, showing its construction of hairs densely matted together.

It grows from a patch of follicles in the skin of the nose, and is supported on the nasal bones, but unattached to them.

477. Pair of horns of Bison.

One retains the bony core on which it is moulded. This, in the hollow-horned ruminants, is always supported on the frontal bone.

478. Pair of horns of Ram, showing their eccentric curvature.

479. Horns of four-horned Ram.

No existing mammal has more than four horns, but the extinct genus *Dinoceros*, lately discovered in North America, appears to have had six—one pair on the frontal, one on the maxillary, and one on the nasal bone.

480. Horns of Syrian Goat.

481. Horn of Goat, showing spiral curvature.

See also preps. 14, 173.

482. Mandibles of Toucan.

The term mandible applied to tho inferior maxilla is also used for the horny epidermic sheaths of the upper and lower jaws in tortoises, birds, and the Ornithorhyncus.

483. Cutis vera of Goose, injected.

483[5]. Sebaceous gland from tail of Goose.

484. Birds' feathers : the vascular follicles injected.

484[5, 10]. Other specimens.

484[50]. Large quill feather (*penna*), showing the parts of which it is composed, viz., the quill (*calamus*), with its orifice (*umbilicus inferior*), the quadrangular shaft (*scapus*), grooved on its inner surface, with the vane (*rachis*), on each side, composed of barbs (*rami*), and barbules (*hamuli*).

Notice also the superior umbilicus and the secondary vane (*hyporachis*), both situated at the junction of the barrel with the shaft. On the structure and arrangement of feathers, see Nitzsch : " Pterylography " (Ray Soc. transl., 1867).

484[60]. Down feathers (*plumulæ*).

484[70]. Feathers of Cassowary.

Barbules loose, hyporachis as largo as rachis, making it a double feather.

485. Skin of Crocodile.

Notice that these horny dorsal scuta do not overlap, and that they are ridged longitudinally ; beneath them are dermal bones.

486. Skin of Iguana ; epidermic scales.

486[5]. Cast of epidermic nasal horn of *Iguanodon*, au extiuct genus belonging to the Order Dinosauria.

486[50]. Rattle of Rattlesnake.

This consists of modified epidermic scutes which rattle upon the caudal vertebræ they loosely cover.

487. Scaly Skin of large Serpent.

Two pieces, one with adjacent part of skeleton attached, showing the intercostal nerves.

488. Part of slough of Snake.

489. Slough of Cobra-di-capello, showing the transparent skin which covered the eyes detached with the rest.

490. Two other specimens of sloughs of snakes, likewise showing the antocular epidermic membrane.

491. Carapace and plastron of Green Turtle.

The carapace is partly endo- and partly exoskeletal (v. No. 342); the plastron is wholly exoskeletal, consisting entirely of dermal bones. The horny scuta which cover both belong to the epidermic exoskeleton.

On the outer surface of the carapace are seen in the middle line, in front, a small nuchal scutum, then five large median or "vertebral" horny plates, four lateral or "costal" right and left, and beyond them appear the ends of the ribs with only tough skin between them.

The plastron is seen to be made up of two large lateral dermal bones on each side (Hyoplastron and Hypoplastron), two in front (Epiplastra = clavicles ?), with one azygos between them (Entoplastron = Interclavicle ?), and two behind (Xiphoplastra), all connected by dried skin.

492. Carapace and plastron with horny epidermic exoskeleton of Starred Tortoise (*Testudo geometrica*). ♂ Africa, India.

The dorsal scutes are convex. There are 5 median, 4 lateral right and left, and 24 marginal, of which the central one in front is called nuchal, and that behind caudal or pygal. The plastron has 12 scutes, arranged 6 on each side. The vaulted carapace is a generic character, the concave plastron a sexual one.

493. Carapace of *Testudo radiata*. Australia.

494. Horny epidermic plates from carapace of Radiated Tortoise.

495. Plastron of land Tortoise (*Testudo indica*).

There are two rows (right and left) of 6 scuta, named from before backwards, gular, post-gular, pectoral, abdominal, præ-anal and anal. The dermal bones of the plastron, underneath these epidermic plates, are seen to have ancylosed into a single mass.

496. Carapace and plastron of a Terrapin or Marsh Tortoise (*Emys decussata*).

The carapace is flatter than in the land tortoises. The scuta are as in 492, except that instead of a single azygos caudal plate there are two, a family character.

497. Bony plates of skin of Sturgeon.

These are dermal ossifications, and are covered with enamel, forming what is known as a ganoid exoskeleton.

498. Scale of *Lepidosteus*; microscopical preparation.

This is a dermal bone, and on section shows its characteristic lacunæ, with few canaliculi; but they are not arranged in Haversian systems.

499. Skin of Conger Eel.

In this family of fishes (*Anguillidæ*) the scales are very minute.

499⁵. Skin of Sea Porcupine or Urchin fish (*Diodon histrix*).

499¹⁰. Chenoid scale: microscopical preparation.

The serrated or comb-like form of the free edge of this process of the dermal exoskeleton is characteristic of most Acanthopteri, and of the family *Pleuronectidæ*.

499¹⁵. Cycloid scale: microscopical preparation.

The circular edge here seen is characteristic of the scales of most of the Malacopterous fishes, and of the family *Labridæ*. The attached edge is seen in this and the preceding preparation to be divided into lobes by radiating lines.

Series III.—DIGESTIVE APPARATUS.

A.—Teeth.

Functionally, these organs serve for prehension and mastication, but also as instruments of offence, and thus are often modified as secondary sexual characters.

Structurally, they may be horny, as in *Ornithorhynchus*, in some birds, and in the lamprey; but usually are dermal ossifications (of the corium) of the mucous membrane of the mouth and adjacent parts. They may consist of true bone (*cementum*, *crusta petrosa*), usually without Haversian Systems, or ivory (*dentine*), or osteo-dentine, or various combinations of these, to which in the most perfect teeth a still harder substance (*enamel*) is added.

If their fangs divide and become ancylosed with the bone to which they are attached, the dentition is called "rhizodont;" if they are united only at one side, "pleurodont;" if implanted in distinct sockets (*alveoli*), as in man, "thecodont."

When all the teeth resemble each other, the dentition is called "homodont;" when differentiated, as in man, "heterodont."

If there is only one set of teeth, the term "monophyodont" may be applied; if two, as in man, "diphyodont"; and if more, as in Crocodiles, "polyphyodont."

In the class Mammalia the teeth implanted in the præmaxilla are called "incisors;" that next to the suture, "canine"; the ones behind it which were preceded by milk teeth, "præmolars;" and the remaining maxillary teeth, "molars." Of the mandibular teeth, those are called inferior molars which are unpreceded by milk teeth; and those in front are more arbitrarily divided into inferior præmolars, canines (shutting in front of the upper canines) and incisors.

The number of the different kinds of teeth may be indicated by a "dental formula." Thus i. $\frac{2-2}{2-2}$ c. $\frac{1-1}{1-1}$ p.m. $\frac{2-2}{2-2}$ m. $\frac{3-3}{3-3} = 32$, indicates that of the 32 teeth in an adult man two on each side, above and below, are called incisors, one canine, two præmolars, and three molars.

Owen: "Odontography," with Atlas of plates, 1840—45. See also Flower: "Homologies and Notation of Mammalian Teeth," J. Anat. and Phys., May, 1869, and Moseley and Lankester, ibid., Nov., 1868.

Frugivora.

The chisel-shaped incisors, small canines, and tubercular molars of man and of monkeys are fitted for feeding on fruit.

500. Jaws of Catarrhine Monkey.

Dental formula, $i.\ \frac{2-2}{2-2}\ c.\ \frac{1-1}{1-1}\ p.m.\ \frac{2-2}{2-2}\ m.\ \frac{3-3}{3-3} = 32.$
Notice the diastema or interval which is not seen in human dentition.

501. Skull and lower Jaw of Monkey, showing the milk teeth, with the alveolar process cut away to show the eruption of the permanent ones.

502. Skull of Platyrrhine Monkey, with an additional præmolar on each side, above and below, making the number of teeth 36.

This is a young specimen, with the sutures still open.

502 . Teeth of Male Mandril.

The large canines are a secondary sexual character.

502[10]. Skull of Lemur.

$i.\ \frac{2-2}{2-2}\ c.\ \frac{1-1}{1-1}\ p.m.\ \frac{3-3}{3-3}\ m.\ \frac{3-3}{3-3}.$ The R. and L. upper incisors are wide apart. The lower canines are close to the incisors, and like them procumbent.

Insectivora.

The sharp incisors and pointed cusped molars are characteristic of the food of this group.

503. Skull and lower jaw of Mole.

$i.\ \frac{3-3}{3-3}\ c.\ \frac{1-1}{1-1}\ p.m.\ \frac{4-4}{4-4}\ m.\ \frac{3-3}{3-3}$ or $i.\ \frac{8}{8}\ c.\ \frac{2}{2}\ p.m.\ \frac{6}{6}\ m.\ \frac{6}{6}.$
The so-called upper canine is in the præmaxilla, and has a double fang, and the lower "canine," which shuts in front of it, is more like an incisor, while the first premolar is caniniform.

504. Skull and lower jaw of Mole, with carnassial, or laniary tooth of Hedgehog.

This name was given by Cuvier to the large trenchant molar in both jaws of Carnivora. In the maxilla it is the last præmolar, in the mandible the first "true" molar.

504[5]. Skull and teeth of Shrew.

The middle upper incisors are large, as in Rodents; the homologies of the teeth are not certain, and their number varies (from 26 to 32). For an example of insectivorous dentition in a marsupial, see 219, an opossum's skull with the following dental formula:—

$$\text{i. } \frac{5-5}{4-4} \text{ c. } \frac{1-1}{1-1} \text{ p.m. } \frac{3-3}{3-3} \text{ m. } \frac{4-4}{4-4}.$$

Carnivora.

Most of these feed on living prey, some on carrion, and many eat insects or fruit, as well as flesh.

505. Skull of young Bear.

$\text{i. } \frac{3-3}{3-3} \text{ c. } \frac{1-1}{1-1} \text{ p.m. } \frac{4-4}{4-4} \text{ m. } \frac{2-2}{3-3}.$ Many of the bear family are wholly frugivorous, or eat honey.

507. Skull of Ferret (*Putorius furo*).

$$\text{i. } \frac{3-3}{3-3} \text{ c. } \frac{1-1}{1-1} \text{ p.m. } \frac{3-3}{3-3} \text{ m. } \frac{1-1}{2-2}.$$

508. Upper and lower jaw of Stoat (*Mustela erminea*).

Dentition as in the ferret.

509, 510. Skull and lower jaw of Otter: two specimens.

$\text{i. } \frac{3-3}{3-3} \text{ c. } \frac{1-1}{1-1} \text{ p.m. } \frac{4-4}{3-3} \text{ m. } \frac{1-1}{2-2}.$ The præmolar wanting in the mandible is the first, the molar wanting in the maxilla, the second.

511. Skull of Racoon.

$$\text{i. } \frac{3-3}{3-3} \text{ c. } \frac{1-1}{1-1} \text{ p.m. } \frac{4-4}{4-4} \text{ m. } \frac{2-2}{2-2}.$$

512. Skull of Badger.

Notice that the glenoid cavity is so deep that the mandible does not fall out even in the dry skull. It is a perfect ginglymoid joint, admitting of no lateral motion. Also the great size of the upper molar.

$$\text{i. } \frac{3-3}{3-3} \text{ c. } \frac{1-1}{1-1} \text{ p.m. } \frac{3-3}{4-4} \text{ m. } \frac{1-1}{2-2}.$$

513. Skull of Coati.

Dentition as in racoon. This is an old male specimen, with very large canines. Notice also the high sagittal crest for the temporal muscles, and the obliterated sutures, compared with the skull of 81, a younger specimen. The lower canine is grooved internally.

514, 515. Skulls of Cat.

i. $\frac{3-3}{3-3}$ c. $\frac{1-1}{1-1}$ p.m. $\frac{3-3}{2-2}$ m. $\frac{1-1}{1-1}$. The last præmolar in the maxilla and the first molar in the mandible are the "carnassial," laniary, or sectorial teeth. They consist of a blade with three cusps, with, in the upper one, a small internal tubercle. The upper molar and the first præmolar are very small, and often fall out.

516. Part of upper and lower jaws of Lion, showing the small incisors and large canines.

517. Section of carnassial molar tooth of Lion, with the pulp-cavity coloured red.

517[5]. Skull of Hyæna. Presented by Mr. Callaway.

i. $\frac{3-3}{3-3}$ c. $\frac{1-1}{1-1}$ p.m. $\frac{4-4}{3-3}$ m. $\frac{1-1}{1-1}$.

518. Skull of Dog.

i. $\frac{3-3}{3-3}$ c. $\frac{1-1}{1-1}$ p.m. $\frac{4-4}{4-4}$ m. $\frac{2-2}{3-3}$. Notice that, as is usually the case, the præmolars increase in size backwards, and the true molars forwards. The first præmolar (pm. i.) falls out early, especially the lower one, and these teeth have no predecessors in the milk dentition.

519. Skull of Bull Terrier, showing the distorted form of the upper jaw.

520, 521. Other specimens of the dentition of dogs.

521[5]. Teeth of Seal.

i. $\frac{3-3}{2-2}$ c. $\frac{1-1}{1-1}$ m. $\frac{5-5}{5-5}$.

522. Upper and lower jaw of Walrus, one of the tusks in section.

There are usually two small upper incisors, then the great canine tusks, small lower canines, and a variable number of upper and lower molars. The tusks are weapons of offence: they consist of pure dentine.

523. Section of tusk of Walrus.

523[5]. Upper canine tooth of Walrus, showing the cavity and calcified pulp of osteodentine.

Omnivora. Teeth uniformly developed. Tubercular molars.

524. Skull and lower jaw of common Pig.

i. $\frac{3-3}{3-3}$ c. $\frac{1-1}{1-1}$ p.m $\frac{4-4}{4-4}$ m. $\frac{3-3}{3-3}=44$. The full number of teeth for a placental mammal. Cf. Prep. 548. The large canine tusks are secondary sexual characters.

526. Skull and lower jaw of Babirussa: alveolar processes cut away to show the sockets of the teeth.

i. $\frac{2-2}{3-3}$ c. $\frac{1-1}{1-1}$ m. $\frac{5-5}{5-5}$. Notice the curious way in which the socket of the upper canines is reversed in direction. The use of these tusks is probably to defend the eyes.

527. Tusks of Hog in section.

528. Molar teeth of Hog in section.

The tubercular "hillocks" or cusps of the grinding teeth shown here is a character common to the non-ruminant Artiodactyles, and has led M. Kowalewsky to apply to this section the term "Bunodont." Cf. 547.

Herbivora. Molars of complicated structure.

529. Section of molar tooth of African Elephant. Presented by Mr. Bell.

Notice the alternate layers of enamel, enclosing dentine, and separated by cement. Also the lozenge-shaped pattern thus formed on the grinding surface. The same constituents are seen in the section, and also the large ramifying pulp-cavity.

529[5]. Outer half of molar tooth of fossil Elephant (*E. meridionalis*).

Notice the black parallel oblongs of enamel, enclosing dentine, and separated from each other by enamel, as in the Indian species.

529[10]. Separate transverse plates of molar tooth of fossil Elephant.

Each forms one of the ridges of ivory and enamel, which are afterwards united by cement to form the tooth. The edge is not worn, from the tooth having never cut the gum, and so its digitate processes are still seen.

529[11]. Molar tooth of fossil Elephant, showing the islets of enamel produced by the wearing down of the digitate processes of the transverse plates, before the plate itself has been opened as in 529[5].

530. Parts of fossil molar teeth of Mastodon.

In this genus the enamel and dentine did not form parallel ridges as in the Indian, or lozenges as in the African Elephant, but nipple-like projections, whence the generic name.

531. Skull of Tapir. Presented by Mr. Bell.

i. $\frac{3-3}{3-3}$ c. $\frac{1-1}{1-1}$ p.m. $\frac{4-4}{3-3}$ m. $\frac{3-3}{3-3}$.

532. Part of upper and lower jaws of *Equus caballus* ♂

The incisors or nippers have a fold of enamel running into their cutting surface, which produces the "mark." This is worn away at the age of six in the inner, and by eight in all the lower incisors. It persists somewhat longer in the upper ones. The small canines, called "tushes," are a secondary sexual character, but often appear in aged mares. In the stallion or gelding they are cut at about four years old.

533. Section of lower jaw of horse, showing roots of three molars, injected.

534. Several molars of horse, some in transverse and others in longitudinal section.

Notice the long undivided roots and short crowns; also the broad waving outer ridge of enamel and dentine, and the ant. and post. inner lobes, more or less separated by cement according to the degree of wear.

535. Incisors and canines of horse.

536. Section of lower jaw of Horse, showing pulp-cavity, and nerve.

537. Part of upper jaw of horse, cut to show incisors and canines.

i. $\frac{3-3}{\quad}$ c. $\frac{1-1}{\quad}$ m. $\frac{6-6}{\quad}$. Three of the molars are preceded by milk teeth above and below, and there is a small deciduous præmolar in front of them.

538. Part of right ramus of lower jaw of Horse.

i. $\frac{\quad}{3-3}$ c. $\frac{\quad}{1-1}$ m. $\frac{\quad}{6-6}$

539. Skull of Stallion, showing the complete functional dentition.

540. Upper jaw of *Equus asinus*.

Ruminant Herbivora. No upper incisors.

541, 542. Skulls of Sheep.

i. $\frac{0-0}{4-4}$ c. $\frac{0-0}{0-0}$ m. $\frac{6-6}{6-6}$. The lower incisors bite against a a horny pad in the upper lip. It is possible that the outer inferior incisors represent canines. Three of the molars are preceded by milk teeth, and so are præmolars, the other three being true molars. There are three incisors in the upper jaw in the fœtus.

544. Skull and lower jaw of Goat; alveolar process cut away to show roots of teeth.

545. Pulps of teeth of Calf, injected.

546. Lower jaw of Ox, showing molar and incisor teeth.

i. $\frac{}{4-4}$ c. $\frac{}{0-0}$ m. $\frac{}{6-6}$. Notice the fan-like arrangement of the incisors.

547. Separate molar teeth of Ox.

Notice the double crescent of enamel and ivory, whence this family, *Bovidæ*, and its allies have been called Selenodont.

Marsupial Herbivora. Dentition analogous to that of the Horse.

548. Teeth of Kangaroo.

i. $\frac{3-3}{1-1}$ c. $\frac{0-0}{0-0}$ p.m. $\frac{1-1}{1-1}$ m. $\frac{4-4}{4-4}$. This family of marsupials represents the Herbivorous placental mammals, and has been named Poephaga. Notice the absence of canines, the uniform molars, and the procumbent inferior incisors, which, as usual in Marsupials (cf. 219), are exceded by the præmaxillary teeth in number. The dentition of marsupials generally is monophyodont, except one molar, pm. iii., in each jaw, which is preceded by a milk tooth. The præmolars exceed the molars in number, four and three being a usual proportion. Cf. 524.

548[5]. Mandibular teeth of a Kangaroo Rat.

The bone has been cut away, to show the long socket of the single incisor running under the roots of the two anterior molars.

Rodentia. Scalpridentata of Hunter. Incisors with persistent pulps. No canines. Molars with transverse ridges.

549. Upper and lower jaws of Hare.

Notice the small external incisor on each side, peculiar to this genus. They drop out early, as in the Hyrax (102). i. $\frac{2-2}{1-1}$ c. $\frac{0-0}{0-0}$ m. $\frac{6-6}{5-5}$. The last three molars are unpreceded by milk teeth. The mid-incisors are grooved.

550. Maxillary teeth of Squirrel.

i. $\frac{1-1}{}$ c. $\frac{0-0}{}$ m. $\frac{5-5}{}$. There is one præmolar less below.

Notice the orange coloured incisors, enamelled only in front.

551. Maxillary teeth of Rat.

i. $\frac{1-1}{}$ c. $\frac{0-0}{}$ p.m. $\frac{1-1}{}$ m. $\frac{2-2}{}$. Thus there are only sixteen teeth altogether, and in a species of the allied genus *Hydromys*, from Australia, there are only twelve, i. 1, pm. 1, m. 1.

551[5]. Two skulls of Mouse.

552. Skull of Guinea Pig* (*Cavia cobaya*).

553. Skull of European Porcupine (*Hystrix cristata*).

553[5]. Upper and lower jaw of Porcupine from Honduras (*Cercolabes*, sp.)

Four molars above and below, as in *Hystrix* and *Cavia*.

Piscivora. Numerous, uniform, pointed teeth.

554. Jaws of Porpoise.

Notice that the teeth have no sockets, and are all alike (homodont), and very numerous.

554[5]. Another specimen, with the bone cut away to show the implantation of the teeth.

Cf. Rymer Jones, fig. 311.

554[10]. Another specimen, with the teeth and the dry mucous membrane of the gums separated from the bones.

555. Transverse section of mandibular tooth of Sperm Whale.

The upper jaw is edentulous.

555[5]. Two teeth of Sperm Whale. Presented by Dr. Lever.

555[10]. Teeth of Sperm Whale in longitudinal section.

556. Tusk of Narwhal (*Monodon monoceros* ♂).

This is the left, which is the only one developed. Cf. prep. 186, which shows both tusks in situ. Both remain mere germs in the female narwhal. Sometimes the right instead of the left tusk is developed, and occasionally both together. The tusk is implanted in the maxilla, and is therefore a canine tooth, not an incisor, as supposed by Cuvier. In the fœtus there is a second external denticle on each side. The tusk is formed of dentine, with a thin layer of cement, uncovered by enamel. See Turner, J. Anat. and Phys., Nov. 72, and J. W. Clark, P.Z.S., 1871.

Edentata. Canines always, incisors almost always, molars sometimes, absent.

557. Upper and lower jaws of Armadillo.

Notice that all the teeth are alike (homodont), that they have no fangs, and no enamel.

---

* This animal inhabits South America. Its trivial name is probably a corruption of Guaiana. The Germans call it *Meerschweinchen* (pig from over the sea), and the French, *Cochon d'Inde*, *i.e.*, West Indian pig, as *Coq d'Inde* (dinde, dindon), the American turkey.

559. Head of Ornithorhyncus.

This edentulous monotreme has the place of teeth supplied by the two flat horny surfaces behind, which act as molars, and the serrated bill for prehension.

560. Another specimen.

Aves, all edentulous.

561. Case of Birds' Skulls, showing various forms of the beak as an organ of prehension, answering to the incisor and canine teeth of Mammals.

Notice among them the tearing beak of Raptores, with hooked and notched upper mandible; the hooked but less-arched beak of fish-eating Gulls and Albatrosses; the long forceps-like bill (for searching in soft mud) of the Snipe; the strong vaulted beak of *Gallinaceæ*, and the flat, shovel-like bill of Ducks and their allies.

565. Upper and lower jaws of Hornbill (*Buceros*), cut so as to show their exceedingly light cancellous structure.

566. Upper and lower mandibles of Toucan, in section.

See Owen ii. 131.

567. Upper and lower mandibles of Adjutant.

570. Skull of Swan, showing the serrations on the horny mandibles.

In a fossil bird from the Sheppey clay (*Odontopteryx*) there were similar serrations of true bone.

Owen: Proc. Geol. Soc., June 25, 1873.

Reptilia edentata.

571. Skull of Turtle.

The horny mandibles supply the place of teeth, as in birds.

R. thecodontia.

573. Skull of young Crocodile.

Teeth in alveoli. Not quite homodont. Notice that the large canine-like tooth of the mandible bites outside the maxilla.

574. Skull of *Alligator Mississippiensis.*

Notice that the canine-like tooth of the mandible bites inside the maxilla.

575. Teeth of Crocodile: two of a fossil species.

Notice the hollow into which the new tooth grows.

575^5. Tooth of Megalosaurus (fossil).

R. pleurodontia.

576. Head of Chamæleon, showing upper and lower jaws and tongue.

The teeth of the Iguana are also pleurodont (cf. 315), i. e. they are attached to the jaw by their outer surface. Those of the Monitors (cf. 334) are acrodont, i. e. ancylosed by their extremities only.

R. rhizodontia.

577. Upper and lower jaws of Boa.

There are no teeth in the præmaxilla.

577[5]. Dentition of a Non-venomous Snake.

578. Head of Viper, showing the poison fangs in the maxilla

578. Another specimen.

579. Cast of Skull of Ichthyosaurus (fossil).

The teeth were homodont, conical, numerous, and consisted of cement, dentine, and enamel.

Pisces.

581. Teeth of Parrot-fish (*Scarus*, sp.)

The præmaxillæ and mandible form a kind of beak, covered with granular denticles.

581[5]. Another smaller specimen.

581[10]. The superior pharyngeal teeth (convex) and inferior (concave) of *Scarus*.

Owen: Comp. Anat. and Phys. of Vert., fig. 255.

582. Pharyngeal Teeth of Tench (*Tinca vulgaris*).

582[5]. Teeth of Carp (*Cyprina carpio*).

583. Teeth of *Sargus*.

They are remarkably like human molars and incisors.

584. Upper jaw of Pike, showing the palatine teeth.

585. Skull of Pike, showing teeth and tongue.

586. Skull of Perchpike (*Sphyræna Baracuda*).

587. Skull of Wolf-fish (*Anarrhichas lupus*), showing the pharyngeal teeth.

587[5]. Loose teeth of the same species.

588. Upper jaw of Grey-snapper.

588[5]. Palate teeth of *Ptychodus* (fossil).

588[10]. Teeth of *Myliobates* (fossil).

589. Teeth of Saw-fish: three specimens.

These are developed in sockets of the ossified rostral cartilages, found in other Sharks in front of the snout.

590. Teeth of fossil Shark (*Lamna*).

Mag. Nat. Hist., vol. iii., p. 451.

591. Upper and lower jaw of Shark.

The teeth are seen to be placed in several rows, each of which succeeds the one in front of it.

592. Another smaller specimen.

592[5]. Separate Teeth of Shark (fossil).

593. Upper and lower jaws of Ray (*Zygobates*).

The teeth are small and united to form a kind of pavement for crushing shells.

594. A smaller specimen.

595. Teeth of Ray.

B.—Tongue.

597. Tongue, Larynx, and Trachea of Monkey.

598. Tongue of fœtal Seal, slightly bifid.

599. Tongue of Dog, cut open to show the lytta, or "worm."

This is a fibrous thickening of the median septum.

600. Tongue, Pharynx, &c., of Tiger.

Notice the large recurved filiform papillæ.

601. Tongue and salivary glands of Bat.

602. Tongue, &c., of Rabbit.

Notice the division between the anterior part which corresponds to the incisor and posterior to the molar teeth; also the oval patch of vertical grooves on each side near the base which contains the taste-sacs.

602[5]. Patch of fur inside the cheek of the Rabbit.

603. Tongue of Squirrel.

604. Tongue of Gazelle.

605. Tongue of Elephant, dissected to show the nerves.

606. Tongue, &c., of Emeu.

607. Tongue of Swan.

608. Tongue, salivary glands, and hyoid apparatus of Woodpecker.

Notice the large glands and long curved cornua of the hyoid bone attached to the top of the skull. See Owen, loc. cit. ii. 152.

609. Salivary glands of Turkey.

610. Tongue of Alligator, dissected.

The tongue of this family is firmly united to the gums of the lower jaw all round: hence Herodotus supposed the Crocodile had no tongue (Euterpe, c. 68).

611. Chameleon dissected, showing tongue and lingual muscles.

The dilated end of the tongue is thrust out to catch insects.

611^5. Forked Tongue of Snake.

611^{10}. Head of Frog, showing the fleshy tongue attached in front, and free behind.

This is thrown forward like the tongue of the Chameleon.

611^{15}. Tongue of Mackerel.

As in most fishes, it is small and pointed, covered with hard, minute scales, and moulded upon the median process running forward from the hyoid bone, called "glossohyal."

C.—Alimentary Canal.

This section includes preparations of the following organs:—

1. The *Œsophagus*, or gullet, with its dilatations. These form the crop (*ingluvies*) of birds, also their *proventriculus*, or secreting sac; and also, below the diaphragm, two progastric sacs found in the Peccary, and probably answering to those known in Ruminants as the *reticulum* and *psalterium*.

2. The stomach proper (*ventriculus*), with (*a*) its cardiac orifice, (*b*) a dilatation to the left, usually lined with thick epithelium, and forming the paunch (*ingluvies*), or cardiac cul-de-sac, a (*c*) dilatation

to the right forming the more vascular pyloric *antrum*, and (*d*) its *pylorus*, with a more or less complete valve.

3. The small intestines, occasionally dilated into a duodenal pouch, and opening by a valve into

4. The colon, occasionally provided with a rudimentary *vermiform appendix*, and more frequently with a blind pouch (*caput cæcum coli*), or, as in birds, with two cæcal appendages.

5. The rectum, which may end separately, or may open into a cloaca, as in Monotremata, Aves, Reptilia, Amphibia, and Placoid Fishes.

As in the preceding section, the preparations are arranged according to the kind of food for which the organs are fitted.

Flower: Hunterian Lectures, publ. in Med. Times and Gazette, 1872.

Frugivora.

612. Stomach of Monkey, mucous membrane injected.

Like other fruit-eating animals, Monkeys and Opossums also live on insects, and some of the latter even on small birds and reptiles.

612[5]. Cæcum and appendix of Monkey: two specimens, dried.

The so-called cæcum, like that of human anatomy, is only a lateral pouch formed by the bulging of the external of the three tracts, into which its longitudinal muscular bands divide the colon. The true blind end of the large gut which remains of fœtal dimensions, is the appendix vermiformis.

613. Stomach and cæcum of Opossum: three specimens.

613[5]. Cæcum of Male Opossum, dried.

Insectivora.

614. Intestines, liver, and gall-bladder of Bat, from Mr. T. E. Bryant's Museum.

615. Fœtal Hedgehog, with the intestines dissected in situ.

616. Mole, dissected to show the various parts of the alimentary canal. The guts are seven times the length of the body.

In this, as in most Insectivora, there is no cæcum.

Carnivora.

617. Stomach and Cæcum of Cat, dried.

The Cat and its allied families (Æluroidea, p. 37) have a small cæcum, except one genus of Viverridæ, *Nandinia*, which is without any. The intestines are only three or four times as long as the body.

617[5]. Ileum and Cæcum of Cat, injected and dried.

618. Small intestine of Cat, injected to show the villi.

619. Stomach of Lion, dried.

620. Cæcum of Yaguarondi, dried.

621. Rectum and anal glands of Yaguarondi.

622. Stomach of Striped Hyæna, dried.

623. Cæcum of Hyæna, dried.

623[5]. Two dried specimens of the Stomach and Cæcum of the Indian Ichneumon (*Herpestes griseus*), and one of the Egyptian species (*H. Pharaonis*).

624. Stomach of Large Dog, dried.

625. Stomach of large Dog, dried in situ, showing its attachment to the diaphragm; arteries injected.

626. Cæcum of Dog; dried.

The cæcum of the genus *Canis*, and its allies, is longer than that of the cats, and is folded.

627. Cæcum of small Dog, arteries and veins injected; dried.

628. Stomach of Fox (*C. vulpes*); dried.

629. Cæcum of Fox; dried.

There are three coils in this species.

631. Stomach of Coati (*Nasua nasica*).

This animal, like the other carnivora allied to the bears (Arctoidea, p. 37) has no cæcum. Intestines about twelve times length of body.

632. Stomach of Badger (*Meles taxus*); dried.

633. Pylorus of Bear.

Piscivora.

635. Stomach and cæcum of Seal.

The Pinnipedia differ from the Ursidæ in having a cæcum.

635[5]. Stomach, with spleen and gastro-splenic omentum, and cæcum, from a fœtal Seal.

636. Colon of Seal, arteries injected; dried.

637. Compound stomach of Porpoise ; dried.

638. Another specimen, dissected, in spirit, by Mr. T. W. King.

The first large oval stomach is a cardiac cul de sac or paunch; the second and fourth are digestive sacs, the former with large folds, the latter elongated and probably answering to a pyloric antrum. The third is small, and cut open square. The cavity kept open by a glass rod is a dilatation of the duodenum between the pylorus and the entrance of the biliary and pancreatic ducts.

639. Stómach of Dolphin ; dried.

None of this family have a cæcum; *Balænoptera* has one.

Rodentia omnivora.

641. Stomach of Rat, injected and laid open.

642. Stomach of Rat, seen from behind.

Laid open to show the contrast between the thick mucous membrane, with squamous epithelium, of the cardiac end, and the soft membrane of the pyloric half.

643. Another specimen, injected and everted to show the vascularity of the mucous membrane of the pyloric portion.

644. Stomach of Rat.

644[10]. Cæcum and sacculated colon of Rat.

Rodentia herbivora.

644[15]. Cæcum of Rabbit.

This is excessively long and sacculated.

Ungulata omnivora.

645. Stomach of Peccari ; dried.

Notice the two progastric sacs of the cardiac part, the mid portion which receives the gullet, and the pyloric antrum.

646. Cæcum of Peccari, distended with plaster of Paris.

The cæcum in all Artiodactyla is rudimentary like this, or is absent.

647. Wax model, showing the whole of the alimentary system of a Sucking Pig.

The pyloric antrum of the otherwise simple stomach is well seen, also the voluminous small intestines, and folded colon; the liver and gall-bladder, and the pancreas opening into the duodenum apart from the gall-duct. The thoracic duct is coloured yellow.

647[5]. Pylorus of Pig, showing the thick valvular process which rises up from the lower wall of the opening.

Ungulata herbivora.

648. Stomach of Foal; dried.

648[5]. Cardiac orifice of stomach of Horse.

649. Pylorus of Horse.

650. Part of stomach of Horse, at junction of squamous and glandular portions.

651. Cæcum of Colt, with part of ileum and colon.

The cæcum of the Equidæ is very large, and sacculated, in correlation with their simple stomach. The colon in the adult Horse measures 20 feet.

653. Part of small intestine of Ass, injected.

655. Stomach of Elephant; dried.

Notice its elongated form: it has no subdivisions.

656. Cæcum of Elephant; dried.

Though capacious, this viscus is rudimentary compared with the cæcum of the rhinoceros and the horse.

657. Part of ileum of Rhinoceros, injected, showing the villi.

Herbivora Ruminantia.

660. Part of Œsophagus of Giraffe.

661. Part of first stomach of Giraffe.

This is the cardiac cul-de-sac enormously dilated. It is lined with thick squamous epithelium, and is known as the *rumen*, *ingluvies*, or paunch (*l'herbier*).

662. Part of second stomach of Giraffe.

This *reticulum*, or honeycomb stomach (*le bonnet*), apparently answers to one of the progastric sacs of the peccari. Cf. prep. 645.

663. Part of the third stomach of Giraffe.

This *psalterium*, *omasus*, "bible," or manyplies (*le feuillet*), apparantly answers to the second (left hand) progastric sac of the peccari.

664. Part of fourth stomach of Giraffe.

This is the true digestive cavity, lined with a vascular mucous membrane containing peptic glands, and answers to the *antrum pylori*, the pyloric half of the human stomach. It is known as the rennet-bag, *abomasus*, or reed (*la cailette*).

665. Specimen showing these parts in their mutual relation.

666. Four stomachs of fœtal Calf; dried.

Notice the relatively small paunch and large fourth stomach, compared with their size in the adult animal.* The milk does not enter the paunch. The folds of the psalterium and loculi of the reticulum can be seen through their walls, when held up to the light.

667. Compound stomach of fœtal Ruminant, at earlier stage; dried.

669. Four stomachs of fœtal Ruminant, injected.

671. Stomachs of young Moose-deer (*Cervus alces*); dried.

673. Intestines and omentum of fœtal Calf.

The cæcum of Ruminants is small, the colon very long and spirally twisted, as here seen.

Herbivora marsupialia v. *Poephaga.*

674. Sacculated stomach of a Kangaroo.

The œsophagus enters at right angles to the axis of the stomach, leaving a bifid cul de-sac corresponding to the cardiac part of the human stomach. There is also a simple cæcum.

Aves.

675. Œsophagus and double crop, &c., of Pigeon.

676. Ventricular glands of Ostrich.

677. Œsophagus, crop, proventriculus, and gizzard of Chick.

The gizzard is the homologue of the mammalian stomach, but its walls are enormously thickened in graminivorous birds, and its epithelium made thick and horny in order to fit it for crushing the hard vegetable food they live on.

678. Crop of Duck (dry).

678[5]. Proventriculus of bird, with the peptic glands dissected.

This *ventriculus succenturiatus* is structurally a second œsophageal sac, but functionally answers to the digestive stomach of mammals, and secretes the gastric juice.

680. Proventriculus of Emeu; dried.

681. Stomachs of Cormorant and Pelican (in case with 689).

The membranous stomach of flesh and fruit eating birds answers to the gizzard of those which live on grain, hard insects, &c.

682. Gizzard and proventriculus of Cuckoo (*Cuculus canorus*).

683. Gizzard of Swan; dried.

There is no crop, as also in most insectivorous birds.

---

* This relation of size does not, however, exist at an earlier period of fœtal life. At the fourth month the paunch is the largest cavity, as in the adult. See figs. by Mr. Gedge, in J. Anat. and Phys., May, 1868.

684. Gizzard of Swan, in vertical section.

685. Gizzard of Goose, injected and dried.

686. Gizzard of Raven, laid open.

687. Section of large bird's gizzard.

688. Part of small intestine with short cæca of Emeu.

689. Intestine and long cæca of Swan.

689^{5}. Long cæca of common Fowl.

689^{10}. Short cæca of Pigeon.

Reptilia.

690. Œsophagus of Turtle.

Notice the large horny papillæ directed backwards.

691. Œsophagus and cardia of Turtle.

692. Small Tortoise, with stomach and intestines shown in situ.

692^{5}. Another specimen.

693. Stomach of Tortoise; dried.

694. Another specimen, dried.

695. Cæcum of Tortoise.

696. Stomach of Turtle, minutely injected; showing also the reticulated mucous membrane of the duodenum.

697. Duodenum of Turtle, showing the orifice of the biliary duct in the middle line at the upper part of the preparation.

699. Stomach of a large Tortoise, dried.

700. Cæcum and small intestine of large Tortoise, dried.

701. Cæcum of Land Tortoise, dried.

702, 703. Intestine of Turtle injected, showing the longitudinal ridges of the mucous membrane.

704. Small intestine of Tortoise, everted to show the largely-developed absorbent folds.

705. Large intestine of Tortoise, everted to show its three coats, mucous, muscular, and peritoneal.

706. Stomach of young Crocodile.

Cf. Rymer Jones, fig. 253.

707. Stomach and intestine of Chamæleon, everted and injected.

708. Pylorus of Iguana.

709. Cæcum of Iguana, dried.

710. Part of intestine of Boa, everted and injected.

711. Cæcum of Boa, injected.

712. Small intestine and kidneys of Viper, injected.

Amphibia.

713. Frog, showing stomach, liver, intestines, &c.

714. Stomach, liver, &c. of Tree Frog (*Hyla viridis*), dissected.

716. Stomach and intestine of common Frog.

717. Toad, showing stomach and intestines; injected.

718. Toad, dissected, to show the alimentary canal.

719. Tadpole of *Pseudis paradoxa*, showing the coiled intestinal canal.

The great length of the intestines is correlated with the vegetable food of the Tadpoles of Amphibia. Compare it with the short intestines of the adult insectivorous Frog.

720. Another specimen.

721. Stomach and intestine, with ovary, of Newt, dissected in situ.

722. Another specimen.

722[5]. Stomach, intestines, &c., of a North American perennibranchiate Amphibian (*Menobranchus lateralis*).

The stomach is simple in character and the intestine short, the animal being carnivorous. The liver is seen to the right, and the spleen to the left, of the stomach.

Pisces.

723. Stomach and intestines of Skate.

Notice the "siphon" form of stomach, and the spiral fold of the gut, which greatly increases its absorbent surface.

724. Stomach of Skate, injected.

725. Perch, dissected to show the digestive system, &c.

Notice the simple stomach of the "cæcal" form, and very short intestine, correlated with the carnivorous habit which the Perch shares with most of the class. There are only three cæcal tubes appended to the stomach.

726. Cæcal Stomach of Eel, with duodenum.

728. Stomach of the Wolf-fish (*Anarrhichas lupus*).

729. Part of intestine of Wolf-fish.

730. Intestine of Cod.

731. Stomach, gall-bladder, and pancreatic tubes of Cod. Cf. 734.

D.—Pancreas.

This organ in Mammalia precisely resembles the parotid gland in structure, and is hence called by German anatomists the Salivary Gland of the Abdomen. In Sharks, Rays, and some other Fishes, it is of the ordinary glandular structure, but in most fishes it is absent, or perhaps represented by a variable number of cæcal tubes opening into the duodenum.

The pancreatic duct usually opens with the gall-bladder, but sometimes, as in the Rabbit, separately. In many cases, as in most Birds, Turtles, &c., there are two ducts, and in the Fowl and Pigeon three.

731[5]. Pancreas of Rabbit.

731[10]. Pancreas of common Fowl (*Phasianus gallus*).

Notice its position in the fold of the duodenum.

Pancreas of Frog: v. 760.

732. Stomach and pyloric appendages of Mackerel.

Pyloric cæca of Cod: v. 731.

734. Wax model showing the digestive viscera of the Cod.

The large œsophagus, lying between the four pectiniform gills on each side, has been cut through and turned back, showing the anterior extremities of the long kidneys behind it. The siphonal stomach is seen on the loft side of tho abdomen, with the numerous pyloric tubes lying on it and the undivided livor, which is turned over to the right, with its gall-bladder. Further back is shown the rectum, and tho anus opening in front of the urethra, which again is in front of the genital orifice.

E.—Liver.

This organ has, at least in the higher vertebrata, other functions beside secreting bile. Moreover, it has not the simple racemose structure of the pancreas and of the invertebrate liver.

In form, it is a mere cæcal tube in *Amphioxus*, undivided in Cyclostomous fishes, *Salmonidæ*, &c., consists of two lobes in Sharks and Rays, *Gadus*, and many other genera, and is more divided in other osseous fishes. In serpents it is single; in most reptiles it consists of two lobes, as also in the majority of birds.

In its most complete mammalian form, the liver consists of a right and left central lobe, divided from each other by the umbilical vein (round ligament), answering to the right lobe with the lobulus quadratus and the left lobe, respectively, in human anatomy; an accessory right and left lateral lobe, unrepresented in man; a Spigelian lobe, divided off by the Vena cava; and a caudate lobe, of which that in the human liver is a mere rudiment.

The gall-bladder always lies upon, or is more or less enveloped by, the right lobe. It is present in most Fishes, in Amphibia and in Reptiles; is absent in the Toucan, Pigeons, Ostrich, and some other birds, and also in many Rodents, in Cetacea, Camelidæ, Cervidæ, Perissodactyla, and the Elephant.

Flower: Lectures in Med. Times and Gazette, 1872.

735. Part of Liver of Horse.

The horse has normally no gall-blader, though one is occasionally present.

736. Part of Liver of Camel, with each lobule distinct.

736[5]. Liver of Dog.

The umbilical vein (suspensory ligament) divides the right central lobe, which lodges the gall-bladder, from the left central. The right lateral lobe is marked by a red, the left lateral by a blue, rod. Above is seen the Spigelian, and (running off from it to the right) the long caudate lobe.

736[10]. Liver of Guinea Pig.

Notice the small right lateral, and large caudate lobe, supported on a blue glass rod.

737. Liver and gall-bladder of Kangaroo.

738. Double gall-bladder of Ox.

This is abnormal.

738[5]. Liver of Pigeon, without gall-bladder.

739. Liver of Turtle: lymphatics injected.

740. Liver of Frog, see also 714.

For liver of Menobranchus, see 722[5]; and for model of liver and gall-bladder of Cod, see 734.

741. Liver and stomach of Lamprey: dissected by Dr. Habershon.

There are no hepatic lobes and no gall-bladder.

F.—Spleen.

This organ is peculiar to Vertebrata, and is always closely connected with the stomach in position, vascular supply and function. Besides being an appendage of the portal system of vessels, its Malpighian bodies are cytogenic organs (Cf. p. 147.)

742. Spleen of Dog, injected with mercury.

743. Spleen of Cat.

744. Another specimen, injected and corroded.

745. Spleen of Ox, inflated and dried.

This and the following preparations were made by Sir Astley Cooper.

746. Spleen of Ox, injected with wax and dried.

747. Spleen of Calf, prepared in the same way.

748. Another specimen.

749. Spleen of Sheep, injected with wax.

750. Spleen of Sheep.

751. Another specimen.

752. Another specimen, injected and inflated.

753. Another specimen.

754. Part of spleen of Giraffe.

754[5]. Another specimen, the pulp washed out so as to show the trabecular structure.

755. Spleen of Horse, inflated and dried.

756. Splenic vessels and nerves of Horse.

757. Spleen of Kangaroo.

Notice its peculiar T-shape.

757[5]. Spleen of Pigeon.

758. Spleen of Turtle, injected with mercury.

759. Spleen of Lizard.

760. Spleen and pancreas of Frog.

Spleen of Menobranchus (v. 722[5]).

762. Spleen of Perch.

A narrow, elongated mass, lying in the first convolution of the intestines.

Series IV.—ORGANS OF CIRCULATION.

A.—Heart.

In all Vertebrata, except *Amphioxus*, there is a multilocular heart. In Mammalia, it almost exactly resembles that of man. In Birds, the chief difference is that the auriculo-ventricular valve on the right side is muscular instead of being formed by membranous curtains. In the higher Reptiles, the heart consists of four cavities, in the lower, of three only, there being no ventricular septum, and there are numerous gradations between these two conditions. In Amphibia and *Lepidosiren* there is only one ventricle, and two auricles, the left or pulmonary being the smaller. In other Fishes the heart is only branchial and consists of a single auricle and ventricle with a bulbus arteriosus, which is contractile in the Placoids and Ganoids.

There is a single left aorta in Mammals, a right one in Birds. In Reptiles and Amphibia it is double, and in Fishes divides into four, five or more primary branchial arteries on each side.

The various ways in which the branches of the aorta take their origin is noted under the preparations illustrating them. These are of interest from similar arrangements being found as abnormalities in man.

766. Human Heart.

A single right innominate, left subclavian and carotid, are the primary branches of the aorta.

767. Heart of Ourang-Outang.

Left carotid from innominate : left subclavian from aorta.

768. Heart of Chimpanzee.

Origin of arteries as in man.

769. Heart of Baboon ; dry.

Innominate and left subclavian from aorta, as in 767.

770—775. Six hearts of Monkeys; three injected and dried.

Branches of aorta as in 767.

776. Heart of Lemur.

Branches of aorta as in monkeys.

777. Heart of Hedgehog.

Two primary aortic branches.

778. Heart and Lungs of small Bat.

Two innominate arteries, as in birds.

779. Heart of Leopard: dissected, with many others, by Mr. T. W. King.

In the Carnivora the primary branches of aorta are the same as in monkeys, the left carotid arising from the innominate.

780. Heart of Jaguarondi.

781. Heart of Ocelot.

782. Heart of Cat, the vessels cut off.

783. Heart of fœtal Kitten.

784. Heart of Lion, injected and dried.

The L. ventricle and aorta are coloured red, as also the innominata, with its L. carotid, R. subclavian and R. carotid branches, and the L. subclavian. The R. ventricle, pulmonary artery, and venæ cavæ, with the two innominate veins, are coloured blue.

785. Heart of Dog, with vessels and part of spine.

786. Another specimen, with the vessels cut off

787. Heart of Australian Dog.

788. Heart of Fox; injected and dried.

789. Heart of Silver Fox (*Vulpes arcticus*).

790—792. Heart of Otter: three specimens.

793. Heart of Ichneumon.

796. Heart of Bear.

797. Heart of Bear (dry).

798. Heart of Seal; five specimens.

Innominate, left carotid and subclavian, as in man; but the L. vertebral artery arises from the aorta direct. The appendix of the R. auricle is bifid.

798[5]. Heart of fœtal Seal.

Notice the open ductus arteriosus (ductus Botalli) and the slightly bifid apex, an occasional character found also in the Porpoise (Cf. 831).

799. Heart of Beaver.

In most Rodents the aorta divides in the same way as in Monkeys and Carnivora; its branches in the Beaver and *Muridæ* are like those in man. Notice the moderator band in the R. ventricle.

800. Heart of Porcupine.

801. Heart of Hare (vessels removed).

802. Heart of Rabbit.

803. Heart of Squirrel (with the primary branches of the aorta displayed on talc).

804. Heart of Elephant, injected and dried.

Both carotids arise from a short common trunk, which comes off close to the origin of the R. subclavian. The L. subclavian arises separately. These vessels are coloured pink; the venæ cavæ and pulmonary artery blue. Notice the enormous sinuses of Valsalva in the latter.

805. Aortic valves of Elephant.

806. Heart of Sucking Pig.

Primary aortic branches as in Carnivora. See also wax model, 647.

807. Heart of Peccari.

808. Heart of Tapir, injected and dried.

809. Heart of Horse, injected and dried.

In the Equidæ and *Tapirus* all the four great aortic branches spring from a common trunk called the anterior aorta, here coloured red: the pulmonary artery and the systemic veins are yellow.

809[5]. Another specimen, wet preparation.

810. Bicuspid valves of Horse.

811. Tricuspid valves of Horse.

812. Heart of Horse, the cavities laid open: moderator band.

814. Heart of an Ass (dry).

815. Another specimen (wet).

817. Heart of Zebra (dry).

818. Heart of Reindeer (dry).

Large common trunk (ascending aorta), from which arise first both subclavian and then both carotids. This arrangement is common to most Ruminants; but the Llama has a separate origin for the left subclavian, and the Giraffe the same, with an additional primary aortic origin for the left vertebral artery, as in the Seal.

819. Heart of Axis Deer (dry).

820. Heart of Antelope (dry).

821. Heart of Gazelle.

822. Bone from ventricular septum of heart of Ox.

823. Bicuspid valve of Ox.

824. Heart of Sheep, opened to show the moderator band.

See Wilkinson King: Guy's Hospital Reports for 1837.

825. Part of heart of Sheep; apex cut off to show septum, and auricles removed to show upper surfaces of valves.

826. Another specimen.

827. Heart of Goat.

828. Heart of Camel (dry).

829. Heart of Llama.

830. Heart of Ruminant, with the cavities laid open.

831, 832. Heart of Porpoise: two specimens, the former bifid.

Aortic branches as in Carnivora; in *Balænidæ* as in man.

833. Heart of Porpoise, with vertebral column (dry).

834. Heart of Dolphin (dry). Presented by Sir A. Cooper.

Two innominate arteries, as in Birds.

835. Heart of Kangaroo, injected and dried.

The left carotid arises from the single right innominate artery, as in Carnivora. There is no fossa ovalis in the right auricle.

836. Heart of Kangaroo, with the cavities laid open.

837. Heart of Kangaroo Rat.

838. Heart of Hedge Kangaroo.

839. Heart of Opossum.

840. Heart of Ornithorhyncus.

Notice its oblong shape. Aortic branches as in man.

841. Hearts of birds.

In all birds there are two innominate arteries, and the descending aorta turns over the root of the right lung and runs down the right side of the spine.

The right carotid is not developed in about half the genera of Aves. See Garrod, P. Z. S., 1873.

842. Heart of Vulture.

Both carotids are present, as in other birds of prey.

843. Heart of Buzzard (*Buteo vulgaris*).

844. Two Hearts of Parrots.

In some parrots both carotids are developed, either running close together as usual in Aves, or separate as in mammals; but in others the left only, and in one Cocatoo, by a singular exception, the right.

845. Three hearts of Ravens (*Corvus corax*).

The Corvidæ, and the other genera of the great group of Passeres, have only a left carotid.

846. Heart of Crow (*Corvus cornix*).

846[5]. Heart of Hornbill (*Buceros carrianna*). Africa.

Both carotids developed.

847. Two hearts of tame Pigeons (domestic variety of the Blue Rock Dove, *Columba livia*).

Both carotids are developed in the Columbidæ.

849. Heart of Curassow (*Crax alector*). South America.

Both carotids are developed in Gallinaceous birds.

849[5]. Heart of Guan (*Penelope cristata*). South America.

850. Heart of Turkey (*Meleagris gallopavo*).

Introduced from North America.

851. Heart of Herat fowl.

853. Heart of Pheasant (*Phasianus colchicus*).

Introduced from Asia Minor.

854. Heart of Silver Pheasant (*Euplocamus nychthemerus*) China.

855. Heart of Moorhen (*Gallinula chloropus*).

856. Heart of Ostrich.

From Mr. T. E. Bryant's collection. "This bird was a male which died in the Surrey Zoological Gardens in 1834."

857. Heart of Emeu.

This genus, like *Struthio* and *Casuarius*, has two carotids, but the American Ostrich (*Rhea*) and *Apteryx* have only the left.

858. Heart of Emeu, cut open.

859. Two hearts of Cranes.

The Grallæ have both carotids developed, except *Botaurus* among the herons.

860. Heart of Heron.

861. Three hearts of Geese.

The family of Ducks (*Anatidæ*) have two Carotids.

862. Two hearts of Ducks.

863. Heart of Swan (dry).

863[5]. Heart of Swan.

864. Heart of Penguin.

The *Spheniscidæ* have both carotids developed.

865. Heart of Cormorant, with vessels and trachea (dry).

866. Heart of Cormorant.

867. Three hearts of Divers.

868. Two hearts of Grebe (*Podiceps* sp).

This genus, alone among its allies, has only a left carotid.

869. Heart of Alligator, with lungs.

Four cavities: permanently open ductus arteriosus; double aorta, right and left.

870. Heart of Alligator in longitudinal section, injected with mercury.

871. Heart of a large Tortoise.

Single ventricle; double aorta uniting. Notice also the spongy character of the ventricular walls. Cf. 873.

872. Two hearts of Tortoise, injected and dried.

873. Section of wall of ventricle of Tortoise.

874. Three hearts of Turtle.

874^{15}. Heart of large Turtle, opened.

874^{20}. Heart of Chamæleon.

875. Hearts of Boa Constrictor ; two specimens.

876. Heart of a Snake, injected and dried.

877. Frog, injected and dried, showing the heart, and the right and left aortæ uniting behind into a single trunk.

878. Heart of Frog.

See 406^{10} for the heart of a perennibranchiate Amphibian, *Menobranchus*.

879. Three hearts of Shark.

Pulmonary heart, of two cavities, with a single median aorta provided with a contractile and multivalve bulbus arteriosus, and sending off Right and Left five branchial arteries.

880. Heart of Shark, dry.

881. Heart of Cod, dry.

Like that of Shark, except that the bulbus arteriosus has only a single pair of valves, and is not contractile.

882. Heart of Cod, injected with mercury and cut open.

883. Heart of Brill (*Rhombus vulgaris*).

884. Two hearts of Salmon (*Salmo salar*).

885. Heart of Salmon, in section, showing valves.

886. Heart of Fish, in section.

For heart of Perch dissected in situ, see 725.

888. Bulbus arteriosus of osseous Fish.

889. Heart and gills of Wolf-fish (*Anarrhichas lupus*), dissected by Dr. Habershon.

B.—Blood-vessels.

892. External jugular vein of Camel, everted to display its valves.

893. Part of Vena Cava Inferior of Camel.

895. Main artery and intercostal plexus, "rete mirabile," of Porpoise.

896. Intercostal arterial rete, and spinal venous sinuses of Porpoise.

897. Intercostal rete of Porpoise, injected.

900. Part of spinal cord of Porpoise, with arterial rete and venous sinuses displayed.

901. Aorta of Ox dissected.

901^{10}. Injected mesentery of Elephant.

902. Injected mesentery of Duck.

902^{5}. Aorta of Swan with its branches.

There are two innominates, as in all birds, and two carotids running close together, as in most web-footed birds.

903.
903^{5}. } Two specimens of mesentery of Turtle, with the veins injected red and lacteals with mercury.

903^{50}. Four preparations from the Frog, minutely injected.

(1) Lungs, (2) Skin, (3) Small Intestine, (4) Rectum.

C.—Lymphatic vessels.

The lymphatic or absorbent system of vessels is only differentiated from that conveying blood in Vertebrata. Unlike the latter, it is not a closed system of vessels, for it begins in lacunæ, like the systemic veins of Mollusks and Crustacea, these lacunæ being the great serous cavities and the areolæ of connective tissue. It ends by opening into the veins. In Amphibia and Reptiles there are pulsatile cavities which act as lymphatic hearts. The lymphatics of the intestines are usually called lacteals, from the milky fluid (lymph rich in fat granules) which they convey during digestion.

904. Lymphatic vessels of Thyroid of Horse injected.

904^{15}. Lacteals of Sheep injected with mercury.

904^{20}. Lacteals of cæcum of Seal, injected and dried.

904^{50}. Injected preparation of absorbents of Stomach of Turtle.

904^{55}. Receptaculum Chyli of Turtle, inflated and dried.

904^{60}. Lacteals of small intestine of Turtle.

This and the following preparations to 904^{88} were made by Sir Astley Cooper.

904^{65}. Another specimen.

904^{70}.
904^{75}.
904^{80}.
904^{81}. Four other specimens.

904^{85}. Absorbents of Rectum of Turtle.

904^{86}.
904^{87}. Lymphatics of Trachea of Turtle, two preparations.

904^{88}. Lymphatics of Lung of Turtle.

904^{90}. Frog dissected, to show the anterior and posterior lymphatic hearts.

904^{99}. Lacteals of small intestine of Skate.

The spiral valve within is seen by holding it up to the light.

D.—Lymphatic Glands and other Adenoid Organs.

The so-called " conglobate " or lymphatic glands, are totally unconnected with true secreting glands both in character and function: moreover, they are differently developed. They have no duct, contain no secreting epithelium, or true acini, and their blood-vessels run through, not around, their cavities. They are composed essentially of reticulated connective tissue, holding in its meshes leucocytes. Their function is the manufacture of the corpuscles of lymph and chyle, which are poured into the blood as its colourless cells, and thus they are the ultimate source of the red blood corpuscles also.

Made up like the lymph glands of closed "follicles," and agreeing with them in essential structure and probably in function, are the Thymus, the Tonsils, and Peyer's Patches; and beside these may be classed, as appendages of the lymphatic system, the large closed capsules about the back of the tongue and fauces, the "glandulæ solitariæ," and the Malpighian bodies of the Spleen, all of which are so many adenoid "follicles."

Lastly, adenoid, or, as it is also called from its function, "Cytogenic" (*i.e.* cell-forming) tissue, is found in its simplest form, not collected in follicles, but scattered under the mucous membrane of the intestines, in the liver, the splenic pulp, the lungs, the marrow of bones, and some other regions.

905. Tonsil of Elephant

905[10]. Peyer's Patch from intestine of Dog.

905[12]. Mesenteric gland of Ox.

905[15]. Thymus of fœtal Seal.

This organ has not been found in Fishes, but exists in some Amphibia and in all higher Vertebrata. It attains its maximum size soon after birth, in man at about two years of age. The fœtus from which this was taken was fully formed, covered with hair and with incisor teeth ready to cut the gum. See preps. 90, 798.

Series V.—RESPIRATORY SYSTEM.

In Vertebrata the organs of respiration are constructed on two types, that of lungs for breathing air directly, and that of gills or branchia for breathing the air which exists dissolved in water.

The lungs are formed by an extension of the mucous membrane of the alimentary canal into two, more or less ramified, hollow bags, to which the air is admitted through the trachea. The ultimate air vesicles are smallest in the lungs of Carnivora; in Birds there are numerous supplementary airsacs. In Reptiles the air vesicles become larger, and the organ less efficient in consequence (preps. 937, 942, 948, 951, 406^{10}), and in snakes only the upper part of the airbag is divided or vascular. In Frogs the function of the lungs is still more limited, being partly supplied by cutaneous respiration. In two genera of Fish (*Lepidosiren* and *Ceratodus*) there are true lungs, and in all the Physostomi a single airsac, with a ductus pneumaticus opening into the gullet or stomach. This is a rudimentary lung structurally, and in some cases (e.g. *Cuchia*) functionally. Lastly, the closed airsac, or "swimming bladder," found in the Perch and many other fish, is probably the rudiment of the same organ.

Connected with the trachea is the larynx, or apparatus for producing "voice" by impressing vibrations upon the expired air as it passes between the vocal chords. In Birds there is a second double larynx below this one, at the bifurcation of the trachea. In Reptiles and Amphibia the larynx becomes rudimentary.

Gills appear in two forms among Amphibia, internal in the tadpole stage, and external both then, and, when persistent, in the adult: cf. prep. 406^{10}. The former are vascular fringes on the branchial arches of the hyoid apparatus, the latter more or less divided leaf-like processes. In Osseous Fishes the gills are internal, comblike, and placed, four on each side, on the branchial arches; they are covered by an operculum which in some cases is adherent.

In Ganoids their structure is very similar; in Placoids (Pentabranchii) there is no operculum, but five apertures on each side, leading to as many branchial chambers; and in Cyclostomi there are seven. Lastly, the Lancelet has no gills, and breathes by means of a perforated pharynx, which much resembles that of Tunicata.

A.—Nares, Larynx and Trachea.

906. Tongue, larynx, and trachea of Monkey.

906[5]. Part of trachea of Tiger.

907. Larynx, trachea, &c. of Dog, with the muscles dissected.

908. Tongue, larynx, trachea, and pharynx of Seal, dissected.

908[5]. Longitudinal section of head of fœtal Seal, showing the turbinated bones and narrow nasal passage.

909. Larynx and trachea, with thyroid of Porcupine.

909[5]. Section of trunk of Elephant.

See description in Owen: loc. cit., vol. iii., p. 390.

910. Larynx of Elephant.

911. Trachea of Elephant.

912. Larynx, trachea, and pharynx of Horse.

913. Larynx and trachea, with its muscles, of sucking Pig.

914. Part of bronchus of Dugong.

Notice that the rings are spiral.

915. Larynx and trachea and part of lung, injected, of Porpoise.

Notice how the larynx is prolonged upwards into the posterior nares, and embraced by the soft palate.

916. Larynx and trachea, with injected arteries and vertebral column of two Golden-eyed Ducks (*Anas clangula* ♂).

917. Trachea, bronchi, and upper and lower larynges of Pigeon.

The inferior larynx consists of a cross-bone (*pessulus*) between the two bronchi, which supports a tense membrane (*M. semi-lunaris*) projecting by its free edge up into the trachea: and two membranes (*M. tympaniformis*) which form the inner boundary of each bronchus and are attached to its first two or three rings.

Cf. Rymer Jones, fig. 274, and Owen, vol. ii., figs. 102-105.

918. Trachea, &c., of Bird, dried and laid open.

919. Part of trachea of female Emeu, with its pouch, dried.

This bird died in the Surrey Zoological Gardens. The specimen was prepared by the late Mr. T. E. Bryant, who found the membranous pouch to be just 10 inches above the bifurcation of the trachea.

920. Tongue, os hyoides, larynx, and trachea of Emeu.

921. Sternum, with convoluted trachea of wild Swan.

922. Tracheæ of *Anatidæ*, with inferior larynges, dry.

The males of the genera *Anas*, *Mergus*, and their allies, have this bony cavity developed. See Owen, vol. ii., loc. cit., figs. 106, 107. Cf. prep. 915.

923. Larynx, os hyoides, and trachea of Turtle.

924. Another specimen, dry.

925. Larynx and trachea, with tongue, of young Crocodile.

Notice the absence of uvula and epiglottis, also the musk-glands marked by bristles.

926. Larynx, os hyoides, trachea, lungs, and heart of Iguana.

B.—Lungs.

927. Lung of Monkey, injected.

928. Bronchus and its ramifications in the lung of the Dugong.

See Owen, loc. cit., vol. iii., fig. 452.

929. Portion of lung of Elephant.

930. Lung of fœtal foal, injected.

931. Lung of Calf, injected with wax and dried.

932. Lung of Sheep, inflated and dried.

933. Lungs of Armadillo, injected with wax and dried.

933[5]. Lungs and heart of Porpoise, injected and dried.

Notice the elongated shape of the lungs, which run back for a considerable distance above the abdominal viscera.

934. Skeleton of Pigeon, showing the air-sacs, injected with tallow.

934[5]. Lungs, with bronchi, &c., of Heron, dissected in situ.

Notice their adherence to the chest wall, and the absence of a diaphragm. The kidneys are seen below.

935. Lungs and heart of Turtle, injected with wax, and dried.

936. Lung of Turtle, inflated and dried.

937. Lung of Turtle, injected.

938. Another specimen, absorbents injected with mercury.

940. Lungs and heart of Alligator.

941. Sections of lung of Alligator.

942. Lizard, opened to display the inflated lungs, &c.

943. Lung of Iguana, dry. Cf. 926.

945. Lungs of Chameleon, showing the cæcal processes.

946. Another specimen, inflated and dried.

947. Right Lung of Viper, injected.

In most Ophidia this is more developed than the left.

948. Part of Snake, laid open to display the trachea and lung.

949. Trachea and upper part of lungs of Boa Constrictor.

949[5]. Right Lung of large Boa, injected.

In this genus both lungs are nearly equally developed.

950. Frog, showing left lung, injected and dried, with the great vessels.

951. Lungs of Frog, injected.

952. Another specimen, opened to show the alveoli.

Lungs, gills and heart of Menobranchus. See prep. 406[10].

The lungs are the two long membranous bags floating down from the heart. The three external tufted branchia are seen on each side of the neck, just above the slits of the functionless internal branchial arches, through which bristles have been passed.

C.—Rudimentary Pulmonary Sacs.

953. Double swimming bladder of Carp.

954. Perch, laid open to display the swimming bladder.

955. Large swimming bladder, injected.

Notice its very slight vascularity.

955[10]. Two large swimming bladders, dried.

955[15]. Small double swimming bladder.

956. Gland on inner surface of swimming bladder of Cod.

D.—Gills or Branchia.

957. Branchial skeleton of Cod.

Notice the median chain of *copulæ*, and the four branchial arches on each side, with the superior and inferior pharyngeal bones, each armed with teeth. Outside are seen the two basihyals and azygos urohyal, and beyond on each side the ceratohyal, supporting the branchiostegal rays, the epi- and the stylo-hyal.

958. Gills of Cod, injected.

959. Another specimen.

960. Part of gill of Mackerel, showing the injected laminæ.

961. Branchial arches and gills of Carp.

962. Gills of Perch.

963. Another specimen, injected.

All the above specimens are examples of the Pectinate form of gills, in which four laminæ on each side consist of delicate vascular filaments arranged side by side like the teeth of a comb. Compare the very similar structure of the gills of the Decapod Crustacea, preps. 1394^{25}, 1398^{5}.

963^{4}. Gills of Sturgeon, four on each side, laminar and pectinate.

In the middle line is seen the aorta, marked by a glass rod, and beyond, its first two branchial arteries. On the opposite side of the preparation is seen the tongue, and the four branchial arches on each side.

963^{5}. Right operculum, with adherent half gill of Sturgeon.

964. Head of Lamprey, dissected to show the gills.

There are seven vascular pouches on each side, opening (as in the Sharks, see prep. 459), by separate apertures, whence the name Marsipobranchii given to the order.

Notice also the single nasal orifice on the top of the head, and (better seen in 965), the numerous horny teeth.

965. Another specimen, more deeply dissected.

For gills of Amphibia see prep 406.

Series VI.—NERVOUS SYSTEM.

Physiologically this consists of three parts, central organs with ganglion cells, efferent or afferent nerves, and receptive or transmittent terminal structures (*e.g.* corpuscula tactûs, motor end-plates). Structurally it is divided in Vertebrate animals into—(1) the Sympathetic, chiefly distributed to unstriated muscular fibres, and (2) the Cerebro-Spinal System, which consists of (A) the Encephalon or Brain, with the Spinal Cord, (B) the Nerves, and (C) the Organs of Special Sense.

A.—Encephalon and Cord.

The former is present in all Vertebrata but the Lancelet. It contains:—

(1.) A pair of olfactory ganglia (rhinencephalon), the olfactory bulbs of human anatomy.

(2.) Corpus striatum and Cerebral hemispheres (prosencephalon, *Vorderhirn*), which are secondary outgrowths from

(3.) Thalami (thalamencephalon, *Zwischenhirn*, fore-brain) developed from the anterior primary cerebral vesicle.

(4.) Mid-brain (mesencephalon, *Mittelhirn*) the optic ganglia, called C. bigemina, or quadrigemina, with the Crura cerebri, developed from the middle primary cerebral vesicle.

(5.) Hind-brain, epencephalon, developed from the posterior cerebral vesicle, and including (5*a*.) Metencephalon, *Hinterhirn*, sometimes exclusively called the "hind-brain," corresponding to the Cerebellum and Pons of human anatomy; and (5*b*.) Myelencephalon, *Nachhirn*, or afterbrain, corresponding to the Medulla oblongata or bulb.

The Pineal body (*conarium*, epiphysis cerebri), and the Pituitary body (hypophysis cerebri) are two small bodies of unknown function, but constant anatomical relations, developed respectively from the roof and floor of the Thalamencephalon.

The spinal cord (*Medulla spinalis*), varies greatly in length (from that of the Diodon and Sun-fish (*Orthagoriscus mola*) or of the Frog to that of Snakes), and in size (according to the development of the limbs); but is constant in its structure throughout the vertebrate series.

Mammalia.—The brain in this class is characterised by the presence of the great transverse commissures of the cerebral and of the cerebellar hemispheres, called *Corpus Callosum* and *Pons Varolii.*

Gyrencephala.—The animals which have well-convoluted cerebral hemispheres and a large C. callosum have been so called.

966. Brain of Monkey.

Notice how very nearly the occipital lobes of the cerebrum conceal the cerebellum. In the highest apes they do so entirely.

966^5. Wax model of head and brain of Monkey.

966^{10}. Another of under surface of brain of Monkey.

967. Brain of Jaguar (*Felis onca*). South America.

Notice that here the cerebellum is uncovered.

967^5. Wax model of brain of Jaguar.

968. Brain of Cat.

969. Another specimen.

969^5, 969^{10} } Wax models of brain of Cat, upper and under surface.

970. Brain of Dog.

970^5, 970^{10} } Wax models of brain of Dog, upper and under surface.

971. Brain of Dog, one hemisphere laid open to show the ventricular cavity.

973. Brain of Pig.

973^5, 973^{10} } Wax models of brain of Pig, upper and under surface.

974. Brain of Horse.

974^5, 974^{10} } Wax models of brain of Horse, upper and under surface.

975. Brain of Cow.

975^5, 975^{10} } Wax models of brain of Cow, upper and under surface.

976. Brain of Sheep.

976[5] } 976[10] } Wax models of brain of Sheep, upper and under surface.

977. Brain of Deer.

977[5]. Wax model of brain of Deer, upper surface

978. Brain and spinal cord of Porpoise.

Notice the remarkable absence of olfactory ganglia or rhinencephala: also the rounded form of the cerebrum, the richly convoluted hemispheres and well developed cerebellum.

978[3]. Section of spinal cord and membranes of Porpoise, in situ.

978[5] } 978[10] } Wax models of upper and under surface of brain of Porpoise, with spinal cord and cauda equina.

Lissencephala.—The following brains have smooth or very slightly convoluted hemispheres, and their owners have classed together under the above name. It will be noticed that they are small animals, and low in the scale of Placental Mammals. Smooth brains are however also found in the Quadrumana, as in the Marmozet Monkeys.

979. Brain and spinal cord of Hedgehog.

Notice that the large olfactory ganglia are uncovered by the cerebral hemispheres.

980. Brain of Hedgehog.

980[5]. Wax model of brain and cord of Hedgehog, with nerves and filum terminale.

981. Brain and spinal cord of Jerboa.

981[5]. Wax models of brain and cord of Jerboa.

982. Brain of Rabbit.

Notice the smooth hemispheres, narrowing anteriorly, and allowing the olfactory bulbs to become visible in front, and the C. quadrigemina behind. Compare this with the brains of other Rodents, and with those of Birds.

983. Brain of Squirrel.

984. Brain of Rat.

985. Fœtal Rat, dissected, to show brain and spinal cord.

986. Brain and spinal cord of Armadillo.

In this animal the C. callosum is small, and the Anterior Commissure proportionally large.

986[5] } Wax models of brain and cord, with cauda equina, of
986[10] } Armadillo.

Lyencephala.—The C. Callosum is exceedingly small in all Marsupials and Monotremes, which has led to their being called Lyencephala (loose-brained).

987. Brain of Kangaroo.

Notice that the hemispheres are well convoluted. They are smooth in a great many other marsupials and in *Ornithorhyncus*, while in others and in Echidna there are slight indications of gyri and sulci.

987[5]. Wax model of brain of Kangaroo.

Aves.—The brain of Birds is characterised by the absence of the transverse commissures of the cerebrum and cerebellum, by uniformly smooth hemispheres, and a pointed anterior extremity.

988. Longitudinal section of skull of Heron, showing the brain and right olfactory nerve.

989. Skull and brain of Snipe (*Scolopax gallinago*).

990. Brain of common Fowl.

991. Brain of Bird, cut open.

992. Brain of Bird.

992[5] } Wax models of the same, upper and under surface.
992[10] }

Notice beside the smooth hemispheres and confluent olfactory bulbs, that the large C. bigemina are thrust downward so as to appear only on the under surface.

Reptilia.—The brains of reptiles have smooth hemispheres; the pineal body, as well as cerebellum, is uncovered, and the latter is smooth, except in Crocodiles, where there are some transverse sulci like those of birds and mammals.

993. Brain and spinal cord of Tortoise.

Notice the above features, and also the elongated anterior extremity in which the olfactory bulbs are confluent with the cerebrum.

994. Brain and medulla oblongata of Turtle.

Compare this and the three following preparations with the figures and description in Owen's "Comp. Anat. and Phys. Vert.," p. 293.

994[5]. Wax model of the same.

995. Brain and medulla oblongata of Turtle, dissected.

996. Brain and medulla oblongata of Turtle: longitudinal section.

Here it is seen that the cerebral and optic lobes are hollow.

997. Brain of Chamæleon.

998. Brain and spinal cord of Adder.

Notice the extreme length of the cord.

Amphibia.—The cerebellum is remarkably small and the C. bigemina large; the optic nerves form a chiasma.

999. Brain and spinal cord of Frog.

999[5]. Brain and spinal cord of Frog, dissected in situ.

First are seen the olfactory and cerebral lobes (confluent), then the optic lobes or C. bigemina, the rudimentary cerebellum, fourth ventricle, and medulla oblongata. Notice the shortness of the spinal cord.

Pisces.—The cerebral lobes are small, smooth, and have no ventricle; the optic are large, and have appendages below called *lobi inferiores;* and the cerebellum usually sends a prolongation backward over the fourth ventricle.

1000. Brain of Skate, in situ, showing eyes and olfactory capsules.

Notice the enormous olfactory bulbs, pedunculated as in man, and the open third ventricle. Compare this preparation with the figure and description in Huxley's "Anat. Vert. An.," p. 134, and Rymer Jones, fig. 232.

1001. Brain of Skate, removed.

Notice that the optic nerves form a commissure or interlacement of their fibres (chiasma), as in mammals; also the large pituitary body or hypophysis.

1002. Brain of Shark, on talc.

1002[5]. Wax model of brain of Shark.

Notice the pedunculated olfactory lobes, the large, smooth cerebral lobes, and the large cerebellum with sulci, as in the vermiform process of man. Compare the fig. in Owen: "Comp. Anat. and Phys. Vert.," p. 283.

1003. Section of vertebral column of Shark, showing spinal cord.

1003[5]. Brain and olfactory and optic nerves of Sturgeon dissected from below; from Mr. Bryant's museum.

Notice the chiasma of the optic nerves, as in the Skate and Shark. The portio mollis (auditory nerve), of the vii nerve is seen on both sides, the portio dura only on the right.

1004. Brain and olfactory nerves of Cod; from Mr. Bryant's museum.

Notice the long peduncles of the olfactory lobes. The optic nerves are cut off short; immediately behind them is the pituitary body. The cerebellum is smooth, and has a posterior lobe projecting over the fourth ventricle. The optic nerves, as in all osseous fishes, merely cross, without interlacing their fibres so as to form a chiasma. Compare prep. 1057^5, where the same is dissected in situ.

1005. Brain and optic nerves of Perch, dissected from below.

The olfactory bulbs are sessile, the cerebellum small. The conarium (pineal body), and hypophysis (pituitary body), are well developed, the cerebellum is small, and the optic lobes (corpora bigemina) have two large *lobi inferiores* (hypoaria), seen on the base of the brain.

1006. Brain of Garr-fish.

1007. Head of Eel, displaying brain.

1. The sessile olfactory; 2. the small cerebral; 3. the optic lobes; 4. the smooth cerebellum; 5. the medulla oblongata.

1008. Another specimen, dissected in situ.

1009. Brain and spinal cord of Lamprey, dissected in situ.

See figures and description in Huxley's "Anat. Vert. An.," p. 124. The olfactory lobes are sessile, the cerebral small, the optic large, and the cerebellum represented by a mere transverse band of nervous substance in front of the fourth ventricle.

B.—Nerves.

1011. Brachial plexus of Monkey, dissected.

1012. Hedgehog; labial nerves, dissected.

1013. Lion; nerves supplying the whiskers, dissected and dried.

1014. Tiger; nerves supplying the whiskers, dissected.

1015. Cat; nerves supplying the whiskers, dissected.

1016. Seal; nerves supplying the whiskers, dissected.

1018. Tapir; nerves of proboscis, dissected.

1019. Dry preparation of Elephant's trunk, with nerves dissected.

1019[3]. Dissection of nerves supplying the end of the trunk of the Elephant.

1020. Elephant's tongue, with lingual nerve, dissected on the right side.

The small nerve behind is the glossopharyngeal. On the left side are seen four circumvallate papillæ. The fungiform and filiform are very small.

1021. Dry preparation, showing how the spinal nerves pierce the dura mater of the cord in the Horse. The ganglia on the posterior roots are coloured dark.

1022. Lenticular ganglion of the Horse.

The optic nerve and internal rectus are seen behind, the nasal branch of the ophthalmic above, and the third nerve below the ganglion.

1023, 1023[5], 1023[10]. Brachial plexus of Gazelle; three preparations by Dr. Habershon.

1024. Armadillo; brachial plexus.

C.—Organs of Special Sense—Eye.

The eye of other Mammals closely resembles that of man, but there is usually a third eyelid (*Membrana nictitans*), and in most Carnivora and Ungulata the back of the choroid is not black, but coloured (*tapetum*). In Birds there is a third eyelid, and two lacrymal glands: the cornea is very convex, and surrounded by bony plates, and there is a vascular process (*pecten*), projecting forwards from the choroid into the vitreous humour. The eye of Reptiles resembles that of Birds in most respects, but is more globular, and in Snakes and Geckonidæ there are no eyelids. In Fishes the cornea is flat and the lens globular; there are no lacrymal glands (as in Cetacea among Mammals), and the pecten of Birds is represented by a *falciform process* of the choroid. In cartilaginous fishes the eyeball is supported upon a pedicle fixed to the bottom of the orbit.

1025. Eye of Horse; transverse section, showing lens and ciliary processes.

1026. Eye of Sheep; dissection of nerves, dry preparation.

The levator palpebræ, the four straight and two oblique muscles, the lacrymal gland and optic nerve are also shown.

1027. Section showing ciliary processes and iris; arteries injected.

This and the three next prepartions were made by Mr. Poland.

1028. Transverse section, posterior half, showing choroid.

1029. Eye of Sheep; choroid injected with mercury, iris and sclerotic removed.

1030. Eye of Sheep; longitudinal section, choroid injected with mercury.

Notice in this and the preceding preparations the vasæ vorticosæ.

1031. Retina, ciliary processes, &c., of Eye of Sheep; the external tunics removed.

1032. Eye of Reindeer, showing eyelids and adjacent gland.

This subocular gland (*Sinus lacrymalis*) is characteristic of the family Cervidæ.

1033. Eye of Bullock, showing lens, iris and ciliary processes.

1033[5]. The same, with the sclerotic removed, to display the choroid.

1034. Eye of Rabbit, showing sclerotic and cornea.

1035. Eye of Seal, sclerotic cut open.

Notice the thickness of the sclerotic both at the back and, to a less degree, close to the cornea. This is only an exaggeration of what is the case in the human eye. The section also shows the ciliary processes, retina and vitreous. The lens, as in other aquatic animals, is nearly globular.

1036. Eye of Whale, in section.

Notice the extreme thickness of the back of the sclerotic. This, as in the seal, serves to resist the pressure of water at considerable depths; but in the Cetacea it grows gradually thinner forwards without any second thickening.

1037. Eye of Cachelot or Sperm Whale (*Physeter macrocephalus*), showing the anterior part of the sclerotic and the iris.

1038. Dried crystalline lens of Sperm Whale. From Dr. Alderson.

Notice its division into antero-posterior segments.

1039. Bony circle of a Bird's sclerotic, surrounding the cornea, which has been removed.

1040. Eye of a Bird, showing the Membrana nictitans or "third eyelid."

This corresponds with the *plica semilunaris* of the human eye. The preparation also exhibits the muscle which draws this membrane over the cornea, and its tendon passing through a pulley formed by a second muscle at the back of the sclerotic.

1041. A dry preparation, showing the same structure.

1050. Two eyes of Birds, dried.

Notice the conical cornea with a circle of bony plates around it. Cf. Rymer Jones: figs. 278 and 279.

1051. Dried crystalline lens of Eagle.

1052. Eye of Turtle, longitudinal section.

Notice the thickness of the back part of eyeball, as in other aquatic animals. Cf. preps. 1035, 1036.

1053. Eye of Turtle, with the large (external) lacrymal gland dissected out (dry).

There is also a second smaller one, situated at the inner and lower part of the eye, and called the Harderian gland.

1054. Another specimen, in spirit.

1055. Head of Frog, showing eye, eyelid, and membrana tympani.

1056. Dried crystalline lenses of Fishes.

1056[5]. Eye of Fish, cut open to show the plicated falciform process of the choroid within the eyeball. From Mr. Poland.

Notice the flatness of the cornea, and the large globular lens.

1057. Eyes and optic nerves of Whiting, in situ.

Notice that the optic nerves cross without forming a chiasma.

1057[5]. Left eye of Cod dissected in situ, with brain, muscles and nerves; optic nerves, as in Whiting.

The olfactory nerves have been cut away, and the upper part of skull removed.

For eye and optic nerve of Sturgeon see 1068[25].

D.—Ear.

The ear of Birds and Reptiles differs from that of man and other mammals in having no auricle, only one ossicle (the *columella* or stapes), and an untwisted cochlea. In some Reptiles and Amphibia the cochlea and single ossicle disappears, as well as the external meatus, so that the membrana tympani comes to lie flush with the skin. In Fishes, and in some Amphibia, there is no tympanum or Eustachian tube, so that the organ of hearing is reduced to the nerve with the sacculus and otoliths, and three semi-circular canals. The Lamprey has only two of these, and the Myxine only one.

E. H. Weber: De aure et auditu hominis et animalium, 1810. Hyrtl: Vergleichende anat. Untersuchungen ü. das innere Gehörorgan des Menschen u. der Säugethiere, pl., 1845.

1058. Cranium and ossicula auditûs of a Marmozet Monkey; from Mr. Bryant's Museum.

On the black card are seen from above downwards, first, the *Stapes*; second, the *Incus*; third, the *Malleus*; fourth, the *Labyrinth* with its three semi-circular canals; and lastly, the tympanic and squamosal bones of the left ear.

1058[10]. Ear, with auricle, of Pig.

1059. Ear of Guinea Pig (*Cavia cobaya*). South America.

In this, as in other rodents, the cochlea makes more turns than in the human ear.

1060. Temporal bone of Lion, with the large globular bullar expansion of the tympanic bone cut open, to show the antero-posterior septum which divides it.

1061. Tympanic ring and membrane of a Carnivore.

1061[5]. Bullous tympanum, with the M. tympani, Malleus and cochlea of Cat. From Mr. Bryant's museum.

1062. Eustachian tube of Lion: a probe passed through it.

1063. Bony parts of ear of Ram.

EAR.

1064. Ear of Calf, cut to show the cochlea, meatus internus, and nerves.

1065. Another preparation.

1065^{5}. Membrana tympani; Eustachian tube, malleus and incus of Horse.

1065^{10}. Osseous labyrinth of a Rodent.

1066. Bony part of ear of the Small Finner or Pike Whale (*Balænoptera rostrata*), right and left.

1066^{5}. External ear of Owl.

This is a cavity outside the external meatus formed by folds of skin. The "horns" of the so-called eared Owls are mere tufts of feathers unconnected with hearing.

1066^{10}. Membrana tympani, columella, and semicircular canals of Owl, with the rudimentary, untwisted cochlea.

1067. Ear of Turtle, showing the membrana tympani and the columella attached to it, and passing inwards.

1067^{5}. A similar preparation, showing the concave internal extremity of the columella, and the external scales covering the membrana tympani.

1067^{10}. A third preparation, showing, in addition, the three semicircular canals.

1068. Otoliths of Haddock (*Gadus æglefinus*), Cod (*G. morrhua*), Tench (*Tinca vulgaris*), and Turbot (*Rhombus maximus*).

These large calcareous bodies answer to the otoconia of the human labyrinth.

1068^{10}. The three semicircular canals of the Sturgeon.

1068^{15}. Auditory nerve and membranous labyrinth, &c. of Sturgeon, dissected in situ.

1068^{20}. Ear of Ray.

Notice that the anterior and posterior semicircular canals are nearly complete circles. This is not the case in Sharks and other fishes.

E.—Olfactory Capsule.

This is single in the Lamprey, double and without posterior nares in ordinary Fishes. For dissections, showing some of the forms of the olfactory nerve and membrane, see preps. 908[5] (seal), 988 (heron), and 1000 (skate).

1068[25]. Head of Sturgeon, dissected to show the olfactory, optic, and auditory nerves and capsules.

The dermal bones have been removed and the cartilaginous cranium cut down to a level with the brain-case.

At some distance behind the end of the rostrum is seen, on the L. side, the double orifice leading to the large nasal capsule, which is lined with radiating folds of mucous membrane, as seen on the R. side. The two olfactory nerves are seen passing from these sacs towards the anterior cavity of the cranium, which lodged the Rhinencephalon.

Behind is seen the globular eyeball on the left side, with the optic nerve, which forms a chiasma with its fellow. The nerve passing below the optic nearly at right angles is the sup. max. of the 5th.

Further back is seen, on the L. side, the cartilaginous horizontal semicircular canal, and on the right the same, with the corresponding membranous canal in situ. Notice its anterior ampulla and the beginning of the inner limb of the anterior vertical canal. Behind is seen (better on the L. side) one limb of the posterior vertical canal. A gutta-percha rod is passed through the canal on each side, which leads to the gillchamber.

At the back of the preparation are shown the four tentacles attached to the rostrum.

Series VII.—URINARY ORGANS.

A.—Kidney.

This, in the three higher vertebrate classes, is a compound tubular gland, consisting of one or more "pyramids," either separate or fused together, the summits of which open into the "pelvis" of the ureter. In Amphibia and Fishes the kidneys answer to the Wolffian bodies of the human fœtus.

1069. Kidney of Monkey, injected. See also 1084.

1069^5. Kidney of Lion; longitudinal section.

1069^{10}. Kidney of Cat.

Notice that it consists of only one pyramid, with a single infundibulum and mamillary process projecting into the pelvis.

1069^{50}. Kidneys of Seal, one injected.

These are lobular, as in the human fœtus, that is—the pyramids of which they are composed are separate down to their bases in the cortex of the gland.

Kidneys and bladder of Hedgehog. See 1105.

1070. Kidney of Elephant, in section, injected. From Mr. Morgan.

1070^5. Kidneys of Tapir.

Urinary organs of Gazelle. See 1099.

1071. Thyrsoid Kidney of Porpoise.

So called from its resemblance to a bunch of grapes.

1071^5. Another specimen.

1073. Kidneys, ureters and cloaca of Emeu, with one oviduct.

Notice that the kidneys have no distinct pelvis, but open into the ureter by successive ducts. As in other birds, they are moulded by the irregular surface of the sacrum into which they fit.

1074. Kidneys of Swan. See also 934^5.

1075. Kidneys, ureters, and cloaca of Alligator.

1076. Nummular Kidneys of Boa.

So called from the "pyramids" resembling coins in shape. Compare 1116[2] and 1272.

Kidneys of Frog.

See preps. 1082, 1116[10] and 1276.

Kidneys of Menobranchus.

See prep. 406[10], where they appear as very long glands, lying behind the testes, and opening by several ducts into the convoluted tube which also acts as vas deferens. Between the hind legs is also seen the small bladder.

1077. Kidneys of Skate.

1077[5]. Kidneys of Mackerel.

These are long, narrow, and reach far forward. See also prep. 734.

B.—Bladder.

A proper urinary bladder only exists in Mammalia. It is developed from the proximal portion of the allantois. In Birds, Reptiles, and Amphibia, the ureters open into a urogenital sinus, and that again into a cloaca. In most Fishes they open by a separate orifice situated behind that of the genital ducts and of the rectum.

1078. Urinary bladder of Monkey, inflated and dried.

1079. Bladder of Monkey, showing also the vesiculæ seminales, prostate, and penis: from Mr. Bryant's museum.

1080. Bladder of Horse, dried.

There is shown also the entrance of the ureters, the vasa deferentia, and vesiculæ seminales.

1081. Urinary bladder of Pig, with ureters.

1081[5]. Cloaca of Goose, with the rectum laid open.

In this a thick bristle is placed, and small bristles in the oviduct and ureter. The foot has only two toes.

1082. Kidneys and double bladder of Frog: prepared by Dr. Gull.

This viscus, though developed, like the Mammalian bladder, from the proximal part of the allantois, does not receive the ureters, but contains a limpid fluid, almost pure water. A similar "bladder" is found in Lacertilia and Chelonia.

Series VIII.—REPRODUCTIVE ORGANS.

The sexes are distinct in all Vertebrata, including *Amphioxus*. Sexual congress occurs among Lampreys, Sharks and Rays only of Fishes, and in Amphibia; coitus proper only in the three higher classes.

A.—Male Organs.

Beside the essential glands, the Testes (which are compound and tubular), with their ducts (vasa deferentia), which alone are present in Branchiate Vertebrata, the three higher classes possess an intromittent organ (penis): either an eversible cæcal tube, as in Ophidia and Lacertilia, and in the *Anatidæ*, *Rhea* and *Casuarius* among Birds;* or a solid grooved organ, as in Chelonia and Crocodiles and in Monotremata; or a triple structure, traversed by the urethra, as in Marsupialia and all other Mammals. The testes are usually placed within the abdomen, in front of the kidneys (cryptorchic, testicondous), but in some Mammals they descend into a scrotum in adult life (phanerorchic), and in others come down to the inguinal regions at the seasons of functional activity. Beside the vesiculæ seminales and Cowper's glands, there are other accessory organs which are found in some Mammals, especially Insectivora.

Secondary sexual characters, which are chiefly male, are most marked in Birds, and very little in Reptiles and Branchiate Vertebrata. Some of these have been illustrated in preceding sections.

---

* The penis of the Ostrich is formed on a different plan.

MALE REPRODUCTIVE ORGANS.

1084. Testes, vasa deferentia, penis, bladder, and kidneys of a Monkey.

All the Primates are phanerorchous. Notice the presence of vesiculæ seminales, and the long piece of urethra between the bladder and the bulb.

1085. Testis and epididymis of Monkey, injected with mercury.

1086. Testes of Hyæna, in scrotum.

The Carnivora are phanerorchous, with the exception of the Pinnipedia.

1087. Testis of Hyæna.

1088. Penis of Indian Ichneumon. Presented by Mr. Bell.

1089. Os penis of Bearded Seal (*Phoca barbata*).

This bone is an ossification of the fibrous *septum pectiniforme* between the right and left Corpora Cavernosa.

1090. The same from the common species (*P. vitulina*).

1091. Os penis of Walrus, in longitudinal section.

1092. The same from a Dog.

1093. Testes of Mole during the winter, injected, and dissected in situ.

All the Insectivora are cryptorchous or testicondous, *i.e.*, the testes habitually retain the position in front of the kidneys which they occupy in the fœtus, but they pass more or less downwards at the season of functional activity. The urinary bladder, here seen between the testis and epididymis of each side, is concealed in March by the hypertrophied prostatic glands.

1094. Male organs of Rat during functional inactivity.

The testis and epididymis R. and L. with the vasa deferentia are seen below, the penis lies between them. Above it is the bladder, collapsed, with the ureters, higher still the vesiculæ, of racemose structure, and behind the rectum.

1095. The same organs, dissected and removed from the body.

Above are seen the vesiculæ seminales, somewhat dark in colour. The accessory glands, answering to Cowper's in human anatomy, lie, the R. below the corresponding vesicula, the L. close to the bladder, which is turned somewhat to one side. Below are the smaller prostatic glands, and a large præputial gland is seen opening on the glans penis. The testes are separated to each side.

MALE REPRODUCTIVE ORGANS.

1097. Testes of Rat, removed during the spring. Compare 1094.

1098. Male genital organs of Guinea Pig, dissected.

The testes, racemose vesiculæ, bladder and prostate, with Cowper's glands lying on each side of it, will be readily identified. The two long tubes which pass upwards from the urethra are the bifurcations of the Utriculus masculinus or protometra (sinus pocularis of human anatomy), which is the homologue of the uterus in the female, and is thus largely developed in some of the lower mammals.

The glans penis is covered with minute horny spines.

1099. Genital and urinary organs of a Gazelle.

1100. Vesiculæ seminales of a Deer, injected with wax, and dried.

1100[5]. Præputial musk-sac of the true Musk Deer (*Moschus moschiferus*). Thibet.

This is a highly specialized sebaceous gland.

1101. Penis of Reindeer, injected.

1102, 1102[5]. Testis of Bull, injected and dried; two specimens.

1103. Testis of Bull, injected and cut open.

1104. Penis, &c., of Boar (dry).

Notice the pointed glans and small bladder.

1104[5]. Penis of fœtal Pig, with accessory parts and retractile muscles, dissected by Dr. Hodgkin.

1105. Male genital organs of Hedgehog, dissected in situ, during the period of functional inactivity.

Behind is the lumbar part of the spine, the tail, pelvis, and hind legs, with the kidneys. In front the bladder is seen, supported by a thread; very large vesiculæ seminales right and left; next, the prostate on each side; then, two glands answering to Cowper's and furnished with long ducts; and, below these, the testes. Immediately in front of the short tail is the rectum, and in front of it again the long penis with its hairy prepuce.

1106. The same organs, removed from the body.

Above are the large vesiculæ seminales with three compartments R. and L. Next, the lobular prostate R. and L.; behind, the bladder with its muscular coat exposed, Cowper's gland, the testis and epididymis of each side, and the penis with its bifid glans.

1107. Penis of Horse, injected and dried.

1108. Penis of Porpoise (dry).

Notice the long prepuce and still longer acuminate glans.

1109. Testis and epididymis of a Cetacean, injected.

1110. Another specimen, injected and laid open longitudinally.

1111. Testes, &c., of Porpoise, dissected in situ, by Dr. Oldham.

The lobulated kidneys are seen at the upper part of the preparation; below them the testes, each with its epididymis and vas deferens. Behind the ureters is the long, narrow bladder, and behind that again, the penis, the glans of which is seen on the opposide side, emerging from a vulvalike aperture, four or five inches in front of the anus. Notice the absence of vesiculæ seminales, and also that the ureters open into the bladder high up.

1112. Testes of a fœtal Porpoise, injected, and dissected in situ.

The rectum, cut short, is seen with the testes, vasa deferentia, urachus, and base of penis, and the umbilical cord on the other side of the preparation, in front of the glans penis.

1114. Testis of a Sparrow, in situ, during the breeding season.

All birds are cryptorchous; but, as in the rat, the testes enlarge enormously when functionally active.

1115. Penis of large Tortoise.

The blunt triangular glans is seen at the upper part of the preparation; the urethra, incomplete above, is kept open by pieces of glass, and lies between the two corpora cavernosa. On the other side are seen the large retractor muscles, which draw it back into the cloaca.

1116. Base of Penis of large Tortoise.

This corresponds to the previous preparation, and shows the commencement of the urethral groove. A black probe has been passed from the sinus urogenitalis into the cloaca.

1116². Urino-genital organs of Male Viper.

The two testes with their ducts are seen in the upper part of the preparation, and the long tortuous kidneys (compare 1076) lower down. Both glands empty their secretion into the common cloaca, which is laid open. Notice that the right testis is higher (i.e. in the natural position, anterior) to the left, in accordance with the lack of bilateral symmetry necessitated by the elongated and narrow body of Ophidia.

1116⁵. Frog, showing the papillary development of the thumb, which becomes an organ of prehension during sexual congress.

1116¹⁰. Male Frog, injected and dissected.

The two oval white testes are seen in situ, lying in front of the primitive kidneys. The preparation also shows the tongue, liver, gall-bladder, &c., and the vascular processes of sub-peritoneal fat around the kidneys.

1116[15]. Testes and appendices adiposæ of Frog, injected: see 952.

Testes of Menobranchus. See prep. 406[10].

Their ducts are seen opening into the common urino-genital tube (duct of Müller).

1117. Testes or "milt" of Eel.

This, as in the Cyclostomatous fishes, is not a secreting gland, but a mass of indifferent tissue in which sperm-cells are formed, as the ova in the ovary of most Vertebrata.

B.—Female Reproductive Organs; including preparations illustrating Utero-gestation, Ovulation, and Fœtal Anatomy.

The ovary in Vertebrata is not, as a rule, a true secreting gland, and instead of passing off through a duct, the ova developed in it are either dropt into the peritoneal sac or caught by an open "oviduct," or tuba Fallopii. Many osseous fishes, however, have the oviduct continuous with the ovary, and this is a tubular gland. The oviduct unites directly with the ureter in most fishes and in Amphibia. In *Perca*, *Blennius*, *Carcharias*, &c., among Fishes, there is only one ovary, and also in Birds (usually the left).

The lower part of each oviduct is dilated in Sharks, Frogs, many Reptiles, and Birds; but only in Mammals do these dilatations form two *uterine cornua*, which, by their more or less complete union, produce a bicorporate, bicornual, or entirely single uterus.

The ova of most fishes are excessively numerous and very small. In Sharks and Rays they are few, large, and enclosed in a horny shell. In Amphibia they are numerous, and enclosed in a mass of mucus. In Ophidia and Lacertilia they are much larger and oval: in Chelonia and Crocodilia enclosed in a calcareous shell, as also in all Birds. In Placental Mammals the ova are smaller even than those of fishes, and have no shell; but (beside the amnion and allantois which are also found in Birds and Reptiles) the surface of the mature ovum becomes covered with vascular tufts (*chorion*), which are supplied with blood through the allantois. These are received into the thickened and vascular mucous membrane of the uterus, and thus a *placenta* is formed. If this simply falls off from the uterus at parturition, it is said to be *non-deciduate*, i.e. to be a purely fœtal structure; but if it grows to the uterine mucous membrane, so that at birth this (membrana mucosa caduca v. decidua) comes off with it, the placenta is said to be "*deciduate*," i.e. made up fœtal chorion and maternal decidua. The various arrangement and extent of the permanent villi of the chorion has further led to the placenta being described as diffuse, zonary, discoid, or cotyledonous.*

The most important secondary female organs are the mammæ, highly developed sebaceous glands, which are peculiar to the highest class of Vertebrata.

Placenta deciduate and discoid—i.e. the villi, which at first cover the entire chorion, fall off, except on a round disk- or cake- (*placenta*) like surface, where they are highly developed and grow into the uterine decidua.

1118. Ovaries, uterus and vagina of Monkey.

Notice that the uterus, like the human, has a single fundus.

1119. Female genital organs of Mole, injected, in situ.

The ovaries, Fallopian tubes, and uterus, are shown.

1120. Ovaries of Rat, with oviducts, bladder, and uterus.

1121. Ovaries of Cape Mouse, in situ; uterus bicornis.

1122. Pregnant White Mouse, dissected.

Both horns of the uterus are filled with embryos, each attached by its umbilical cord and a separate placenta.

1123. Another specimen, further dissected.

1124. Pregnant uterus of Mouse, injected.

The left horn, with three fœtus, is unopened; the right is opened, and shows four fœtus with their placentæ, each contained in its amnion.

---

* There are, however, many varieties of form beside these; and just as a "zonular" placenta may be nondeciduate, so a cotyledonous one may have a decidua. For an account of the placenta in the Tamandua, see A. Milne Edwards (Ann. des Sc. Nat., xv., 1872), in the Grampus (Turner), and in the two-toed Sloth (Id. Jour. Anat. and Phys., June, 1873).

1125. Membranes of rodent fœtus.

The umbilical cord is seen attached, with the fœtal and maternal parts of the placenta, the latter being anterior. Also the chorion in front and amnion behind.

1126. Placentation of Rodent: chorion and placenta injected.

1127. Pelvis of Guinea-pig, with fœtal head, showing the relaxation of the ligaments in parturition.

1127[5]. Uterus of Guinea-pig, the muscular fibres dissected and vessels injected—uterus bicornis.

1128. Female genital organs of Beaver, dissected, showing the castor glands.

The rectum, which opens below into a partial cloaca, is laid open. In front of it is the two-horned uterus, with its Fallopian tubes, and the ovary at each end, cut open. In front of this is the large bladder, also opened, and the long urethra, which is seen joining the vagina just before the opening of the latter into the sinus uro-genitalis. This latter cavity receives the four castor bags; the left ones are laid open. Cf. Rymer Jones, fig. 319 (male).

Placenta deciduate and zonary—i.e. the villi are fully and permanently developed only in a girdle running round the middle of the choroid at right angles to the long axis of the ovum.

1129. Ovaries, uterus, and vagina of Tiger (unimpregnated), both ovaries and vagina cut open.

1130, 1130[5]. Uterus of Cat, injected (two specimens).

1130[10]. Uterus of pregnant Cat.

The R. cornu contained 4, the L. 5 fœtus. The small ovaries are seen at the end of the Fallopian tubes.

1131. Pregnant uterus of Cat, at later period of gestation, injected.

The uterus has been cut open to display one of the two contained fœtus, which is seen floating in its transparent amnion, and surrounded by its vascular zonary placenta, from which the maternal part has been removed.

1132. Placenta of Cat, injected.

The uterus has been stript from the placenta, to which the decidua remains attached.

1133. Fœtal Kitten, with the membranes injected.

The placenta has been removed from the uterus, inverted, and wrapt round a black cardboard cylinder.

1134. Fœtal Puppy, lying in the amniotic sac.

1135. Fœtal Kitten, with the placenta injected and separated.

1136. Fœtal Lion.

1137. Another specimen, fully formed, with the hide partly spotted.

This peculiarity of the Lion at an early stage of development is an instance of young animals showing common characters of the family to which they belong.

1138. Ovary with corpus luteum of Bitch.

Two specimens, the lower one cut open.

1139. Uterus, with ovaries and Fallopian tubes of Bitch.

1140. Vagina of Bitch, injected.

1142. Part of uterus and uterine decidua of Bitch, showing the irregular alveoli of the latter, injected.

1143. Decidua of Bitch.

1144. Vagina, &c., of Bear.

1145. Uterus with Fallopian tubes, ovaries, bladder, and rectum of common Seal (dry). From the Surrey Gardens.

The tuba never reaches the ovary, so that gestation would be always extra-uterine but for a pouch of peritoneum, which receives the ovum as it is discharged.

1145^{5}. Pelvis, &c., of fœtal male Seal.

The rectum immediately in front of the short tail is marked by a piece of whalebone. In each groin is seen the testis in its permanent position, with the spermatic vessels and vas deferens. In the middle line behind is the rectum and in front the bladder with the urachus passing up to the umbilicus, where it is met by the R. and L. umbilical arteries, and forms the funis, seen to the left, together with the umbilical vein which is seen passing upwards towards the liver. Between the umbilicus and the rectum is the penis with its large prepuce.

1145^{10}. Placenta of the same fœtus.

The amnion and bare part of the chorion are seen behind, the zone of villi in front, and the cord with its branching attachment to the placenta above.

1146. Clitoris of Elephant.

Notice its bifid glans.

Placenta non-deciduate and diffuse: i.e., the chorionic villi persist over the whole surface of the ovum, except at its two poles: this form is hence sometimes called "zonular."

1147. Ovary of Sow.

1148. Ovary and Fallopian tube and cornu of uterus of Sow.

Notice that the infundibular opening of the Fallopian tube is not fimbriated: the latter condition is only found in Man, and the higher apes.

1149. Uterus of Sow, three weeks pregnant.

Cf. Rymer Jones, fig. 335. The term of gestation is sixteen weeks.

1150. One horn of uterus of pregnant Sow, with oviduct, thin infundibulum and ovary. Presented by Dr. Oldham.

1152. Bifid uterus and vagina.

1153. Fœtal Pig.

1154. Urachus, &c., of fœtal Pig, dissected.

The urachus is the part of the allantois between that which forms the bladder and that which extends beyond the umbilicus into the cord. It becomes obliterated, and remains after birth as the so-called anterior round ligament of the bladder.

1155. Uterus and vagina of Tapir.

Placenta non-deciduate and cotyledonous. In this form of placentation the chorionic villi only persist in bunches (fœtal cotyledons or placentulæ), which fit into corresponding "maternal cotyledons" of the uterus.

1156. Specimens of injected mucous membrane of gravid uterus of Sheep (the upper specimen), Bitch (the four middle ones), and Sow (the lower one).

1157. Injected specimens, from several animals with non-deciduate placentation.

1. The external or uterine surface of the chorion of the Porpoise, showing its rugous arrangement: 2. The same from the non-villous part: 3. Maternal and fœtal parts* of placenta of sheep: 4 (left). Uterine mucous membrane of Pig: 5 (right). Terminal portion of fœtal membranes of Pig: 6 and 7. Single cotyledon or placentula of Sheep, half-separated: 8. Single placentula from fœtal Calf.

* The "maternal part" is the thickened and vascular mucous membrane of the uterus, which, however, never forms a true decidua, since it does not become structurally continuous with the chorion, nor fall off with it at birth.

1158. Chorion of (1 and 2) Sow, (3) Sheep, with two cotyledons, (4) fœtal or internal surface of chorion of Porpoise: injected.

All form placentæ without true decidua.

1159. Ovary of Cow, injected, with a corpus luteum.

1160. Corpus luteum of Cow.

1161. Part of pregnant uterus of Cow, showing two maternal cotyledons.

Notice that these are convex. Cf. preps. 1164, 1167.

1162. Uterus and vagina of Calf.

1163. Part of pregnant uterus of Cow, with its placental tufts; the maternal and fœtal portions united.

1164. Two uterine cotyledons of Cow, one in section, injected.

1165. Part of uterus of Cow, with placentulæ, injected.

1167. Chorion, with fœtal placentulæ of Cow, injected.

1168. Fœtal membranes with the cotyledons of Calf, injected yellow.

1169. Part of amnion (internal) and chorion (external) of fœtal Calf, the latter showing two placentulæ.

1170. Chorion of Calf, injected.

This preparation shows an early stage of development, with only traces of commencing cotyledons.

1171. Another specimen; the non-cotyledonous part.

1172. Part of allantois of fœtal Calf.

The allantois of placental mammals, beside forming the urinary bladder, is chiefly of use in conducting the umbilical vessels to the chorion. The extra-fœtal part soon ceases to grow, collapses, and is finally lost in the tissues of the cord.

1172[10]. Umbilical cord of Calf.

1172[15]. Fœtal Calf, dissected.

Notice the heart and small intestine, the two umbilical arteries, urachus, and navel string.

1173. Uterus of Sheep at an early period of pregnancy, injected.

A probe is passed through the os uteri, and both cornua are opened to display the uneven and vascular mucous membrane.

1174. Part of one of the horns of a Sheep's uterus, everted to show the cup-shaped maternal cotyledons at an early stage of development.

Compare these hollow cotyledons with the convex bosses of the Cow's uterus. Preps. 1161, 1164, 1165.

1175. A similar specimen, with the cotyledons smaller, more prominent, and closer together.

1176. Part of uterus of Sheep, with the maternal part of two placentulæ, injected.

1177. Chorion, with the fœtal cotyledons, injected red, of Sheep.

Each of these corresponds to a cup in the maternal part of the placenta (1174, 1175 and 1176), into which its villi fit, as seen in 1179, like so many fingers into a glove. The two extremities ("poles"), of the chorion, almost bare of villi, correspond with the cornua of the uterus; so that even a cotyledonous placenta has to some extent the girdle shape of the diffuse and zonary kinds.

1178. Separate fœtal cotyledons, or placentulæ, of the same.

1179. Gravid uterus of Sheep, injected.

The walls have been opened to show the chorion and amnion within; and at several points is seen the connection of the former with the lining membrane of the uterus, by means of the interlocking of the fœtal and maternal cotyledons.

1180. Fœtal Lamb, suspended in the transparent amnion.

The fœtus floats in the liquor amnii, which lies between the embryo and (the internal layer of) the amnion.* The external layer of this serous membrane is closely united with the chorion, and has been removed with that membrane.

1181. Another specimen, with amnion and chorion.

Hold it up to the light, to see the chorion outside, with its villi already collecting into cotyledons, and the amnion within, with its reflexion on the umbilical cord.

1182. Uterus of Goat (dry).

Compare with 1173.

1183. Amnion of Kid (dry).

---

* Like the cerebrospinal fluid between the brain and the visceral layer of of the arachnoid.

1184. Fœtal lamb, showing the heart and the primitive alimentary canal before its first flexure.

The anterior extremities alone appear, as buds.

1185. Another specimen, further advanced.

The posterior limbs and tail have appeared.

1186. A third, in which the eyes have already appeared, and the primitive heart is displayed.

Other forms of Non-deciduate placentation.

1188. A fœtal foal.

Notice the low position of the attachment of the umbilical cord, due to the slow development of the posterior half of the body.

1189. Injected chorion of Zebra.

Observe how the villi cease towards its poles, corresponding with the ends of the uterine horns. Cf. prep. 1177. There is a similar bare spot opposite the os uteri in many diffuse placentæ.

1189[10]. Median part of the same placenta.

The villi are seen scattered " diffusely " over the surface.

1189[15]. The same; arteries injected red, veins blue (dry).

1189[20]. The same; one pole of the chorion with numerous villi still upon it.

1190. Fœtal Pangolin (*Manis*).

The placenta of this family of Edentata is nondeciduate, but neither diffuse nor cotyledonous, the villi covering the chorion except where a bare band extends along its convexity from one uterine horn to the other.

1192. Ovary, cut open, with oviduct, one uterine horn, and broad ligament of Porpoise.

A black rod is passed through the os uteri into the rugous vagina.

All the Cetacea have a diffuse non-deciduate placenta, with the two poles in the uterine cornua, and also the spot opposite the os uteri, bare of villi.

1193. Portion of gravid uterus of Porpoise, injected.

Notice the small glandular apertures with vascular walls, which receive the villi of the fœtal chorion.

1194. Membranes with umbilical cord of fœtal Porpoise, showing the diffuse villous chorion (injected yellow) and the transparent amnion. Presented by Dr. Oldham.

1195. Fœtal Porpoise.

The penis is seen behind the umbilical cord. Also, notice the blowhole on the vertex.

1196. Portion of a diffuse placenta, injected.

Marsupiata v. *Didelphia.—Placenta absent; double uterus; double vagina.*

1198. Fœtal Kangaroo, showing its attachment to the teat.

The mammary gland is situated in the marsupium, which is formed of a fold of the abdominal skin and panniculus carnosus. There are two nipples, to one of which the fœtus is attached, and the milk is squeezed into its mouth by the cremaster muscle.

Suckling thus being a passive act on its part, the larynx is prolonged up beyond the soft palate, as in the Porpoise (see prep. 915), in order to prevent suffocation. See Rymer Jones, fig. 331.

Ornithodelphia.—Placenta absent; two uteri; ova large; mammæ without any nipple.

1199. Female genital organs of Ornithorhynçus.

The kidneys are seen above, with the ureters opening into the sinus urinogenitalis, immediately below the openings of the two uterine dilatations of the oviducts. The oval body above is the urinary bladder. The urinogenital sinus communicates with the cloaca by an orifice, into which a blue rod is passed, near the opening of the rectum, a part of which is seen behind. Below is the broad and flat tail.

See Rymer Jones, fig. 326.

Aves.—Ova large, the yelk being covered by a thick layer of albumen and a calcareous shell, both secreted by the vascular walls of the oviduct. No chorion or placenta; amnion and large allantois, which serves as an organ of respiration for the fœtus while in the egg.

1200. Pelvis, ovary, and oviduct of a bird, injected.

A calcified egg is already in the cloaca ready for extrusion. Others are seen in various stages of development in tho oviduct and ovary, which, as usual in the class Aves, is tho left, the right never becoming functionally active.

1201. Ovary of Hen, injected.

1202. Ovary of Hen, with oviduct and cloaca.

1203. Oviduct of Hen, shortly after passage of an egg. Dissected by Dr. Sibson.

Notice its tortuous course, and the thick walls and rugous mucous membrane, where it has been laid open. The rectum is also seen partly opened, and the cloaca in which both canals terminate. Injected yellow.

1204. Genital organs of Hen, injected, with egg in cloaca.

The rectum is seen to the left, cut off.

1205. Oviduct, with soft egg in it.

1206. Oviduct of Goose, injected.

1207. Oviduct of bird, showing its villous mucous membrane, injected.

1208. Oviduct of Fowl, with part of ovary.

1209. The terminal part of the oviduct of a Hen, from which an egg has been removed, injected.

1210. Oviduct of Hen.

1211. Another specimen.

1212. Embryo of Hen.

1213. The same, more advanced; the omphalo-meseraic vessels injected.

1214. The same, with its membranes. Two specimens.

The lower one shows the allantois and the yelk-sac. In the upper (more advanced) the allantois has been opened.

1215. The same, with yelk-sac fully developed, injected red.

The transparent amnion is also partially seen.

1216. The same, at a more advanced period of incubation.

The yelk-sac is injected red, the allantois yellow.

1217. The same, mature and ready to be hatched.

1218. Injected specimens of the fœtal membranes of birds.

"The preparation in the upper part of the glass shews the radiating branches of the omphalo-mesenteric vessels toward the point where the albumen has entered, which is securely closed by the contraction of the vessels. The uninjected membrane above, which has an attachment at this point with the yelk-sac, seems to be one layer of the allantois, which closes over the yelk sac. The three other injected preparations are portions of the allantois of a chick (yellow) and of a gosling (red)."—Dr. Oldham.

1219. Omphalo-mesenteric vessels injected, radiating from the point where the vitelline duct (from the yelk sac) opens into the intestine, some coils of which are seen in the upper part of the preparation.

1221. Two similar preparations, both injected; with (below) detached portions of the same membrane.

1223. Three specimens of the same membrane, uninjected, separated from their connection with the embryo. The point of union is in the centre of each.

1231. Preparation showing the communication of the yelk sac with the gut by the vitelline duct in the embryo of the common Fowl.

1236. Fœtal Chick.

Notice the undifferentiated fore-limb, with the pollex distinct from the rest of the manus and præaxial (anterior) in position; also, the large head and eyes, the orifice of the ear, and the horny knob upon the upper mandible.

1238. Another specimen further advanced.

The remains of the yelk sac and allantois are seen attached ventrally.

1239. A third specimen, showing the way in which the Chick is folded into an oval shape.

Notice also the rudimentary feathers without visible barbs and closely resembling hair.

1242. Egg of Partridge (*Perdix cinerea*), opened to show the position of the embryo within.

1244. Chick further advanced, showing the proportion of the embryo to the yelk at this period of development.

1246. Egg cut open to show the position of the Chick and yelk at a somewhat earlier period than the last.

1247. Egg of Moor-hen (*Gallinula chloropus*), showing the way in which the Chick breaks the shell.

Notice the little horny tubercle on the upper mandible.

1248. Preparation showing the position of the Chick and yelk-sac in the shell.

1250—1260. Twelve preparations of fœtal Chickens at successive stages of development, from eggs which had been covered with four layers of paper soaked in albumen.

See Mr. Towne's account in the Hospital Reports for 1839, p. 385.

1261. Eleven wax models by Mr. Towne, illustrating the development of the common Fowl.

(1) taken two hours after incubation had begun. The cicatricula is seen on the surface of the yelk, with the Area pellucida and Area opaca.

(2), (3), (4), and (5) taken after four, eight, twelve, and forty-eight hours of incubation respectively.

(6) and (7) after sixty and seventy-two hours respectively. The Area vasculosa is now seen.

(8) after four days' incubation. The eye and heart (*punctum saliens*) of the embryo are now visible, and also the large right and left omphalo-mesenteric veins, which bring blood and yelk elements to the embryonic heart.

(9) at the end of the sixth day of incubation. The cerebral vesicles can be distinguished and the rudimentary fore-limbs. The omphalo-mesenteric veins are red, the artery blue.

(10) a somewhat later stage; the embryo seen through the transparent amnion.

(11) at the end of the tenth day. The two omphalo-meseraic arteries and veins are here seen with their branches ramifying over the yelk-sac.

1261[5, 6]. Two wax models, showing the thin lining membrane of the shell of a Fowl's egg before incubation, and its thickness and opacity after twenty days.

1261[10]. Case with models, showing the same change in the membrana putaminis in the Turkey.

See plate in Mr. Towne's paper, G. H. R., 1839.

1261[15]. Case of four models, illustrating the development of the common Duck.

(1) shows the cicatricula; (2) the amnion; (3) the membrana putaminis before, and (4) the same after impregnation.

1261[20]. Seven models, illustrating the changes during incubation in the egg of the common Goose.

These should be compared with 1261.

FEMALE ORGANS AND OVULATION.

Reptilia.—General structure of ovum like that of Aves. Two ovaries.

1262. Cloaca with sinus urogenitalis and rectum of female Crocodile.

The rectum is seen laid open at the upper part of the preparation, and a white probe shows its communication with the cloaca. This last cavity, also cut into and held apart, contained the egg seen at the bottom of the glass. The orifices by which the two oviducts open into the cloaca, are marked by a brown and a pink probe; and the former duct is laid open behind to show its rugous mucous membrane. Lastly, the two ureters are marked by bristles which show the points where they open into the cloaca.

1263. Three Alligator's eggs.

Notice that they are oval in shape, but, unlike a Hen's egg, symmetrical at each end.

1264. Ovary of Turtle.

The minute unimpregnated ova are seen contained in folds of the peritoneum. In Reptiles both ovaries are functionally active.

1265. Ovary of Tortoise with large ova at the period of laying.

1267. Ovaries, oviducts, cloaca, &c., of Tortoise, with egg ready for extrusion. Dissected by Dr. Sibson.

The ovaries, with eggs in various stages, are seen above. The two oviducts are laid open to show the mucous membrane. The rectum is cut off short. The two small kidneys are also seen with short ureters, through each of which a bristle has been passed into the cloaca; and, below, the thin, membranous bladder. Notice that the eggs have a calcareous shell, and are nearly round.

1269. Urinogenital organs of female Chamæleon, dissected in situ.

The two kidneys are long and tortuous (cf. 1026 and 1272). The ovaries are dark and show minute ova; bristles are passed into their openings into the cloaca. The rectum is cut off short; the cloaca opens by a transverse slit.

1270. Ovary, with ova and oviduct, of Lizard.

Notice the elongated, oval, symmetrical form of the eggs. The shell never becomes calcareous.

1271. A Green Lizard, laid open to show the oviducts, which contain several eggs.

Part of the intestines, the liver, and the lungs, are also shown.

1272. Ovaries, with ova and oviducts of Viper, dissected.

The eggs resemble those of the Lizard, but are more elongated. Below are seen the two kidneys with the ureters, and the rectum. The cloaca is laid open.

Anamniota.—Ova small and numerous, without any calcareous shell; no amnion; allantois rudimentary or absent; yelk-sac large.

1274 Female Frog, injected and laid open, displaying the ovaries and ova (upper specimen).

The ovaries are black, spotted with the small light-coloured ova. Partly concealing them is the immense mass of mucus, which surrounds the eggs.

1275. Genital organs of female Frog, dissected in situ.

The spotted ovaries are seen in the middle, with the mucous masses on each side and the convoluted oviducts above.

1276. Ovaries of Frog, dissected.

The convoluted oviducts are seen above the ovaries on each side; each measures about two feet: below are their dilated lower extremities and the cloaca into which they open, also the kidneys injected red, and the ureters with bristles inserted. At the back of the preparation is seen the globular, membranous, so-called bladder.

1277. Ovaries and oviduct of female Frog, dissected.

The two ovaries are seen above, with their separate lobules well shown. Below is the dilated oviduct injected.

1280. Three specimens, showing the development of the tadpole of the common Frog.

In the upper one, the hind limbs only have appeared; in the left hand, both pair; and on the right the change from a urodelous to an anurous condition is almost completed.

1284. Horny egg-shell of Skate, laid open.

The ova of Sharks and Rays are few, large, and enclosed in these horny shells, which open, like a pillow-case, at one end.

1285. Egg of Shark.

Notice that the corners are drawn out into long tortuous processes instead of the simple horns of the Skate's egg.

1286. Another specimen, laid open.

1287. Two other specimens (dried).

1288. Egg of Shark (*Chiloscyllium*), with the surface transversely ribbed; from Rent's Island, between Sydney and Melbourne. Presented by Dr. Lever.

1289. Female genital organs of Carp.

Beside the two large ovaria with their oviducts, into the common opening of which a blue rod is inserted, the two kidneys and the ureters are also seen.

In the Carp, as in other osseous fish, the ova are very small, numerous, and uncovered by a shell, and the oviducts are directly continuous with the glandular ovaries.

1290. Ovary, &c. of Wolf-fish (*Anarrhicas lupus*).

The fibrous covering has been stripped off from the ovaries where they unite, and the oviduct laid open.

1292. Viviparous Blenny, laid open to show several young ones; one mounted separately shows well the connection of the yelk-sac.

1293. A portion of the so-called uterine sac of a viviparous Blenny. Presented by Dr. Oldham.

It is seen to have some processes which are highly vascular and which are threaded among the fœtus when the sac is occupied by them.

1293^5. A number of young fœtuses from the viviparous Blenny.

1294. Ovaries of Eel.

There are no oviducts, the ova, as they are discharged, dropping into the peritoneal cavity, and finding their exit by the abdominal pore, as in the Lampreys.

1295. Lamprey, laid open to show the arrangement of ovaries.

The simple intestine and part of the liver, as well as the pouch-like gills with their seven openings, are also seen.

Series IX.—VISCERA OF UNKNOWN FUNCTION.

A.—Thyroid.

This structure is found in all the vertebrate classes. It consists of closed vesicles, lined with epithelium and containing a gelatinous fluid, which are bound together by areolar tissue, and surrounded by a thin fibrous tunic. It is developed from the pharynx, and attains its largest relative size before birth. It is very vascular and liable to important diseases. No probable conjecture of its use has been offered.

1296. Thyroid of Horse, injected, and dissected in situ.

1296[5]. Thyroid of Horse, in section.

Notice the large closed vesicles of which it is composed.

1296[10]. Another specimen.

The vesicles in this case are smaller, and the structure more compact.

1296[15]. Another specimen.

Notice the fibrous septa between the lobules.

1297. Thyroid of Lamb, in situ.

1299. Thyroid of Porcupine.

B.—Supra-renal capsules.

Syn.—Adrenals: renes succenturiatæ: Nebennieren. These organs are found in a rudimentary condition in both cartilaginous and osseous fishes, in Amphibia and in Reptiles. They are present in birds as small yellow bodies lying under the anterior end of the kidneys, and are said to enlarge during the breeding season. In Mammals they are relatively larger. Their structure is unlike that of any other organ: they are well supplied with blood-vessels, especially veins, and still more richly with nerves, chiefly sympathetic. They attain their largest relative size in the human fœtus at about three months, up to which time they exceed the kidneys. They are liable in man to a peculiar disease (*Morbus Addisonii*), but neither this, nor experiments on them in animals, have led to any knowledge of their function.

1300. Capsules of Guinea Pig, in their natural position on the kidneys.

With the Thyroid and the supra-renal Capsules may be classed by the negative characters of peculiar structure and unknown function, the Hypophysis or Pituitary body, the Conarium or Pineal body, and the so-called Hybernating gland of Rodents.

Part II.—INVERTEBRATE SPECIMENS, ARRANGED IN ZOOLOGICAL ORDER.

Sub-kingdom—MOLLUSCA.

Char.—The four classes of Mollusca proper (Cephalopoda, Pteropoda, Gasteropoda, Lamellibranchiata), agree in the following characters.

The body is bilaterally symmetrical with respect to most organs, but this is much disturbed by adult development, especially in Cephalopoda and Gasteropoda. There is no serial homology. There is no true exoskeleton, and only a very rudimentary endoskeleton in a few genera. The skin is highly developed, and forms "the mantle"—muscular, glandular (mucous and pigmentary) and protective—which again secretes a calcareous shell, while on the ventral surface it forms the "foot."

The alimentary canal is convoluted and proctuchous; the anus being very rarely terminal.

There is a well-developed systemic heart, with at least two cavities, true corpusculated, colourless blood, and a more or less incomplete (lacunar) vascular system. Respiration is usually by gills; in other cases pulmonary, or vague.

The nervous system consists of a collar round the œsophagus, and at least three ganglia—cerebral, pedal, and parietosplanchnic.

There is a distinct urinary gland known as the organ of Bojanus.

Reproduction is always sexual, and accordingly there are no compound organisms.

Distr.—Most Mollusca are marine, some live in fresh water and others are terrestrial. They are found in all parts of the globe, but are more abundant in the Eastern than in the Western Hemisphere, and attain their maximum of development in the Indian seas. Mollusca occur abundantly in all the geological periods after the Cambrian formation.

MOLLUSCA.

Class.—The three higher classes agree in possessing a head, and a variously modified masticating apparatus: hence they are sometimes grouped together as Cephalic Molluscs or Odontophora. They also have the foot developed into three median lobes, known as the anterior or propodium, middle or mesopodium, and posterior or metapodium, beside two lateral lobes, the epipodia. Only in a few genera however, as *Atlanta*, are all these parts found together. Lastly, the Odontophora are either naked, or possess an internal or external univalve shell, or, in one family, a multivalve one, but never a bivalve.

The Mollusca of Aristotle (τὰ μαλάκια) were what are now known as Cephalopoda. By Linnæus mollusks were included with all Invertebrate Animals but Insects, under the head of Vermes. Cuvier first pointed out (1795) the true importance and characters of this as a primary division of the animal kingdom. Four of his classes, as here given are still universally admitted: the changes in arrangement since made will be mentioned under the heads Brachiopoda, Tunicata, and Bryozoa.

Ref.—Of historical importance are Martin Lister's "Cochlearum Angliae Liber," with figures of fossil species (1678), and Poli's "Testacea utriusque Siciliæ" (1791-1826), of which the edition by Delle Chiaje is the foundation of the Zoology of Molluscs, as are Cuvier's "Mém. pour servir à l'Histoire et Anat. des Mollusques," for their morphology.

Beside Gegenbaur's "Vergl. Anatomie," may be mentioned Huxley: "Morphology of Cephalous Mollusca," Phil. Trans. 1853, and Art. "Mollusca," English Cycl.; Woodward: "Recent and Fossil Shells," 1851; Lacaze Duthiers: "Ann. des Sc. Nat.," 1856-1858.

Forbes and Hanley's "British Mollusca;" Gosse's "Marine Zoology of the British Isles," vol. ii.

On the Structure of Shell, see Todd's Cycl. Anat. and Phys., Art. "Tegumentary Organs," and Rainey, on the "Mode of Formation of Shells," (1858).

Class—CEPHALOPODA.

Char.—The mantle secretes a single external spiral or internal flat calcareous or horny shell, or there is none at all. The ventral foot is twisted round in the process of development, so as to surround the mouth, and its edges form long tentacles which usually bear suckers or acetabula. Epipodia are formed, and united so as to form a funnel (infundibulum), by which water is ejected from the branchial sac. In the female of one genus (*Argonauta*), the large dorsal pair of tentacles secrete a single spiral "false shell."

The gills are two or four in number, internal and racemose, with branchial hearts, if only two.

The odontophore forms a beak, with a large ventral and a smaller dorsal mandible. The intestine has a primary neural flexure.

The nervous system is highly developed, with a cartilaginous "cranium," large and perfect eyes, and auditory vesicles, with otoliths. The sexes are distinct.

All Cephalopoda are marine, and are mostly active and predacious in habit.

Palæontology.—The majority of this class are now extinct. It is one of the most ancient; some Nautili appearing early in the Palæozoic period, while the Ammonites and all the dibranchiate families chiefly belong to Secondary formations.

Classification.—The class may be thus divided :—

Order Dibranchiata : 2 gills ; inkbag.

a. Octopod genera. *Octopus*, *Argonauta*, and fossil forms.

b. Decapod genera. *Loligo*, *Sepia*, with Belemnites and other fossil forms.

Order Tetrabranchiata : 4 gills ; more than 10 arms, and these without suckers ; no inkbag ; shell external and chambered.

Nautilus pompilius is the only living representative of this order, to which Ammonites and other fossil genera belonged.

CEPHALOPODA.

Lit.—Beside the books referred to under Mollusks generally, may be mentioned Owen: Art. "Cephalopoda" in Todd's Cyclopædia, Kölliker: Entwickelungsgeschichte der Cephalopoden.

Dibranchiata.

1302. The common Poulpe (*Octopus vulgaris*).

The branchial cavity is laid open to show one of the two characteristic gills of the order. Immediately above this is seen the funnel, then the two large eyes, and then the mouth and beak, surrounded by the eight enormous arms, united at the base, each bearing its double row of acetabula. There is no shell, external or internal.

This animal is the Polypus of the Ancients (Odyss. v. 432, Arist. Hist. An. iv. 1).

1303. Acetabula of the arms.

These suckers, named like the cavity of the hip joint in vertebrates, from their resemblance to a vinegar or wine-glass, have a strong muscular rim which keeps the vacuum within from the surrounding pressure of air, or, more frequently, of water.

1304. Common Cuttle-fish (*Sepia officinalis*) dissected.

Notice the calcareous internal shell contained in the dorsal fold of the mantle, the funnel on the ventral surface, the mouth and beak, and the ten small arms, two of them much longer than the rest, but these have lost their extremities. The specific name was given from the dried shells being ground and used medicinally. They chiefly consist of carbonate of lime.

1304[5]. Internal shells or "cuttle-bone" of a *Sepia*.

1304[10, 15]. Microscopical preparations of the shell in transverse and longitudinal section.

1305. Squid or Calamary (*Loligo vulgaris*) dissected.

This is a decapod like the Sepia. The two long arms, with their dilated sucker-bearing extremities, are here well seen. Also the horny internal shell, the two gills, the lateral fin-like expansions of the mantle, and the funnel. In the middle line, on the ventral surface, is seen the inkbag. The non-calcified shell is called *Gladiolus*.

1305[5]. Head of Calamary, dissected.

A blue probe is placed in the œsophagus, surrounding which the nervous collar is seen; also the two great cerebral, or supraœsophageal ganglia, from the left of which the optic nerve is seen passing to the eyeball.

1305[10]. Otoliths of the auditory sac.

Compare them with those of fishes. Prep. 1068.

1305[25]. A newly-hatched brood of young.

Some of them show the yolk-sac attached to the front part of the ventral surface.

1306. Another species of *Loligo.*

1307. Another smaller specimen, showing gills, ink-bag, &c.

1308. *Sepiola atlantica.*

1309. Belemnites, the internal shells of fossil decapod cephalopoda.

One has been divided to show the internal phragmocone, chambered and enclosed in its conical "guard."

1310. Female Argonaut (*Argonauta argo*), the so-called "Paper Nautilus."

The mouth and beak are seen above, with the eight arms, of which two dorsal ones expand into oval plates enclosing the shell which they secrete. The siphon projects backward (ventrally). The rest of the body is concealed by the shell.

This is the Nautilus of the ancients, (Arist. Hist. An., ix., 37), so called from the fable of its sailing on the surface of the sea. Cf. Rymer Jones, figs. 206, 207.

1310[5]. Pedal shell of the same, detached.

It is peculiar to the female Argonaut, and is not homologous with the internal shell of a Sepia, nor with the ordinary molluscan shell of the true Nautilus.

Tetrabranchiata.

1311. Fossil shell of Ammonite. Presented by Mr. Shoebridge.

It will be seen that this shell is spiral in a single plane, and is divided into several chambers or *thalami.* This specimen is from the Lias.

1311. Two small Ammonites (*A. splendens*), from the Gault.

1312. Shell of Pearly Nautilus (*Nautilus pompilius*).

This rare genus, from the East India Islands, is the only living representative of the four-gilled Cephalopods, without branchial hearts or inkbag, and with numerous tentacles devoid of acetabula. Cf. Rymer Jones, fig. 205. *Monograph.*—Owen on the Pearly Nautilus, with plates, 1832.

1313. Another specimen, cut open to show the internal chambers.

Notice the siphuncle running through the several partitions. The animal inhabits only the last formed chamber nearest the mouth of the shell.

In this specimen, the external layers of the shells, striped brown, have been removed to expose the deeper nacreous layers.

Class PTEROPODA.

Char.—This small class of oceanic mollusks may be regarded as an aberrant group, with relations both to Cephalopoda and Gasteropoda. They are all small, nocturnal in habit, and free swimmers.

The foot developes only epipodia, which serve as "wings" to swim with. There are numerous tentacles and suckers. The mantle secretes in some genera a simple, conical, external shell.

There is a most elaborate odontophore, a digestive system, and anus, as in Gasteropoda; a bilocular, well-formed systemic heart, but no distinct branchia. All Pteropods are hermaphrodite. In other respects they agree essentially with Gasteropoda, with which class indeed they are united by some zoologists.

1314. *Clio borealis.* Three specimens. Arctic Seas, &c.

The dark central mass shows the position of the liver, the lighter portion to the left, the ovary. On each side are the epipodia, or wing-like additions to the foot, which is otherwise rudimentary. Above is the double hood-like expansion of the mantle, which conceals the jaws and odontophore. In the upper specimen the hood is thrown back and shows the four tentacles. Cf. Rymer Jones, fig. 198.

1315. Shell of *Cleodora pyramidalis.* Altantic, &c.

This covers the posterior part or apex of the body.

1316. *Dentalium*, or Tooth-shell, with animal.

This anomalous genus was classed by Cuvier and earlier naturalists as a Tubicolous Annelid. Deshayes and De Blainville proved its Molluscan character, and included it among the Gasteropoda, in which it formed the Order Cirribranchiata. It is here placed (in accordance with the opinion of Professor Huxley) in the present Class, on account of the structure of the foot, the slightly developed head and eyes, and its larval characters. Lacaze-Duthiers, by whom the mode of its development was ascertained, prefers to place it as sub-class Solenoconchæ, next to, but distinct from, Pteropoda. Claus includes both (with Heteropoda as a third, and the rest of the Gasteropoda as a fourth sub-class) under the general head Gasteropoda. Gegenbaur calls the sub-class Scaphopoda, which he places lowest among cephalous mollusks and allied to Lamellibranchiata.

The foot has a central and two lateral lobes (epipodia ?) There is no heart, and respiration is vague, unless the two bunches of tentacles help in this function. There are the ordinary three ganglia, but no eyes. The sexes are distinct. The embryo is free-swimming and ciliated, with a single velum.

1316[5]. Shell of Dentalium.

Notice that the shell is open at both ends.

Class GASTEROPODA.

Char.—All Gasteropods have a distinct head, with one or two pair of tentacles; a mantle, which usually forms a collar round the neck; and a ventral foot, consisting of propodium, mesopodium, and metapodium, the last often bearing a horny operculum. A pair of lateral epipodia are sometimes developed in addition. All these organs of animal life are symmetrical.

At a certain period of development the dorsal region develops into a "hump," which contains the liver and part of the intestine. This is next thrust over to the right side by excessive development of the left, so as to bring the anus to open on the right; while, lastly, the hump twists round on its axis so as to form a spiral, usually winding thus—. Since the mantle secretes the shell, the latter follows the same course; and a shell of this kind is called "dextral," one with the reversed twist, "sinistral." Gasteropod shells are either univalve (conical or spiral), or multivalve.

The mouth has a cutting, horny tooth, and an odontophore. There is usually a proboscis, a stomach, and a convoluted intestine, with anus, which is rarely terminal. There are salivary glands, and a large liver occupying the apical part of the shell.

The heart has two cavities; it is systemic, and the systemic circulation is incomplete (lacunar).

Respiration is in some Gasteropoda performed by air-sacs; in most it is aquatic, the gills being external or internal, lamelliform, pectinate, &c.

Nervous system as in other Mollusca. Eyes and auditory vesicles.

Diœcious, or monœcius. Oviparous. Embryo swims about as a larva, with a bilobed ciliated velum.

The Gasteropoda are by far the most numerous group of Mollusks, and are widely distributed in spaco and in time.

The following is a convenient arrangement of their principal families:—

I. Pulmonigasteropoda—breathing air, hermaphrodite.

Helix, *Limax*, *Limnæa*, *Planorbis*, *Auricula*, *Cyclostoma*.

GASTEROPODA.

II. Branchiogasteropoda—breathing by gills.

1. *Prosobranchiata*—gills internal and in front of the heart, large shell, diœcious.
   - *a.* Siphonostomatous—edge of shell notched: carnivorous. *Buccinum, Conus, Murex, Cypræa.*
   - *b.* Holostomatous—edge of shell entire. *Haliotis, Trochus, Littorina.*
   - *c.* Multivalve—*Chiton.*
2. *Opisthobranchiata*—gills external and behind the heart, hermaphrodite, carnivorous.
   - *a.* *Tectibranchiata*—with a simple shell. *Aplysia, Bulla, Pleurobranchus.*
   - *b.* *Nudibranchiata* *—without a shell. *Doris, Eolis.*
3. *Heteropoda*—free swimming. *Carinaria, Atlanta.*

Pulmonata.

1317. Case of terrestrial pulmoni-gasteropod shells belonging to the family *Helicidæ*: several divided, to show the columella and arrangement of the whorls.

(1) The Edible or Roman Snail, le grand Escargot (*H. pomatia*).

Common in France and other parts of Europe, rare in England.

(2) The common Garden Snail (*Helix aspersa*).

This is rare in the North of England.

(3) The Banded Snail (*H. hortensis*).

Common throughout England. The marking varies greatly.

(4) A rarer British species (*H. nemoralis*).

(5) The red-lipped Snail *H.* v. *Acavus hæmostoma.*

(6) Species of sub-genus *Theba.*

(7) *Clausilia* sp.

Notice that this is a lævogyrate or sinistral shell, i.e., the whorls (starting from the apex of the cone, in the direction of the actual growth of the shell), run round in the opposite direction to that of the hands of a watch. Aperture closed by a shelly plate (*clausium*).

(8) *Carocolla* sp.

1317[9]. Two small Chrysalis-snails (*Cylindrella*). Fam. *Pupidæ.*

---

* A Monograph of the British species of this group, with beautiful drawings, by Alder and Hancock, has been published by the Ray Society.

1317[10]. Two small species of *Bulimus*. Fam. *Helicidæ*.

1317[15]. Five shells of *Helix aspersa*, cut open to show the whorls and columella.

1317[20]. Monstrous shell of a Double Snail.

1318. Model of *Helix pomatia* in plaster of Paris.

Externally are shown the dextral and somewhat depressed shell, the head with its four tentacles, of which the two upper bear the eyes, the genital orifice on the R. side of the neck, the large pulmonary opening also on the R. side but further back, with the apertures of the rectum and duct of the excreting organ, which is probably a kidney in function, and corresponds to the organ of Bojanus in Lamellibranchiata, but was named by Cuvier, as here marked, "La glande de la viscosité." Above this is seen the "collar" of the mantle which secretes the edge of the shell, and below the flat ventral "foot."

On removing the shell, the liver, pulmonary chamber and two-chambered systemic heart are displayed. Taking off the piece covering the dorsal surface of the body, brings to view the œsophagus and genital apparatus. By removing the heart and lungs, and then the liver, the rest of the alimentary canal, with the crop, stomach and convolutions of the intestine, together with the ovary and testis, are successively brought into view.

The œsophagus and genital organs should next be taken out, and the odontophore and sac of the dart be examined.

Lastly, the right upper tentacle opens to show the optic nerve, and the ganglia, pedal muscles attached to the columella of the shell, &c., are now fully exposed.

1319. Shell of *Pythia scarabæus*. South-Sea Islands.

Notice its carinate form and toothed aperture. This species belongs to the family *Auriculidæ*, and, though a land-snail, has only two tentacles.

1320. Common fresh-water Snail (*Limnæa stagnalis*).

This animal breathes air like the rest of the order, coming to the surface in the same way as the porpoise does. It differs from *Helix* in having only two tentacles, and in the eyes not being placed at their extremities. Cf. 1318.

1320[5]. Eggs of *Limnæa*, enclosed in their gelatinous capsule.

1320[10]. *Planorbis corneus*.

1320[15]. Shells of *Limnæa* and *Planorbis*.

Both are found in fresh water, and in both the turn of the shell is dextral, but the whorls of *Planorbis* are in a single plane, making the shell depressed, those of *Limnæa* are drawn out at right angles to their direction, making the columella long and the shape of the shell acuminate.

GASTEROPODA.

1321. Three shells belonging to the family *Cyclostomidæ*. W. Indies.

The lower one is *Choanopoma fimbriatum*, the middle *Cyclotus corrugatus* with a spiral shelly operculum, and the upper *Helicina*.

1321^5. Five shells of the genus *Cyclostoma*.

The two upper belong to the only British species (*C. elegans*), and one of them shows its horny operculum.

1322. Digestive system of common Slug (*Limax ater*).

The straight alimentary canal is shown, and large bilaterally symmetrical, lobulated liver.

1323. Liver of Slug, dissected out separately.

1324. Nervous and generative systems of Slug, dissected from the dorsal surface.

The blue rod is in the œsophagus, and so passes through the nervous collar which surrounds it. The ganglion seen above the blue rod is the supra-œsophageal, or so-called cerebral, from which a commissure is seen passing to the large sub-œsophageal ganglion, which completes the collar. From this various nerves are seen passing off to the foot (pedal), mantle, and viscera (parieto-splanchnic). On the opposite side of the preparation is seen the flat ventral surface of the foot, the mouth anterior, and the small generative orifice on the right side of the neck, near the pulmonary opening. The large convoluted tube is the oviduct, at the beginning of which is seen the lobulated ovary, and near its end the slender whip-like penis.

1324^5. Another specimen.

The probe is passed into the mouth, and the nervous collar, with its ganglia and efferent nerves, is well seen.

1325. The hermaphrodite genital organs of Slug, dissected out.

In the upper part of the preparation the dark spiral body is the ovary; to the right of it, the testis with its duct; below it, the first stomach, to the right of which is the convoluted oviduct. Lower down are seen the long secreting tubes of the male apparatus and the brush-like tuft of accessory glands.

Compare these preparations (1322—1325) with the plate Rolleston's Forms of Animal Life and its description.

Prosobranchiata siphonostomata.

1326. Wing shell (*Pterocera*s). Fam. *Strombidæ*. India.

1326^5. Shell of *Rostellaria*. Indian Ocean.

Notice the notch in the edge of the aperture, showing where the siphon passed out from the branchial chamber. Also that the whorls turn from the apex outwards in the same direction as the hands of a watch. This dextral twist is the common. Cf. 1326^{40}.

GASTEROPODA.

1326^{10}. Conch-shell (*Triton variegatus.* Fam. *Muricidæ.*
Tropical seas.

1326^{20}. Two shells of genus Murex (*M. saxatilis* and *M. erinaceus*).

1326^{25}. Spiny Woodcock, shell of *Murex tenuispina.* Moluccas.

1326^{35}. Spindle-shell (*Fusus colus*). India.

1326^{40}. Sinistral fossil Spindle-shell (*Fusus antiquus*, var. *contrarius*), from the Red Crag of Norfolk.

Notice that the whorl of the shell, from the apex outwards, goes in the opposite way to that of the hands of a watch. This is called a lefthanded twist, and occurs normally in some genera, and as an abnormality in others.

1327. Tun-shell (*Dolium*). Fam. *Buccinidæ.* India, &c.

1327^{5}. Another species (*D. cassidiforme*).

1327^{15}. Red helmet shell, *Cassis rufa.* West Indies.

1327^{25}. Shell of *Cassis testiculis.*

1327^{30}. Animal of *Harpa ventricosa.* Mauritius.

The apex of the coiled abdominal mass which filled the first whorl of the spire is formed by the liver. A little lower down is seen the testis, and then the great branchial chamber which occupied the last formed and largest "body whorl." This has been divided and thrown back to display the pectinated gills characteristic of the Prosobranchiate Gasteropoda. Notice also the foot with its extra lobe, the siphon characteristic of this group (Siphonostomata), and the small head with its proboscis exserted and two tentacles with eyes placed half-way up them.

1327^{35}. Shell of *Harpa.*

1327^{40}. Shells of genus *Oliva.* Sub-tropical seas.

1327^{45}. Castor-oil shells (*Sistrum* v. *Ricinula arachnoides*). Philippines.

1327^{50}. Female Whelk (*Buccinum undatum* ♀), dissected.

The foot is on a gutta-percha support. The large blue rod is placed in the mouth, between the two tentacles with their basal eyes. The branchial chamber is distended with wool, and a small glass rod is placed in the siphon by which the water is returned from it. The first whorl of the shell, which protects the branchial cavity, has been removed.

See Huxley: Introd., fig. 15.

1327^{55}. Male Whelk (*Buccinum undatum* ♂), dissected.

The foot, with its horny posterior operculum is uppermost. The proboscis is extended from the mouth, and part of the first whorl of the shell has been removed to show the large curved penis.

GASTEROPODA.

1327[60]. Shell of Whelk (*Buccinum*).

Siphonostomatous and dextral.

1327[65]. Whelk's eggs on an Oyster shell.

1328. Shell of Mitre (*Mitra episcopalis*). Fam. *Volutidæ*. Pacific.

1328[10]. Siphonostomatous shell, from the Mediterranean, near Gibraltar (*Cymba* sp).

1328[15]. Shell of Leopard Cowrie (*Cypræa exanthema*). India.

This large and wide-spread family is characterised by the edges of the mantle turning up over the last whorl of the shell and secreting a very hard calcareous material, which gradually encases the whole shell in a smooth, uniform, adventitious covering, leaving only a narrow longitudinal slit, with the siphonal opening at one end and a slight indication of the apex at the other.

1328[16]. Another specimen at an earlier stage.

The apex and whorl are still distinct.

1328[17]. Shells of Children's Cowrie (*Cypræa Childreni*).

Notice the dorsal line which marks where the two lateral lobes of the mantle meet.

1328[18]. Mole Cowrie (*C. talpa*); a young and an adult specimen.

1328[20]. Money Cowrie (*Aricia moneta*). Indian Ocean.

1328[25]. The pimpled Pig-cowrie (*Trivia pustulata*). Pacific.

The name, *Porcelli*, given in Italy to the cowries from their supposed resemblance to pigs, has led to the term porcellaneous, applied to the peculiarly hard shell of this family, and hence to the earthenware of China.

1328[35]. Shell of *Conus*. Fam. *Conidæ*. Tropical seas.

Prosobranchiata holostomata.

1329. Top shells (*Trochus* sp). Fam. *Turbinidæ*.

Notice that the aperture of the shell is entire, showing that the animal had no siphon, also that the columella is perforated at its base. Most of these Holostomatous gastropods are vegetable feeders.

1329[10]. Shell of Turbo (*Meleagris pica*).

1329[15]. Shell of *Nerita Rumphii*. Philippine Islands.

1329[20]. Shells of *Natica monilifera*. Fam. *Naticidæ*.

Notice the perforate columella. This genus is carnivorous.

1329[25]. Common Periwinkle (*Litorina vulgaris*).

1329[28]. Dial-shell (*Solarium*). Fam. *Litorinidæ.* Indian Seas.

1329[30]. Royal Staircase Wentletrap (*Scalaria pretiosa*). Fam. *Turritellidæ.* Indian Seas.

1329[34]. Shell of Worm-shell (*Vermetus*).

Notice that the whorls do not come in contact, so that there is no columella formed.

1329[35]. Part of gigantic Worm-shell (*Siphonium*).

1329[40]. Steeple-shells (*Turritella*).

1329[45, 50.] Two *Cerithiadæ* (*C. asper* and *C. tuberosum*).

1330. Venus's Ear. Shells of *Haliotis tuberculata.*

The outer surface of the largest is covered by *Spirorbis* (Annulata) and *Membranacea* (Bryozoa), and perforated by boring Annelids.

1330[5]. Violet Ocean Snail (*Ianthina communis*). Fam. *Haliotidæ.*

These mollusks swim in fleets on the surface of the Atlantic by means of floats of air bubbles which each constructs with the mucus secreted by its foot.

1330[10]. Animal of *Ianthina* removed from the shell.

Notice the small dark-coloured foot, large proboscis, two tentacles, branchial chamber, collar and spiral liver.

1330[20]. Duck's-bill Limpet (*Parmophorus unguis*). *Fissurellidæ.*

The mantle has been divided to display the pectinate gills. The liver, ovary, &c., are also shown.

1330[40]. The Common Limpet (*Patella vulgaris*). Fam. *Patellidæ* v. *Cyclobranchiata.*

The foot is seen occupying the middle of the opening of the shell. Above it is the mouth and two tentacles, and surrounding the whole the branchial fringe from which the family takes its name of Cyclobranchiata.

1330[45]. Bonnet-shell (*Pileopsis hungarica*). Fam. *Calyptræidæ.*

1330[50]. *Chiton* sp. Fam. *Chitonidæ.*

The mouth, above the broad foot, and the terminal anus are seen in front, with the edges of the semicircle of gills. Behind appear the eight dorsal plates which form its multivalve shell.

Opisthobranchiata tectibranchiata. Gills behind heart, and covered by the mantle or by a small shell. Hermaphrodite.

1331. Shell of *Bulla.*

This is simply rolled on itself, with no spire or columella.

1332. Sea Hare (*Aplysia*), dissected.

Notice the lateral folds of the mantle, one of which has been removed to show the arborescent branchia, covered by the small thin shell.

A white rod has been placed in the mouth and a blue one in the vent. The trivial name is taken from the four earlike tentacles on the head, and the arched back.

1332^{5}. Horny shell from branchial cavity of 1332.

1332^{10}. A smaller specimen (*A. punctata*).

Opisthobranchiata nudibranchiata. Gills, posterior, consisting of uncovered processes of the mantle on the back or round the vent. Adult without shell. Hermaphrodite.

1333. Sea slug (*Doris* sp), dissected from the dorsal surface.

Notice the fringe of vascular processes which serve as gills, arranged in a circle round the anus, which is marked by a blue rod,

1333^{5}. Another species in median longitudinal section.

The mouth with the odontophore, the heart, liver and gills are seen; also the broad lateral processes of the mantle.

1333^{10}. Tongue of *Doris* (from 1333) ; microscopical preparation.

This odontophore, or dentiferous strap, is provided with three rows of teeth, of which the central are small, the lateral hooked.

1333^{15}. Sea-lemon (*Doris tuberculata*).

Notice the two tentacles which can be retracted into the sheaths at their base ; the warty mantle with small lateral lobes and the branchial fringe. The mouth is marked by a white, the vent by a blue rod.

1334. *Eolis.*

Here the gills consist of numerous fringe-like processes over the whole of the dorsal surface of the mantle, which has no folds.

Class LAMELLIBRANCHIATA.

Syn.—This class, so-called by De Blainville, corresponds to the *Conchifera* of Lamarck, and the *Mollusca Acephala testacea* of Cuvier.

Chars.—The mantle forms two Right and Left, bilaterally symmetrical lobes, which grow from the dorsal (hæmal) surface and are sometimes more or less extensively united along their ventral edges. These secrete a corresponding, bilateral, hinged, usually symmetrical, bivalve shell.

In most a foot is developed in the middle line of the central surface, and in some species this secretes byssus.

There is no head or masticating apparatus, but often palpi at the entrance to the gullet, which opens into a stomach and convoluted proctuchous intestine, with a primary hæmal flexure.

There is a systemic heart, with two auricles, and one (or two) ventricles, sometimes perforated by the rectum.

There is true blood, and an incomplete (lacunar) systemic, complete (capillary) respiratory circulation. The gills are four, lamelliform and symmetrical; the inner pair larger.

There are no salivary glands, but a large follicular liver.

Two "Organs of Bojanus," excretory or "renal," are present.

Sexes usually distinct. No non-sexual propagation. Embryo free swimming, with a single ciliated velum.

Nervous collar, with Cerebral, Pedal and Parieto-Splanchnic ganglia.

The Conchifera are all inhabitants of either salt or fresh water. Though widely distributed, both in time and space, they appear to be later in development than the cephalous mollusks, and are less numerous in species than Gasteropoda.

Clas.—The class has been variously divided according to the presence and size of siphons or prolongations of the mantle lobes for respiration, the simple or sinuous pallial line, and the presence or one or two adductor muscles. The following are some of the principal families:—

Asiphonata integropalliata.	Ostreadæ v. Monomyaria	*Ostrea, Gryphaea, Spondylus, Pecten.*
	Aviculidæ	*Avicula, Malleus, Pinna, Inoceramus.*
	Mytilidæ	*Mytilus, Lithodomus.*
	Arcadæ	*Arca, Pectunculus.*
	Unionidæ v. Naiades	*Unio, Anodon* (a fresh water family).
Siphonata integropalliata.	Chamidæ	The largest species are found in this family.
	Cardiadæ	*Cardium* (Cockle).
	Cyprinidæ	*Cyprina, Isocardia.*
Siphonata sinupalliata.	Veneridæ	*Venus, Cytherea; Mactra; Tellina.*
	Solenidæ	*Solen* (razorshell).
	Myadæ	*Mya, Saxicava.*
	Pholadidæ	*Teredo, Pholas, Xylophaga.*
	Gastrochænidæ	*Gastrochæna, Aspergillum,*

1335. Shells of Tree-oyster (*Dendrostrea*), attached to a branch of mangrove. From the Gulf of Para. Presented by Mr. Longmore, Surgeon, 19th Regiment.

1335[5]. Shells of common Oyster (*Ostrea edulis*).

The apex is dorsal, the lower convex valve left, and the flat one, right. Each valve is unsymmetrical; has one muscular impression only, and a continuous but indistinct pallial line. Some are cut through to show how the shell is formed in successive laminæ, by the growth of the mantle which secretes it.

1335[10]. Shell of Oyster, with mineral part (chiefly carbonate of lime) removed by immersion in acid.

There is, as a rule, a greater proportion of animal matter in the shells of this class than of gasteropoda.

1335[15]. Oyster shell, cut to show adductor muscle.

This corresponds with the posterior one in those Conchifera which have two.

1335[20]. Oyster, dissected from the right.

Shows the single, dark brown adductor muscle on the neural or ventral side of the intestine, the double-valved mantle, and the four gills.

1335[25]. Oyster, dissected from the left.

Shows the heart with the dark auricle, and white ventricle lying in the pericardium, immediately to the left of the muscle, between it and the great dorsally (hæmally) placed liver.

1335[50]. Shells of Hammer-headed Oyster (*Malleus vulgaris*). China.

1335[60]. Shell of *Gryphæa incurva* (fossil genus), from the Lias.

1335[70]. Shell of Spiny Oyster (*Spondylus Americanus*).

1335[73]. *Plagiostoma giganteum* (fossil). From the lias of Lyme Regis.

1335[75]. Natural cast of *Inoceramus* (fossil), from the chalk.

1336. *Pinna*, dissected to show its nervous system.

The fringed gills surround the specimen. The liver is seen above, and glass rods are passed beneath the nervous filaments.

1536[5]. Nervous system of *Pinna*, dissected separately.

1336[10]. Shell of large *Pinna*.

This is the bivalve from the byssus of which gloves are spun at Naples.

1337. The common Scallop, or S. James's Cockle (*Pecten Jacobæus*), with its shell removed, and pallial lobes separated.

The dark coloured mass, corresponding with the dorsal suture of the pallial lobe, is the liver. The large adductor muscle is seen near it, the foot in the middle line, one of the large triangular palpi near it, and the grooved, feathery gills widely separated right and left.

1337[10]. Shells of *Pecten varius*.

1337[12]. Common Sea-mussel (*Mytilus edulis*), with the left valve of the shell removed.

The umbo is below. The thick folded ventral margin of the right mantle-lobe is seen to the right of the observer, and within it the lamelliform gills. Above is the posterior adductor muscle with the rectum ending by passing along its dorsal (here left) side. The brown fleshy organ pointing downwards, or towards the umbo of the shell, is the foot; and at its base are seen the black threads of byssus secreted there. The liver has been incised to show the course of the rectum.

1337[13]. Another specimen.

The right hand valve is to the observer's left and *vice versâ*. The foot with its byssus is in the middle line, pointing forwards and downwards; the anterior adductor muscle, just within the apex of the shell, has been broken off; the right and left mantle-lobes and gills, and the posterior adductor muscle at the back of the preparation are well displayed.

LAMELLIBRANCHIATA.

1337^{15}. Fresh-water Mussel (*Anodonta cygnea*).

The left valve of the shell, except the parts attached to the anterior and posterior adductor muscles, and the left lobe of the mantle have been removed. A white rod indicates the mouth and a blue one the vent. Under the mouth is the triangular median foot, pointing forwards, and immediately above its base is the liver and ovary. The lamellar gills and R. lobe of the mantle are also seen.

Cf. Rolleston: pl. v., pp. 54—66, 193—198.

1337^{16}. Pearl-Mussel (*Unio margaritiferus*).

The right valve of the shell and mantle have been removed, Beside the parts shown in the last preparation, notice the ganglia marked by black bristles, the heart marked by a red one, and the two large siphons.

Cf. Huxley: Introduction, figs. 13, 14.

1337^{17}. Shell of Unio.

Notice the thick epidermis, and the two hinge-teeth which distinguish this genus from *Anodon*.

1337^{18}. Shell of *Arca Noæ*.

1337^{19}. Two fossil shells of *Pectunculus*, from the Red Crag.

The hinge, as in *Arca*, is long, with numerous equal teeth.

1337^{20}. Fossil shell of *Trigonia*, from the chalk. Fam. *Trigoniadæ*.

1337^{25}. Bear's-claw Clam (*Hippopus maculatus*). Fam. *Tridacnidæ*. Indian Ocean.

1337^{26}. *Fragum Guichardi*. Fam. *Cardiadæ*. New Caledonia.

1337^{27}. Shell of common Cockle (*Cardium edule*).

Hold it with the hinge upward, the brown dried ligament towards you. Then the ventral edge is below, the dorsal or hæmal side uppermost, the posterior edge proximal, and the anterior distal. The "umbo" is the boss on the apex of each valve, the "lunule". the curved space in front of this. Notice inside the pallial impression made by the edge of the mantle (M), and the anterior and posterior muscular impressions.

1337^{28}. Fossil Shell of the same species from the crag.

1337^{30}. *Cyprina Islandica*. Fam. *Cyprinidæ*.

1337^{33}. Small shells belonging to the genus *Cyprina*.

1337^{35}. *Tapes decussata*. Family *Veneridæ*. Mediterranean.

This group is by far the largest amongst conchifera.

1337[36]. *Venus reticulata.* Torres Straits.

1337[37]. *Dione Hagenoui.* Red Sea.

Comparing this with 1337[27], it will be seen that the pallial line is not uniform between the two adductor impressions (*integropallial*), but is interrupted by a curved indentation (*sinupallial*) made by the muscles which retract the siphon. Also compare the hinge-teeth with 1337[19] and 1337[40].

1337[38]. Otter-shell (*Lutraria elyptica*). Fam. *Mactridæ.*

1337[40]. Fossil shell (*Tellina obliqua*), from the Red Crag. Fam. *Tellinidæ.*

The shells of this family much resemble those of *Veneridæ*, but the hinge teeth are fewer.

1337[43]. Rosy tellina (*T. radiata*).

1337[45]. Razor shells (*Solen*). Fam. *Solenidæ.*

These are burrowing animals with a large foot and short siphons. The hinge of the shell is external and its teeth few.

1337[50]. Wood from Lowestoft Harbour, with burrows of the Ship-worm or Pile-borer (*Teredo navalis*). Fam. *Pholadidæ.*

The boring is not accomplished by any chemical secretion, nor by the shell, but by the action of the foot.

1337[55]. Shell of Piddock (*Pholas dactylus*).

Equivalve, inequilateral, gaping, very hard and brittle, without hinge or ligament. There are three accessory calcifications dorsally, between the valves, which led Linnæus to class *Pholas* as a multivalve. The animal burrows into chalk, or much harder rocks, by help of its shell.

1337[60]. Watering-pot Shell (*Aspergillum*). Fam. *Gastrochænidæ.*

The small, equilateral shell is in the adult wide open, and the long siphons are so overgrown with calcareous deposit, that the umbones alone are visible. At the distal end of the siphonal tube, which projects beyond the mud in which the animal burrows, is seen a perforated disk, through which the water passes in and out.

Class BRACHIOPODA.

Nomenclature.—This class has also been named Palliobranchiata. Its present name (which was also the original one) should properly be written "Brachionopoda." It and the two classes which follow are sometimes united with the Mollusca proper, sometimes classed together as Molluscoida, and sometimes separated, Brachiopoda being retained as a Molluscous class, and Tunicata and Bryozoa put among "Vermes."

Chars.—Marine animals, with a bivalve, dorsi-ventral, shell, and long, curled, ciliated arms.

Alimentary canal sometimes aproctous; its first flexure neural.

A single true heart with one cavity. No complete system of blood vessels.

No branchia present. Respiration probably effected by means of an "atrial" vascular system with contractile pseudo-hearts.

Nervous system, a single pair of ganglia on the œsophagus, with, in some cases, additional smaller ones.

Sexes mostly distinct; reproduction only by true oviparous generation.

Affinities.—The Brachiopoda were classed with the other Mollusca by Cuvier, but their resemblance to Lamellibranchiata is chiefly external. Beside the valves being dorsal and ventral instead of lateral, they differ in microscopic structure, and in most genera are perforated by a series of tubes not found in the preceding class. The nervous, respiratory, and circulatory systems are also very different from the true Molluscan type.

The existing members of the class are a mere remnant of a far larger assemblage, which can be traced from early palæozoic periods. They were most abundant in Silurian and Devonian periods, and have diminished from that time.

Lit. Owen: Tr. Zool. Soc., 1835. Huxley: Ann. Nat. Hist., 1854. Albany Hancock: Phil. Trans., 1858. Lacaze Duthiers: Ann. des Sc. Nat., 1861. Davidson: Monograph of British fossil Brachiopoda, 1853.

BRACHIOPODA.

Classification.—The genera *Terebratula, Waldheimia, Rhynchonella*, with the fossil genera *Producta* and *Spirifer*, have hinged Shells—Articulata; *Lingula, Crania,* and *Discina* have no hinge—Inarticulata.

1338. Nail-shell (*Lingula anatina*).

It has no elastic ligament like Lamellibranchiata, and no perforation or "coach-spring" skeleton as in Terebratula. The valves are equal and each is symmetrical.

1338[5]. Lingula dissected.

Above is the strap or "tongue" by which it attaches itself. In the posterior valve are seen the shining muscles, the lobular liver and visceral mass enclosed in one fold of the mantle, which considerably overlaps them and reaches to the edge of the shell. The two thick tortuous arms project on each side.

Cf. Rymer Jones, fig. 170.

1338[10]. Lamp-shell (*Terebratella caput-serpentis*). Corsica.

The dorsal (anterior) valve is thrown forward, and shows the dried arms of the animal within.

1338[12]. *Terebratula vitrea.* Naples.

The peduncle is attached to the fragment of another shell. The dorsal valve is removed to show the animal within.

1338[15]. *Waldheimia australis.* Torres Straits.

The posterior or ventral valve is attached, and has the characteristic perforation through which the muscular peduncle passes. The anterior or dorsal one is thrown forward, and shows the calcareous framework ("coach-spring" apparatus) which supports the adductor muscles. These muscles are much more complicated than those of Lamellibranchiata. The valves are equilateral but not equivalve, the beaked and perforated ventral one being the larger.

Cf. Rymer Jones, fig. 171, and Hancock's fig. in Huxley's "Introduction," p. 28.

1338[20]. Fossil Brachiopod shells *Spirifera Walcotii* from the Lias, and *S. bisulcata* from the Carboniferous Limestone.

Class TUNICATA.

Syn.—Also called Ascidioidea. They are the Tethya of Aristotle, the Mollusca acephala nuda of Cuvier.

Chars.—Marine animals; some free-swimming, most sessile; single, social, or compound.

Distinct, proctuchous, freely suspended alimentary canal. Large perforated pharynx. Oral tentacles.

No shell, but a thick external "test," or tunic, containing cellulose. Within this a muscular sac, and within this again the enormous pharynx.

Heart, when present, simple and tubular, without vascular system. Respiration by the perforated pharynx.

A single ganglion, placed so as to make the first turn of the intestine hæmal.

Usually monœcious. Reproduction by gemmation as well as ovulation. "Alternation of generations." Larvæ usually free, with a tail like a tadpole.

Affin.—The natural affinities of this class are still disputed. They have many points of resemblance to the Lamellibranchiata and more important ones to the Bryozoa. But some eminent naturalists have separated them from the Molluscous series, to unite them with Annelida and some other groups, under the vague term Vermes. Again, the resemblance between them and *Amphioxus* (noticed long ago by Goodsir), and the still more wonderful likeness of their larvæ to the vertebrate type discovered by Kowalewsky and confirmed by Kupffer, seem to show a true genetic connection between them and the lower Vertebrata. Hence they have been styled "Urwirbelthiere." On this subject information will be found in the systematic works of Gegenbaur, Hæckel, Rolleston, Oscar Schmidt and Allman. On other points read Huxley on *Salpa* and *Pyrosoma*, Phil. Trans., 1851, and the preface to Allman's Fresh-water Polyzoa (Ray Soc., 1856).

1339. Social ascidians. Fam. *Clavellinidæ.*

1340. *Salpa.* Oceanic.

A blue rod has been passed through the great pharynx or branchial cavity. At the posterior (lower) end is seen the opaque "nucleus" consisting of the stomach, liver, &c. The atrial exhalant orifice is terminal, not near the oral one as in sessile ascidians. Cf. 1340^{55}.

1340^{10}. Another specimen, showing the transverse bands of muscle, and the nucleus near the pointed posterior extremity. Presented by Mr. H. Goadby.

1340^{50}. *Pyrosoma*, a compound oceanic ascidian, strongly luminous. Atlantic and Mediterranean.

Each of the granulations with which it is covered is a separate individual, but their atrial openings all communicate with the common cavity of the colony.

On the luminous organs of Pyrosoma, see Quart. Journal of Microsc. Sc., 1873.

1340^{55}. The cellulose tunic of *Phallusia*, a simple sessile ascidian. Presented by Dr. Shepherd.

A blue rod is placed in the oral or branchial, a white in the atrial or anal orifice. This outer tunic or test was believed by Cuvier to be the homologue of the calcareous shell of the higher mollusks.

1340^{60}. The muscular tunic or mantle of the same specimen.

1340^{65}. A sessile Ascidian with the external tunic removed to show the mantle. Attached to it is a sessile cirriped.

1340^{70}. *Boltenia reniformis*, a pedunculated simple ascidian. From the East Coast of North America.

The thick outer test has been divided to show the muscular tunic within (best seen from behind), which again has been divided in front to show the viscera. The upper orifice (in which a white rod is placed), is the oral, the lower (blue), the atrial aperture.

Class POLYZOA.

Nomenclature.—So called by Thompson, who first showed their distinction from polyps;* named by Ehrenberg Bryozoa (βρύον, moss, lichen), from their habit of covering seaweeds; by Dr. Arthur Farre, Ciliobranchiate Polyps. They were included by Cuvier in his class Polypi, but separated from them and united with Mollusca by Milne Edwards.

Characters.—Aquatic, microscopic, compound animals, inhabiting both salt and fresh water.

Distinct alimentary canal, proctuchous, freely suspended and separate from body cavity, curved on itself with concavity toward ganglian.

No specialized circulatory or respiratory organs.

Ciliated tentacles around mouth, on a disc either circular or shaped like a horse-shoe. A single ganglion between mouth and anus.

Usually monœcious. Reproduction sexual and by gemmation.

Affinities.—The Bryozoa have only a superficial resemblance to true polyps. After they were separated by Thompson and Ehrenberg from the "Radiate mob," their affinity with the lower molluscous classes was shown by Milne Edwards. This essential morphological agreement with Brachiopoda and Tunicata has been worked out by Professor Allman, and it is closer with the former than the latter. But while Brachiopoda are at present left in the Molluscous series, Bryozoa have, like Tunicata and on still more slender grounds, been transferred by several naturalists of eminence to the revived mob of Vermes.

---

* Busk: Annals of Natural History, 1852.

Distr. — The freshwater Bryozoa appear to be confined to temperate climates; the marine genera are widely distributed.

Nor are any fossil freshwater species known, while the marine forms are very numerous, from the Silurian strata to the chalk, and on to the present time.

Allman: Freshwater Polyzoa, with coloured plates, published by the Ray Soc., 1856.

1341. Common Sea Mat (*Flustra foliacea*).

Each of the depressions scattered over the surface is the cell of a Polyzoon.

The upper specimen has *Cellularia reptans* (another Bryozoon) parasitic on it.

To the right of the preparation, above, is a smaller specimen of the same genus (*F. papyracea*).

1341[5]. Above, three pieces of the polypary of *Salicornaria farciminoides;* below, two of the stony polypary of *Eschara foliacea*.

Both were dredged on the north coast of Devon. When living Eschara is of a beautiful orange colour.

1341[10]. Dried skeleton of *Bugula avicularia*.

The specific name refers to the presence of bird's-head organs, probably extremely modified individuals, which are found scattered over the polypary of this and other Bryozoa.

Right and left are placed for comparison two specimens of white "coralline," a vegetable organism often growing with Bryozoa and Hydrozoa.

1341[15]. Decalcified polypary of *Crisia eburnea*. Microscopical preparation.

1341[20]. Fragment of upper Ludlow Rock, showing numerous fossil Bryozoa, with Encrinites, Bivalves, Sponges, &c.

SUB-KINGDOM ARTHROPODA.

Char.—Complete bilateral symmetry.

Body segmented into somites, which repeat each other serially more perfectly than vertebral segments, and are provided with hollow jointed limbs (whence the name), moved by internally attached, striated muscles.

Nervous system a series of double ganglia for each somite, united by commissures, abdominal.

Mouth ventral, and furnished with lateral jaws. The pharynx passes through the first loop of the nervous chain.

No cilia developed in the embryo or adult.

True corpusculated colourless blood, contained in a systemic contractile vessel or cavity, situated on the dorsal surface.

Special respiratory organs either tracheæ, air-sacs or gills.

Sexes always distinct; reproduction sexual or by parthenogenesis, never by fission or gemmation.

Embryo preceded by a primitive streak, and developed with the dorsal surface toward the yelk. This dorsal or internal surface therefore is the haemal or "mucous" layer (*hypoblast*), and is preceded in development by the external "serous layer" (*epiblast*), from which the abdominal gangliated nervous chord is formed.

This subkingdom includes three classes fitted to live in air, and one (Crustacea) in water. They were each defined by Cuvier, and placed by him with the ringed worms and some other groups, under the general head, "Annulosa."

The following table is intended to show the more probable homologies between the limbs of the four Arthropod classes, represented by the Lobster, the Stagbeetle and larva of the Death's-head Moth, the Scorpion, and the Centipede, respectively. Cf. Rolleston, loc. cit. p. 116, and Gerstäcker (Bronn's Thierreich, vol. v. p. 48.)

		HOMARUS ♂	LUCANUS.	ACHERONTIA (LARVA).	SCORPIO.	SCOLOPENDRA.
Cephalic Somites.	I.	Eye stalk	No limbs	No limbs	No limbs	No limbs.
	II.	Antennula (chelate in *Limulus*)	Absent	Antenna	Absent	Antenna.
	III.	Antenna (chelate in *Limulus*)	Antenna	Absent	Chelicera	Absent.
	IV.	Mandibula	Mandibula	Mandibula	Chela	Mandibula.
	V.	Maxilla i	Maxilla	Spinning jaws	Pes i	Absent?
	VI.	Maxilla ii	Labium	Spinneret	Pes ii	Labium.
Thoracic Somites.	VII.	Maxillipes i	Pes i.	Pes i (Spiraculum)	Pes iii	Maxillipes i.
	VIII.	Maxillipes ii (with gill)	Pes ii. Ala i	Pes ii	Pes iv	Maxillipes ii. (poison fang).
	IX.	Maxillipes iii (with gill)	Pes iii. Ala ii	Pes iii	No limbs (genital pores)	Absent.
Abdominal Somites.	X.	Pes i (Chela) (with gill)	No limbs (Spiraculum)	No limbs (Spiraculum)	No limbs (Pecten)	Pes i.
	XI.	Pes ii (with gill)	Do. (Spiraculum)	No limbs (Spiraculum)	No limbs (Spiraculum)	Pes ii.
	XII.	Pes iii (with gill)	Do. (Spiraculum)	Pes spurius i (Spiraculum)	No limbs (2nd do.)	Pes iii.
	XIII.	Pes iv (with gill)	Do. (Spiraculum)	Pes spurius ii (Spiraculum)	No limbs (3rd do.)	Pes iv.
	XIV.	Pes v (with gill)	Do. (Spiraculum)	Pes spurius iii (Spiraculum)	No limbs (4th do.)	Pes v.
Postabdominal Somites.	XV.	Penis (filiform in ♀)	Do. (Spiraculum)	Pes spurius iv (Spiraculum)	No limbs (1st caudal)	Pes vi.
	XVI.	Pes abd. ii.	Do. (Spiraculum)	No limbs (Spiraculum)	No limbs (2nd caudal)	Pes vii.
	XVII.	Pes abd. iii.	Do. (Spiraculum)	No limbs (Spirac.) dorsal horn	No limbs (3rd caudal)	Pes viii.
	XVIII.	Pes abd. iv.	Do. (Spiraculum)	Pes spurius v.	No limbs (4th caudal)	Pes ix.
	XIX.	Pes abd. v.	Do. (often fused)	....	No limbs (5th caudal)	Pes x.
	XX.	Pes natatorius	Do. (usually fused)	....	No limbs (6th caudal)	Pes xi.
		Telson	(Aculeus in Hymenoptera)	....	Telson	&c.

Class INSECTA.

This enormous class, equal both in species and individuals to all the rest of the Animal Kingdom together, was recognised by Aristotle under the same name (ἔντομα). From the Insecta of Linnæus have since been separated the classes Myriopoda and Arachnida.

Syn.—Hexapoda.

Char.—Arthropod, annulose animals, with six feet. The exoskeleton is always chitinous.

The Head probably contains six somites.* It often carries a wreath of simple eyes (*stemmata* or *ocelli*), and always two compound eyes, with hexagonal facets. Also a single pair of jointed *antennæ*, a pair of *mandibles*, a single pair of *maxillæ* with palpi, a *labium* consisting of a second conjoined pair of maxillæ (*mentum*) with labial palpi, and a *ligula* or tongue.

The Thorax contains three somites, each bearing a jointed pair of legs, with *coxa*, *trochanter*, *femur*, *tibia*, and a *tarsus* of six or fewer joints. The two posterior thoracic somites (*meso-* and *meta-thorax*) each carry a pair of wings in addition, of which, however, one or both may be suppressed.

The Abdomen has usually nine somites, not consolidated. There are typically eleven, and less than nine may be developed. The abdomen of insects corresponds to the abdominal part of the cephalo-thorax with the post-abdomen, in Crustacea. It never has any limbs, though a sting (*aculeus*), ovipositor, &c., may be developed as an azygos appendage.

All Insects are proctuchous, and the anus is terminal. Digestive glands are very slightly developed.

The dorsal heart is multilocular; the circulation is incomplete.

Respiration is by ramifying tracheal tubes, which open by *stigmata* or *spiracles*.

The nervous system is like that of Myriopoda (v. infra, 1386[5]) in the larva, but is more consolidated in the Imago.

---

* If so, the total number will be twenty; cf. Huxley: Linn. Trans. vol. xxii., 1858.

The sexes are always distinct. Parthenogenesis occurs in some families for several generations. The embryo, after leaving the egg, passes through a series of moults, and in most insects undergoes "metamorphosis" through the stages of grub or caterpillar (*larva*), chrysalis (*pupa* or *nymph*), and perfect, winged reproductive form (*imago*).

Lit.—Insectorum Theatrum (by Mouffet, after by Wotton and Gesner: published by Mayerne in 1634). Swammerdam: Hist. Insectorum generalis (1669). Réaumur: Mem. pour servir à l'hist. des Insectes (1734). Kirby and Spence: Introd. to Entomology (1819). *Westwood: Intr. to the Modern Classification of Insects* (1840). Latreille, Hist. nat. des Insectes (1802). Burmeister, Hdbh. d. Entomologie (1832).

Class.—Insects have been divided into the following Orders:—

(M signifies complete metamorphosis; ½ M incomplete, and O only moults).

Mandibulata.	*Haustellata.*
Coleoptera (beetles) M.	Lepidoptera (butterflies) M.
Hymenoptera (bees and ants) M.	Diptera (flies) M.
Strepsiptera *v.* Rhipiptera (*Stylops*) M.	Suctoria *v.* Aphaniptera (fleas) M.
Orthoptera (locusts, &c.) ½ M.	Hemiptera (bugs, &c.), ½ M.
Dermatoptera (earwigs) ½ M.	Parasitica (lice) O.
Neuroptera,* M.	Mallophaga (bird-lice) O.
Trichoptera (Caddis flies) M.	
Pseudoneuroptera,† ½ M.	
Physopoda (*Thrips*) O.	

Collembola (*Podura*) O.
Thysanura (springtails). O.

Geographical Distribution.—Insects are very rare in the Arctic Regions, and only attain the full development of the class in the Tropics. Orthoptera and Hemiptera, in particular, are but scantily represented by their European species. The finest Lepidoptera are from South America and the East India Islands.

---

* Including only the genera *Myrmeleon, Hemerobius, Panorpa* and *Raphidia* (the Ant-lions, Lace-flies, Scorpion-flies and Camel-flies).

† Classed as Orthoptera by Huxley. They include White-ants, (*Termitidæ*), Pearl-flies (*Perlariæ*), Day or May-flies (*Ephemeridæ*) and Dragon-flies (*Libellulidæ*).

Palaeontology.—Remains of Pseudo-neuroptera have been found earlier than the Carboniferous Period, but it is in the Coal Measures that insects first appear in numbers. All these belong to the orders with unmodified, biting mouths, and one genus (*Dictyophlebia*) appears to be intermediate between the Pseudoneuroptera (Orthoptera of Huxley) and true Neuroptera. Hymenopterous remains are first found in the Jurassic strata, as are also those of Hemiptera and Diptera. Lastly, the Lepidoptera have only been as yet discovered in Tertiary rocks,* where also the Hymenoptera are most numerous.

1342. Case illustrating the relations of the chief groups of Insects according to Gegenbaur :—

1. *Libellula.* 2. *Hemerobius.* 3. *Panorpa.* 4. *Mantis.* 5. *Gryllus.* 6. *Certobrachylus.* 7. *Lucanus.* 8. *Vespa.* 9. *Cicada.* 10. *Syrphia.* 11. *Papilio.*

The *Libellulidæ* and other Pseudoneuroptera, with four equal wings, incomplete metamorphosis and unmodified biting maxillæ and mandibles, are the oldest insects known, and probably come nearest (especially the larvæ, with trachæal gills, which appear to be rudimentary wings) to the original type of the class. The Neuroptera proper, represented by *Hemerobius* and *Panorpa* only differ from these by metamorphosis being complete. Nearly related to these, but with the wings differentiated, are the Orthoptera proper represented by *Gryllus* and *Mantis*, and the Coleoptera, of of which *Certobrachylus* and the common stag-beetle are examples, show the same type in their jaws and metamorphosis, but with more modified wings. The Hymenoptera, represented by *Vespa magnifica*, form the highest and most perfect group of this type of Insects.

Of the remaining Insects, which form a parallel series, the simplest and probably the oldest forms belong to the order Hemiptera, represented by the *Cicada*, in which metamorphosis

---

* Since this was written, Mr. Charlesworth has discovered the impression of a Butterfly's wing (Brassolina) in the Lower Oolite limestone of Oxfordshire.

is incomplete. With essentially similar mouths, but only one pair of wings and complete metamorphosis, the Diptera, of which the large fly belonging to the genus *Syrphia* is a type, come next in this series, which is completed by the butterflies, with complete metamorphosis, greatly modified mouth, and wings covered with peculiar scales.

Many insects show retrograde metaphormosis from a parasitic habit. It is in this way probably that the "Suctoria" are related to Diptera, Pediculi to Hemiptera, and possibly Strepsiptera to Coleoptera.

On the Classification and Metamorphoses of Insects, see Sir John Lubbock's papers in "Nature," Apr. 10, 1873, et seqq., since reprinted separately.

Order Coleoptera.

Chars.—Mandibles and maxillæ masticatory. Four wings: anterior hard (*elytra*, shards), posterior, membranous and folded. Metamorphosis complete.

Class.—The chief families of this, by far the most extensive order of Insects may be thus arranged:—

i. Sub-order *Pentamera*.*
- Geodephaga .... *Cicindela, Carabus.*
- Hydrocanthari .... *Dytiscus, Gyrinus.*
- Palpicornes .... *Heterocerus.*
- Necrophaga .... *Silpha, Necrophorus.*
- Brachyelytra .... *Staphylinus.*
- Clavicornes............ *Hister.*
- Lamellicornes .... *Lucanus, Geotrupes, Aphrodisia, Dynastes, Melolontha, Cetonia.*
- Serricornes .... *Buprestis, Elater, Lampyris.*

ii. *Heteromera* .... *Meloe, Tenebrio, Blaps.*

iii. *Tetramera.*
- Rhynchophora .... *Curculio.*
- Longicornes .... *Cerambyx.*
- Phytophaga .... *Chrysomela.*

iv. *Trimera* .... *Coccinella.*

* Referring to the number of joints in the tarsus.

COLEOPTERA.

1342[5]. Case of British species of Coleoptera.

It contains the following Pentamerous genera; *Cicindela campestris* (the green sand-beetle), *Dytiscus* (water-beetles), *Carabus* (ground-beetles), *Gyrinus* (whirligigs), *Silpha*, *Dermestes*, &c. (carrion and burying beetles), *Staphylinus* (the Devil's Coachman), *Byrrhus* and *Hister*, *Lucanus cervus* (stag-beetle), *Scarabaeus* (sacred beetle), *Geotrupes* (dung-beetles), *Melolontha* (cockchafers), *Cetonia* (rose-chafers), *Elater* (fire-beetles) and *Lampyris noctiluca* (glow-worm), Also the Heteromerous genera, *Meloe* (oil-beetle), *Lytta vesicatoria* (Spanish fly), *Tenebrio* (the imago of the meal-worm), and *Blaps*; the Tetramerous genera, *Curculio* (trunk-beetles), *Cerambyx*, *Leptura*, *Cassida* (shield-beetles) and *Chrysomela*; and lastly species of the Trimerous family *Coccinellidæ* (Ladybirds).

1342[10]. Case of foreign Coleoptera, mostly from India.

1.	*Carabus* sp.	Geodephaga.
2.	*Neolucanus caladiva* ♂ and ♀.	Lamellicornes.
3.	*N. castanophorus.*	
4.	*Rhomborrhina opalina* (Cetoniidæ).	
5.	*R. apicalis.*	
6.	*Sagra* sp. (Crioceridæ).	Phytophaga.
7.	*Paralina cyanocollis.*	
8.	*P. ianthina.*	
9.	*Aspidomorpha* sp. (Cassididæ).	
10.	*Batocera v. Lamia calamus.*	Longicornes.
11.	*Taeniotis scalaris* (Brazil).	
12.	*Eurybates hariolus.*	
13.	*Certobrachylus faunus* ♂ and ♀.	Rhynchophora.
14.	*Entimus imperialis* (Brazil).	
15.	*Cyphus gibba* (Brazil).	

1343. Beetle, set out to show the arrangement of the somites and their appendages, by Mr. A. M. Turner.

Compare similar preparations of a Centipede (1386), an Arachnid (1380), and a Crustacean (1397).

1344. Case with two specimens of the Stag Beetle (*Lucanus cervus*), and three of the Rhinoceros Beetle (*Scarabæus* v. *Oryctes nasicornis*.

Both are males, and show in the mandibles and the horn secondary sexual characters.

1344^5. Stag Beetle (*Lucanus cervus* ♂), dissected from above, to show the gangliated double nervous cord passing along the middle line of the abdomen.

Notice the enormous mandibles, short pectinate or comb-like antennæ, hard anterior and large membranous posterior wings.

1344^{10}. Another specimen.

1345. Cockchafer (*Melolontha vulgaris*).

1346. Elephant-beetle (*Dynastes hercules*). Presented by Mr. W. C. Morris. West Indies.

1347. Rose-beetle (*Cetonia aurata*).

1347^5. Giant-beetle (*Goliathus cacicus*). West Africa.

1348. Green Serricorn-beetle (*Sternocera*, fam. Buprestidæ). India.

1349. Oak-beetles and ova (in spirit).

Abdominal segments distinct; elytra short.

1350. Microscopical preparation of tracheæ of *Dytiscus*.

Order Orthoptera.

Char.—Incomplete metamorphosis. Four wings: anterior pair, coriaceous; posterior, membranous. Mouth, masticatory.

Classification:—

Cursoria.	*Blattidæ* v. *Dictyoptera* (cockroaches). *Mantidæ* (praying insects). *Phasmidæ* (stick and leaf insects).
Saltatoria.	*Achetidæ* (crickets). *Gryllidæ** (grasshoppers). *Locustidæ** (locusts).
Dermatoptera†.	*Forficulidæ* (earwigs).

* These two terms are applied inversely by many entomologists (Van der Hoeven, vol. i. p. 451).

† Also named "Labidura" (Léon Dufour, Hæckel), and "Euplexoptera" (Westwood). They were put among Coleoptera by Linnæus, and made a distinct order by Leach, Kirby and Westwood. The position among Orthoptera given them by Fabricius and Latreille is accepted by Gegenbaur and Huxley.

1351. Specimens of Orthoptera (with 1342[10]).

(1) Large green Grasshopper (*Gryllus viridissimus*).

Notice the long setaceous antennæ and four-jointed tarsus.

(2, 3) Red-winged Grasshopper (*Acridium* sp.)

Antennæ short, tarsus three-jointed.

(4, 5) Blue-winged Grasshopper (*Acridium cærulescens*).

(6, 7) Small Grasshoppers.

(8, 9, 10) House Crickets (*Acheta domestica*).

(11) Small Mole Cricket (*Gryllotalpa vulgaris*).

(12) Leaf-insect (*Empusa*, sp.)

1352. Common Cockroach (*Blatta* v. *Periplaneta orientalis*).

1352[5]. The same, dissected to show the alimentary canal and nervous system.

1353. The great green Grasshopper (*Gryllus viridissimus*). Europe.

1354. Locust (*Gryllus migratorius*, sub-genus *Locusta*), short antennæ. Asia and S. Europe.

1355. Female Grasshopper.

Notice the long bivalve ovipositor and long antennæ.

1357. Mole Cricket (*Gryllotalpa vulgaris*).

1358. The praying Mantis (*Mantis religiosa*). S. Europe, &c.

The femora of the first pair of legs are compressed so as to form sharp, sabre-like weapons.

1358[10, 15]. Mantis, dissected to show the nervous system.

1359. Walking Leaf (*Phyllium siccifolium* ♀). E. India Islands.

The large-veined membranous elytra which give the name to this genus, are only developed in the female.

1360. Stick-insect (*Bacteria* v. *Phasma ferula* ♀). India.

Notice the large ovipositor. In this genus both sexes are wingless.

1361. Another specimen (dry).

Notice the rudimentary wings.

1361[10]. Two stick insects (*Bacillus*, sp.)

1361[20]. Earwig (*Forficula auricularia*).

Notice the long antennæ, short elytra, and characteristic forceps on the last abdominal segments. Tho female earwig sits upon her eggs. They do not crawl into the ear more than other insects.

Order Pseudoneuroptera.

Under this term are conveniently classed the following families of Insects, which differ from Neuroptera proper, in not undergoing true metamorphosis.

Libellulidæ (Dragon-flies).
Ephemeridæ (May-flies).
Termitidæ v. Corrodentia (White Ants).
Perlariæ.

These are probably the oldest existing Insects. Many of the larvæ breathe in water by tracheal gills, and this appears to point to the origin of wings in the entire class.

They are grouped by Huxley with the (restricted) Orthoptera (cf. "Introd. to Class," p. 121, *g.f.*), with which order they also have affinities, especially the Perlariæ.

1362. Case containing specimens of Dragon-flies (*Libellula*), and May-flies (*Ephemera*).

The imago of the May-fly has literally an ephemeral life.* The jaws are rudimentary and not used, tho only function fulfilled being that of reproduction. The larva, on the other hand, is active and predaceous, as is the nymph, and in these stages it lives two or three years in the water. Some species have only one pair of wings.

1362[5]. Dragon-fly (*Æshna* sp.).

In this family tho imago is carnivorous, as well as the larva, and tho nymph or active chrysalis.

---

* Ephemeræ larvæ natant in aquis: volatiles factæ fruuntur gaudio, uno saepe eodemque die nuptias, puerperia et exsequias celebrantes. —Linné.

1362[20]. Pregnant "White Ant" (*Termes fatalis* ♀).

The stigmata are still seen in the enormously distended abdomen, which contrasts with the minute head and thorax. It contains about 50,000 eggs. See fig. 130 in Rymer Jones, loc. cit.

1362[25]. Two specimens of wood bored by White Ants.

These destructive insects live in Africa and other tropical regions in great social communities like the true (hymenopterous) Ants. The males and females have four wings, which are deciduous. There are also sexless and blind "workers" and "soldiers," beside active larvæ and nymphs.

Order Lepidoptera.

Char.—Four membranous wings, covered with minute, coloured scales; mouth haustellate, the mandibles being abortive, and the maxillæ produced and united to form a curled proboscis; metamorphosis complete.

Class.—This extensive order, containing about 25,000 described species, may be conviently divided into—

Rhopalocera vel *Diurna*, with clubbed antennæ; the butterflies proper, which fly by day, and erect their wings when alighting; genus *Papilio* of Linnæus.

Heterocera crepuscularia, with antennæ usually fusiform; the twilight moths, most of them having a *retinaculum* for the wings; genus *Sphynx* of Linnæus.

Heterocera nocturna, with fringed antennæ; the night moths, with a retinaculum; genus *Phalaena* of Linnæus.

1363. Case of British Diurnal Lepidoptera.

1. Swallowtail (*Papilio Machaon*).
2. Woodwhite (*Pieris* v. *Leucophasia sinapis*).
3. Large Cabbage Butterfly (*Pieris brassicæ*).
4. Small Cabbage Butterfly (*Pieris* v. *Pontia rapæ*).
5. Greenstreaked White Butterfly (*P. napi*).
6. Orangetip (*Anthocharis cardamines*).
7. Brimstone Butterfly (*Gonepteryx rhamni*).

8. Clouded Yellow Butterfly (*Colias edusa*).
9. Pale-clouded Yellow Butterfly (*C. hyale*).
10. Silver-washed Fritillary (*Argynnis paphia*).
11. Dark-green Fritillary (*A. aglaia*).
12. Small Silver Fritillary (*A. Selene*).
13. Pearl-bordered Fritillary (*A. euphrosyne*).
14. A foreign Fritillary (*A. dictynna*).

1363[5]. Another case of British Butterflies.

1. Red Admiral (*Vanessa Atalanta*).
2. Painted Lady (*V. cardui*).
3. Peacock (*V. Io*).
4. Tortoiseshell (*V. polychlorus*).
5. Little Tortoiseshell (*V. urticæ*).
6. Comma (*V. c-album*).
7. White Admiral (*Limenitis Camilla* v. *Sibylla*).
8. The Marbled White Butterfly (*Argo Galatea*).
9. The Meadow Brown (*Satyrus Ianira*).
10. Large Heath or Gatekeeper (*S. Tithonus*).
11. Ringlet (*S. hyperanthus*).
12. Scotch Argus or Oxeye (*Satyrus* v. *Erebia blandina*).
13. The Wall Butterfly (*S. Megæra*).
14. Speckled Woodlet (*S. Aegeria*).
15. Grayling (*S. Semele*).
16. Small Heath (*Chortobius pamphilus*).
17. The Copper Butterfly (*Lycæna* v. *Polyommatus phlæas*).
18. Chalkhill Blue (*L. Corydon*).
19. Clifden Blue (*L. Adonis*).
20. Brown Argus (*L. agrestis* v. *Dorylas*).
21. The Azure Blue (*L. argiolus*).
22. Green Hairstreak (*Thecla rubi*).
23. The Duke of Burgundy (*Nemeobius lucina*).
24. The Grizzle (*Hesperia* v. *Syrichthus alveolus sive malvæ*).
25. Small Skipper (*Hesperia linea*).
26. Large Skipper (*H. Sylvanus*).

1363[6]. Case of crepuscular and nocturnal Lepidoptera, belonging to the families *Sphingidæ* and *Bombycidæ*.

1. Poplar Hawkmoth (*Smerinthus populi*).
2. Lime Hawkmoth (*Sm. tiliæ*).
3. Eyed Hawkmoth (*Sm. ocellatus*).
4. Death's-head Hawkmoth (*Acherontia atropos*).
5. Convolvulus Hawkmoth (*Sphinx convolvuli*).
6. Privet Hawkmoth (*Sp. ligustri*).
7. Little Vine or Elephant Hawkmoth (*Chærocampa elpenor*).
8. Humming-bird Hawkmoth (*Macroglossa stellatarum*).
9. Clearwinged Hawkmoth (*Sesia sphegiformis*).
10. Burnet Moth (*Zygæna filipendulæ*).
11. Ghost Moth (*Hepialus humuli*).
12. *H. hectus.*
13. Tiger Moth (*Arctia caja*).
14. Footman (*Arctia villosa*).
15. *Euthemonia russula.*
16. *Euchelia Jacobæa.*

1363[10]. Case of nocturnal Lepidoptera.

1. *Callimorpha dominula.*
2. *Spilosoma lubricipedum.*
3. *S. ermineum.*
4. *Orgyia pudibunda.*
5. *O. bucephala.*
6. The Puss Moth (*Bombyx* v. *Cerura, vinula*).
7. The imago of the Silkworm (*Bombyx mori*). Cf. 1365.
8. The Oak-egger Moth (*Lasiocampa quercus*).
9. The Lesser Peacock Moth (*Saturnia carpini*, ♂ and ♀).

These are all *Bombycidæ*. The remaining specimens belong to various genera of the large family or sub-order *Noctuidæ*.

1363[15]. Case of Noctuina and Geometrina.

1363[20]. Case of *Geometridæ*.

The name of the group is taken from the movement of the caterpillars, which are called Surveyors, *chenilles arpenteuses*, *Spanner*.

The names of the species of this family, which corresponds to Linné's genus *Phalæna*, were made by him to end in-*aria* when the antennæ are pectinate, in-*ata* when they are setaceous.

1363[25]. Case of Microlepidoptera, Moths belonging to the sub-orders *Tortricidæ* and *Tineidæ.*

Their species were all made to end in -*ana* and -*ella* respectively. The last genus, *Alucita*, is placed by modern entomologists under the sub-order Pterophora. The Tortrices are leaf-rollers, as caterpillars; but some are parasitic, as *Tortrix pomana* on the apple, and *T. chlorana* vel *vitana* on the vine. The Tineæ are Clothes Moths.

1364. Death's-head Hawk-moth (*Acherontia atropos*).

1364[5]. The same, dissected, to show the nervous system.

1364[15]. Lime Sphinx (*Smerinthus tiliæ*) with the ovary dissected.

1365. Silkworm, with pupa, cocoon, imago, and ova (*Bombyx mori*).

This important species was introduced into Europe from China in the reign of Justinian.

1366. Large black-banded Caterpillar, the larva of *Dicrania vinula.*

Notice the three anterior-jointed legs which answer to those of the imago, and the four abdominal false or tuberculate legs, which only exist in the larval state. The dorsal horn at the end of the abdomen is also found in the Silk Worm and many other genera.

1366[5]. Larva of the same species entering on the chrysalis stage.

1367. Larva dissected from the dorsal surface, showing the intestinal canal with its Malpighian tubes, and the spinning sacks in front.

The latter organs are modified salivary glands.

1367[5]. Another specimen.

1368. Two large Larvæ.

Notice the nine stomata or spiracles, which open into the tracheal system, running in a row along each side, a pair to each somite. There are twelve somites, beside those composing the head, and of these the second, third, and last are without spiracles. There are here the full number of abdominal or false feet, viz., five pair, belonging to the 6th—9th, and the 12th somite.

1369. Hairy Larva of *Bombyx*, sp.

1370. Two large Chrysalids (dried).

This oval, conical form, is characteristic of *Sphingidæ.*

1371. Angular rhopalocerous Chrysalis.

1372. Larva of Privet Hawk Moth (*Sphinx ligustri*), dissected to show alimentary canal and tracheæ.

Cf. 1363^6, No. 6, for the imago.

1373. Quiescant Chrysalis (pupa), and imago of the same.

1374. Pupa in cocoon.

1375. Nest of a larva entering on the Chrysalis stage, in rotten wood, &c.

Order Trichoptera.

Char.—Wings four, membranous, the anterior covered with scales or hairs (whence the name of the Order). Mandibles and maxillæ abortive, but maxillary and labial palpi developed. Metamorphosis complete.

This small Order contains a single family, the *Phryganidæ* or Caddisflies. The larvæ live in water in cocoons covered with bits of wood, &c., and breathe by tracheal gills.

The Trichoptera form a natural transition from Lepidoptera to Neuroptera.

1376. Case-nymph (*Phryganea*, sp.)

Order Neuroptera.

Char.—Wings four, similar, membranous, reticulated, with strong nervures (whence the name); mouth masticatory, with usually all the parts developed normally; metamorphosis complete.

The Neuroptera, thus restricted, form a small natural order, comprising the following families:—

Panorpidæ (Scorpion-flies).
Hemerobidæ (Lace-flies).
Raphidiadæ (Camel-flies).
Myrmeleonidæ (Ant-lions).

All of them are represented in England, except Myrmeleon.

1376[5]. Specimens of the genera *Hemerobius* and *Panorpa*.

Notice the resemblance between the latter and Tipula, 1177[50].

1376[6]. Ant-lion (larva of *Myrmeleo formicarum*): microscopical preparation. South of Europe.

Order Hymenoptera.

Char.—Wings four, membranous, the posterior smaller; mandibles cutting, but not masticatory, maxillæ forming a tube which encloses the labium; metamorphosis complete.

The wings are less veined than in Neuroptera; the tracheal tubes are often sacciform, and the female insect is provided with a borer (*terebra*) or a sting (*aculeus*).

Class.—This extensive Order, of which about 25,000 species have been described, contains numerous families. The following are some of the most important:—

Terebrantia	Serrifera (Saw Flies)	*Tenthredo, Sirex.*
	Cynipidæ (Gall Insects)	*Cynips.*
	Ichneumonidæ (Ichneumon Flies)	*Proctotrupes, Chalcis, Ichneumon.*
	Chrysididæ (Golden Wasps)	*Chrysis.*
Aculeata.	Fossores (Hornets and Sand Wasps)	*Crabro, Sphex.*
	Heterogyna (Ants)	*Formica.*
	Vespidæ (Wasps)	*Vespa.*
	Mellifera (Bees)	*Bombus, Apis.*

1376[10]. Case with specimens of the genera *Tenthredo, Ichneumon, Sphex, Chrysis, Vespa, Apis*, and *Formica*.

Huber: Reserches sur les Mœurs des Fourmis, 1810. Latreille: Hist. Nat. des Fourmis, 1802.

Order Hemiptera.

Syn.—Rhynchota.

Char.—Wings four, similar (Homoptera), or the anterior partly coriaceous (Heteroptera), or both absent (Aptera); mandibles and maxillæ form sharp styles (*setae*), labium long and jointed (*rostrum*), palpi absent; metamorphosis incomplete in almost all, the family *Coccidæ* alone offering instances of complete metamorphosis.

HEMIPTERA.

Class.—The following are some of the chief Hemiptorous families :—

Homoptera	Cicadidæ (Tree-crickets)	*Cicada, Tettigonia.*
	Fulgoridæ (Lanthorn Flies)	*Fulgora.*
	Aphides (Plant Lice)	*Aphis.*
	Coccidæ (Lac Insects)	*Coccus,* Lecanium.*
Heteroptera	Hydrocorisa (Water Bugs)	*Notonecta, Nepa.*
	Geocorisa (Bugs)	*Cimex, Reduvius, Acanthia.*
Aptera......	Pediculidæ (Lice)	*Hæmatopinus, Pediculus.*

Lit.—Denny: Monographia Anoplurorum Britanniæ (Pediculi). Fabricius: Syst. Rhyngotorum (sic), 1803. Léon Dufour, 1833. Douglass and Scott: British Hemiptera (Ray Soc.), 1865.

1377. Specimens of Hemiptera Heteroptera.

1. *Notonecta glauca* (water-boatman).
2. *Nepa cinerea* (common Water Scorpion).
3. *Notonecta furcata.*
4. *Pœcilocoris affinis* (East Indies).
5. *Pycarmum anthymistimum* (East Indies).
6. *Cimex prasinus.*
7. *Reduvius*, sp.
8. *Picromerus bidens.*
9. *Pyrrhocoris apterus.*

1377[20]. Specimens of Hemiptera Homoptera.

1. *Aphæna submaculata ?*
2. Plant Lice (*Aphis rosæ*).

   These insects propagate by parthenogenesis, as well as by impregnation, for a limited number of generations.

3. *Cicada sanguinolenta.*
4. The Tree Cricket (*Cicada* v. *Tettigonia orni*). South of Europe.

This is the τέττιξ of the ancients, celebrated for its song (made by the male insect only), its living upon dew, being without blood, and having a voiceless mate. Arist. Hist. An., v. 30. Virg. Georg. iii. 328. Il. iii. 151. Anacr. xliii. Thuc. i. 6.

---

* The Cochineal Insect (*C. cacti*) is an American species, and yields the best die. The Indian genera afford the die known as "lake," and the resinous substance called "shell-lac."

5. Lanthorn Fly (*Fulgora lanternaria*). America.

Allied species are found in South Europe (*F. europæa*) and in China (*F. candelaria*).

1377[30]. Human Body Louse (*Pediculus vestimentorum* ♀): microscopical preparation.

This is the most frequent cause of Prurigo senilis.

1377[35]. Human Hair Louse (*P. capitis*).

1377[40]. Human Crab Louse (*P. pubis*).

Order Diptera.

Char.—Two membranous wings, with an aborted posterior pair (*halteres*, balancers); or apterous. Mandibles (*cultelli*) maxillæ (*scalpellæ*) and lingua (*glossarium*) are sharp stylets, forming a *haustellum:* labium produced into a proboscis; maxillary, but no labial palpi. Metamorphosis complete.

Clas.—The 25,000 species of this Order have been arranged in the following large groups, each of which contains a number of families :—

Nemocera (Gnats) .... *Tipula, Culex.*
Notacantha (Thornbacks) .... *Vappo.*
Tanystomata (Gad Flies, &c.) .... *Asilus, Tabanus, Bombylius, Empis.*
Athericera (House Flies, &c.) ...... *Œstrus, Musca, Syrphus, Conops.*
Pupipara v. Thoracocephala (Forest Flies) .... *Hippobosca.*
Suctoria v. Aphaniptera (Fleas) .... *Pulex.*

Lit.—Fabricius : Systema Antliatorum, 1805. Dugès on the Anatomy of the Flea, 1832. Lowne on the Anatomy of the Blow Fly, 1870.

1377[50]. Case with specimens of the families Tipulidæ (Crane Flies), Culicidæ (*Culex pipiens*, the Common Gnat), Muscidæ (*Musca vomitoria*, the Blow Fly), Tabanidæ (*Tabanus bovinus*, the Gad Fly), and Hippoboscidæ (*H. equinus*, the Horse Fly).

Notice the imitative resemblance of some of these species to Bees, Hornets, and Wasps.

1378. Two wet preparations, showing the larvæ of *Œstrus* (*Gastrus*) *equi* adherent to the stomach of a horse.

This is not the οἶστρος of the ancients, which was some kind of Wasp or Hornet.

The fly lays its eggs on the horse's skin, where they are hatched. The larvæ, called "bots," are then licked off and swallowed by the horse, and do not become pupæ until they have passed through the intestines.

1378². Egg of *Œstrus*, in its chitinous sheath, attached to the hair of a horse: microscopical preparation.

1378³. Halter of *Tabanus*: microscopical preparation.

1378⁵. Foot of Jamaica Pig affected with the Chigoe, or Sand Flea (*Pulex penetrans*).

This also attacks the uncovered feet of Negroes in Brazil and the West Indies.

Order Mallophaga.

Char.—Wings absent; mandibles and maxillæ; no metamorphosis. This small group of Insects appears to have no connection with *Pediculi*, except from its parasitic habit. *Ricinus* (or *Nirmus*) and *Gyropus* are some of the genera. The latter lives on the Sloth. All Epizoa on birds belong to this Order.

1379. Feathers of Flamingo and Scarlet Ibis covered with the ova of Bird Lice.

1379⁵. *Colocephalon subarquale*, parasitic on the Rook.

Order Physopoda.

Syn.—Thysanoptera.

Char.—Wings four, fringed; feet with palpi; metamorphosis incomplete; mouth with stylets and a sucking rostrum.

This small group of Insects, discovered by De Geer in the last century, has been referred to Hemiptera and to Orthoptera, but differs from both. They live concealed in flowers.

1379⁵⁰. *Phlœothrips coriaceus*: microscopical preparation.

Order Thysanura.

No true metamorphosis; biting jaws and suctorial mouth; apterous. These small Insects have, many of them, a peculiar apparatus bent under the abdomen, by aid of which they jump, which has given the group the name of "Spring-tails." They, like the last group, were first described by De Geer.

For a full account of the group, with figures and description of species, and a discussion on their true position, and the homologies of their parts, see Lubbock: "Monograph of Collembola and Thysanura" (Ray Soc.), 1873.

1379^{60}. Scales of *Machilis maritima*.

This insect belongs to the section or sub-order Thysanura proper, in which *Campodea* and *Lepisma* are also placed,

Notice the longitudinal bars and delicate transverse markings. This is a good test-object for the defining power of a microscope.

1379^{70}. Scales and hairs of *Degeeria*.

This genus, with *Podura*, *Sminthurus*, &c., make up the sub-order Collembola.

Notice the radiating marks from the apex of each scale.

Class ARACHNIDA.

Char.—Arthropod, Annulose animals, with four pair of legs. The Head and Thorax are fused together into a Cephalothorax. The abdomen is separate and segmented. There are no Antennæ recognisable as such; but the homologues of the Antennæ of Insects have been found in the *cheliceræ* of the Scorpion. The mandibles form the *falces*, or poison-jaws of Spiders, and their palpi the large claws (*chelæ*) of Scorpions. There are no wings, or abdominal feet.

The vascular system is essentially like that of Insects, but, as a rule, is more concentrated; some of the lower Arachnida have none.

Respiration is by spiracles which open into tracheæ, as in Insects, or into pulmonary sacs, or both. In the lower Arachnida there are no special respiratory organs.

The digestive system varies, but on the whole is like that of the other air-breathing Arthropoda, less developed than in Crustacea.

The nervous system is often more concentrated than in Insects, which it otherwise resembles. There are no compound eyes.

The sexes are distinct. Reproduction is by ovulation.

There is no proper metamorphosis, only successive moultings. In some cases the first form is hexapod.

Lamarck separated Arachnida and Centipedes from the Insecta of Linnæus and older naturalists, by the absence of wings and of metamorphosis; and Latreille further defined the present class by the absence of antennæ. Its validity was recognised by Cuvier and all subsequent writers.

Distr.—The class is not very numerous, but is widely distributed, the larger species inhabiting the tropics. Several genera live in fresh water, and a few in the sea. Arachnida have been found as early as the Carboniferous period (*Cyclophthalmus*), most like existing Solifugæ. True Spiders first occur in Jurassic rocks.

Class.—The Arachnida may be divided into the following orders :—

Arthrogastra v. Pulmonaria..Fam. *Scorpionidæ* (True Scorpions), *Phrynidæ* v. Thelyphonidæ (Spider Scorpions),* *Galeodeidæ* v. Solifugæ, *Cheliferidæ* v. Pseudoscorpiones (Book Scorpions), *Phalangidæ* (Harvest Spiders).

Araneida v. Amphipneusta (Spiders).......... *Mygale, Argyroneta, Aranea.*

Acarina v. Trachearea (Mites) .. *Acarus* (Cheese Mite), *Sarcoptes* (Itch Mite).

Tardigrada v. Arctisca † (Water Bears) .... *Macrobiotus.*

Pycnogonida (Sea Spiders) .... *Pycnogonum, Phoxichilus.*

Longistellata v. Pentastomidæ .... *Pentastoma, Demodex.*

Of these orders, the Arthrogastra, and especially such genera as *Galeodes*, are least modified and approach nearest to Insects ; they are probably the oldest form of Arachnida. The Araneida, on the other hand, are the most specialised order. Acarina are probably an example of retrograde metamorphosis. Pycnogonida are by some naturalists classed with Crustacea, and Arctisca with ringed worms.

Lit.—Martin Lister : Araneorum Angliæ Tractatus, with figs. (1678). Albin : Nat. Hist. Spiders, with figs. (1736). Hahn u. Koch : Die Arachniden (1831–1846). Blackwall : British Spiders (Ray Soc. 1861).

Arthrogastra.

1380. Somites and appendages of a Scorpion, arranged for comparison with those of an Insect (1343), a Crustacean (1397), and a Myriopod (1386).

Compare also the Table given at p. 214.

1381. Dorsal vessel, with its muscular bands, from a large Scorpion.

1382. Four Scorpions (*Scorpio Afer*).

South of Europe, Africa and Asia.

1382[5]. Young Scorpions.

1383. Book-Scorpion (*Chelifer cancroides*) : microscopical preparation.

---

* These first two families are sometimes united to form a suborder, "Pedipalpi."

† This curious group of "Sloths" or "Water Bears," are placed by Haeckel among the ringed worms.

ARACHNIDA.

Araneida.

1384. Two Spiders.

1385. Three Spiders.

1385^{5}. Spider's Nest, made of chips of wood, joined by a web.

1385^{10}. Nest of Trap-door Spider.

J. T. Moggridge: Harvest Ants and Trap-door Spiders, 1872.

Acarina.

1385^{50}. Cheese Mite (*Acarus siro* ♂ and ♀): microscopical preparation.

Notice that the abdomen is here conjoined with the cephalothorax.

1385^{55}. Itch Mite (*Sarcoptes scabiei* v. *hominis*) ♀: microscopical preparation.

This parasite was known by Ambrose Paré (16th cent.), and even earlier observers. It was figured by Baker in 1742. Notice its eight legs, each with five joints, the anterior two pair ending in suckers, the other two in bristles.

1385^{56}. *S. scabiei* ♂

The male is smaller than the female, and is much more rare: the third pair of legs have suckers, and there is a horseshoe-shaped chitinous penis. The larva has only six legs, conforming like many other young animals to a more generalized type than the adult. Its third pair have bristles.

See the historical account in Hebra: Diseases of the Skin (Syd. Soc. Transl.), vol. ii. pp. 167, seqq.

1385^{57}. Two male and three female acari from the Plover (*Charadrius pluvialis*): microscopical preparation.

Pycnogonida.

1385^{60}. *Pycnognonum* sp. Microscopical preparation.

1385^{66}. *Phoxichilus spinosus:* dredged off the North Devon coast. Microscopical preparation.

1385^{70}. *Demodex* v. *Steatozoon folliculorum.* Microscopical preparation.

This minute parasite habitually infests the sebaceous glands of the human skin. Notice its four pair of legs, and elongated abdomen. No heart or respiratory organs are present.

Class MYRIOPODA.

Char.—Arthropod, Annulose animals, breathing air by tracheæ, and with more than eight legs. The somites are more than twenty in number, and sometimes bear more than one pair of limbs. On the head are eyes, a single pair of antennæ, mandibles, maxillæ and labium. There are no wings, and no concentration of the segments into thorax and abdomen.

There is true blood, a dorsal multilocular heart, incomplete circulation, and tracheal respiration, as in Insects. With them they agree also as to the nervous system, which, however, remains during life in the unconcentrated form found in the larvæ of Insects.

The sexes are distinct, and reproduction only sexual. Metamorphosis is incomplete. Before its first moult, the larva of some centipedes has only three pair of legs.

This small group is most abundant in the tropics. It is known to have existed since the Carboniferous period.

Clas.—Order Chilopoda.	Fam.	*Scolopendridæ.*
Diplopoda v. Chilognatha.		*Julidæ.*

The genus *Pauropus* is intermediate between these two orders (Lubbock : Linn. Trans. vol. xxvi.)

1386. Somites and appendages of a Centipede, arranged for comparison with those of the other Arthropod classes.

Cf. preps. 1343, 1380, 1397, and Table, p. 214.

Head. 1. Sessile eyes.
2. Antennæ.
3. Small mandibles.
4. Labium representing two pair of mandibles.

Body. 1. Rudimentary footjaw.
2. Poison-fang.
3. First pair of ambulatory limbs.
4. Second ditto.
5—20. Succeeding feet : one pair to each somite.
21. Last somite with anus and genital orifice, and the appendages directed backwards.

1386[5]. Scolopendra dissected.

The nervous system is shown from the abdominal surface; the alimentary canal with membranous stomach, short small intestine, and thick colon, together with the ovarian tubules, from the dorsal surface.

1386[10]. Another specimen.

The anterior half of the nervous cord shown by a dissection from the dorsal surface.

1387. Four Centipedes (Scolopendridæ).

1388. *Scolopendra* sp.

Notice the ordinal characters of each segment having only one pair of legs, and the antennæ being long (fourteen joints or more).

1389. Nervous system of Scolopendra, dissected out from the body of the animal, with the antennæ, dorsal plate of head, and one terminal appendage.

1391. Millipede (*Polydesmus margariferus*).

This is one of the Diplopoda. Notice that most of the somites have two pair of legs, and that the antennæ are short (not above seven joints).

Class CRUSTACEA.

Chars.—Arthropod Annulosa, breathing water.

The number of somites is 20, of which 6 form the head. The exoskeleton is chitinous, and often calcareous. Instead of two pair of jaws, as in insects, the limbs of several segments are modified for prehension and mastication, forming *mandibles*, *maxillæ*, and foot-jaws or *maxillipeds*.

The digestive organs, and especially the liver, are much more developed than in other Arthropoda.

So also is the unilocular, dorsal, systemic heart. The circulation is lacunar, except in the branchia. These gills are present (more or less intimately united with the limbs) in all Crustacea, with the exception, more apparent than real, of the terrestrial Isopoda, and of a few which breathe by "vague" or cutaneous respiration.

The nervous system is as in other Arthropoda. Most Crustacea are diœcious. Reproduction is always sexual and by ovulation. In many the larvæ go through a process of metamorphosis.

Distr.—This numerous and important class is distributed very widely, chiefly in the sea, but also in fresh water (Ostracoda, Copepoda, Branchiopoda), and on land (*Oniscus* and land crabs); many are parasitic on fishes and other crustacea. They are, on the whole, more numerous, especially the lower orders, in the colder than in the tropical seas. They are the oldest Arthropoda, beginning as early as the Cambrian period. Two orders became extinct after the Palæozoic period. The most recent Crustacea are Decapods.

Class.—The intricate subdivisions of this class may be conveniently arranged as follows:—

Podophthalmi.	Decapoda—Brachyura	*Cancer, Maia, Gelasimus.*
	Anomura	*Pagurus.*
	Macrura	*Homarus, Astacus, Palæmon, Crangon.*
	Stomatopoda	*Squilla, Erichthus.*
	Schizopoda	*Mysis.*

CRUSTACEA.

Hedræophthalmi.

Amphipoda .... *Talitrus, Gammarus.*
Isopoda* .... *Armadillo, Oniscus, Cymothea.*
Læmodipoda* .... *Cyamus, Caprella.*

Branchiopoda.

Copepoda *v.* Carcinoidea .... *Cyclops.*
Ichthyophthira *v.* Siphonostoma *v.* Haustellata †...... *Lernæa.*
Ostracoda .... *Cypris, Cythera.*
Cladocera .... *Daphnia.*
Phyllopoda .... *Branchipus, Apus, Limnetis.*

Trilobita (extinct) .... *Paradoxides, Angelina.*
Pectostraca: Cirripedia.............................. *Lepas, Balanus.*
Rhizocephala † .... *Sacculina.*
Merostomata: Xiphosura .... *Limulus.*
Eurypterida *v.* Gigantostraca (extinct) .... *Pterygotus.*

The character of the limbs of Trilobites and their true position are still disputed. The Xiphosura show some special affinities to the Arachnida, with which they are classed by some naturalists.

The primitive Crustacean type, in which most of these larvæ still appear, is that known as the "Nauplius-form," with a single eye and three pairs of legs (as in insects), the anterior simple, the second and third bifurcated.

Lit.—Milne Edwards: Hist. Nat. des Crustacés, 1834—40; also Art. Crustacea, in Todd's Cycl. of Anat. and Phys. Bell: British Stalk-eyed Crustacea. Gosse: Marine Zoology, vol. i. Huxley: Lectures publ. in the Med. Times and Gazette, 1857. Spence Bate: Syn. Brit. Edriopth. Crust. (Ann. Nat. Hist, 2nd series, xix). Burmeister: Die Organisation d. Trilobiten. Leydig: Monogr. der Daphiniden. Darwin: Monogr. of the sub-class Cirripedia, 1851—1854 (Ray. Soc). Zenker: Monogr. der Ostracoden. Claus: zur Morphologie der Copepoden. Baird: Nat. Hist. of British Entomostraca, 1850. Fritz Müller: "Für Darwin," 1864.

Decapoda brachyura.

1392. Common Spider Crab (*Maia squinado*) ♀.

1393. Male of the same species, with narrow abdomen.

1394. Stone-crab (*Mithrax spinosissima*). Jamaica.

---

* Mostly parasitic. † Parasitic without exception.

1394^{5}. Dissection of shell of common Crab (*Cancer pagurus*).

1394^{10}. Abnormal bifurcation of dactylopodite of chela of Crab.

1394^{15}. Dissection of the branchial apparatus of a Crab.

The limbs have been removed and the carapace taken off, so as to show from the dorsal surface the gills, with the large flabellum crossing them.

1394^{20}. One gill of a Crab, with the artery partly injected with mercury.

1394^{25}. Transverse section of single gill of Crab, injected.

The branchial artery is seen above, cut across, with the white fibrous septum dividing the gill into equal halves.

1394^{30}. Dissection of the anterior (præoral) part of the head of Crab, showing the eye-stalks, antennules, and antennæ.

1394^{50}. The young of the common Crab, formerly described as a distinct species under the name *Zoea pelagica*; microscopical preparation.

The true larval condition of this form was shown by Dr. Vincent Thompson. The second stage "Megalopa" is scarcely less remarkable. See Rymer Jones, loc. cit., figs. 164—6.

1395. Two small Crabs.

Decapoda anomura.

1396. Hermit-Crab (*Pagurus Bernardus*), with shell and eggs.

1396^{5}. *Remipes scutellatus.* Mediterranean Sea.

Decapoda macrura.

1397. Disarticulated skeleton of Lobster (*Homarus vulgaris*) ♂.

Head.—1. Compound eye, with square facets: mounted on a moveable peduncle or eye-stalk.

2. Antennule, with the organ of hearing. It consists of a three-jointed *protopodite*, and a many-ringed *exo-* and *endo-podite*, "cérites" of Milne Edwards.

3. Antenna: a five-jointed protopodite (notice the hole closed by membrane in the first joint or *coxopodite*, which was formerly considered to be the organ of hearing), and a singled many-ringed endopodite.

4. Mandible with a "palpus," or *exopodite*, the jaw itself being an endopodite.

(*a*) is the azygos *ligula*, or tongue.

(*b*) a pair of foliaceous scales.

5. The first pair of Maxillæ, with palpi, &c., answering to the maxillæ or "lower pair of jaws" in Insects.

6. The second pair of Maxillæ, answering to the labium or "lower lip" in Insects.

7.* First pair of Maxillipeds or foot-jaws with *scaphognathite.*

8. Second pair of Maxillipeds, supporting each a separate gill.

9. Third pair of Maxillipeds, also each supporting a gill.

(*c*) The azygos but bilaterally symmetrical stomach, seen (like the rest of the preparation) from below. A white rod has been placed in the cardiac, a blue in the pyloric orifice.

10.† First pair of so-called ambulatory legs, the claws or Chelæ.‡

I. The *proto-* or *coxo-podite.* There is no exopodite.

II. and III. First and second joints of endopodite (*ischio-* and *mero-podite*) ancylosed together.

IV. Third joint of endopodite.

V. Fourth ditto ditto.

VI. Fifth ditto ditto (*carpopodite*) with an outgrowth prolonged so as to form a chela with VII.

VII. Sixth and last joint of endopodite, *dactylopodite.*

11. Second pair of ambulatory legs: the figures I.—VII. refer to the same parts as in 10. The last joint but one (*carpopodite*) is produced to form a small chela (*pseudochela*) in this and the following leg only. 11, as well as 10, carries a gill and a flagrum (flabellum) or *epipodite.* It and the other ambulatory legs represent the proto- and endo-podites of their respective somites.

12. Third pair of ambulatory legs, similar to 11, and, like it, carrying a gill and flabellum.

13. Fourth pair, the dactylo-podite or terminal joint having no prolongation of the penultimate to meet it. This also carries a gill and flabellum; between it and 12 opens the generative orifice in the female.

14. Fifth and last ambulatory feet of the Decapod Crustacea. They carry the seventh and last gill

---

* This somite is counted with the head by M. Milne Edwards, on the ground of its carrying a gill; so that he makes the cephalic somites 7, the thoracic 7 (instead of 8), and the abdominal also 7, by counting the telson as one.

† If we admit that the three maxillipeds are true thoracic appendages, they must answer to the three ambulatory and thoracic legs of insects, and then this tenth somite will begin a series homologous with the abdomen of Insects. The abdomen, usually so-called, of Crustacea (somites 15 to 20) must then be called a "post-abdomen" and held homologous with the sixth and succeeding segments of the abdomen of an insect.

‡ These are usually unequal in size, and one (either right or left) is serrated, the other is tubercular.

C. The Carapace, formed by the conjoined "*terga*" of the whole cephalo-thorax, i.e. probably by those of head, thorax, and abdomen proper (see note to 10). It is divided by the "cervical suture" (*h*) into a cephalic and thoracico-abdominal part (*cephalo-stegite* and *omo-stegite*), and in some Crustacea, as Ostracoda, these two parts of the Carapace are only united by a moveable hinge so as to simulate the shells of a bivalve Mollusk.

(*d*) is the *rostrum*, an azygos prolongation from the coalesced terga of the anterior cephalic somites. A pair of blue rods has been placed in the openings for the attachment of the eye-stalks (1), and white ones in those for the antennulæ (2), while (*e*) is placed between those for the second pair of antennæ.

(*g*) is the Labrum or upper lip. (*ii*) are on the *sternum* of the second thoracic (= typical abdominal) somite. The "branchial skeleton," placed in its natural position within the carapace, consists of the coalesced sterna of the 1-14th somites, together with internal "visceral calcifications," which divide it into numerous "cells."

15. The first somite of the abdomen (= typical post-abdomen), with its appendages, modified in the male to form organs of intromission, as here seen. In the female they are merely filamentous. Cf. prep. 1398[25].

16. Appendages of the second (post-) abdominal somite, with *proto- endo- exo-* and rudimentary *epi-podite.*

17. Ditto of third ditto.

18. Ditto of fourth ditto.

19. Ditto of fifth ditto. These five abdominal pair of limbs are known as false feet or "swimmerets." They carry the ova in the female.

20. The last somite of the post-abdomen and of the typical crustacean and arthropod body. It has large appendages consisting of a protopodite (*k*), endopodite (*l*), and two jointed exopodite (*m*).

T. The Telson. A blue rod is passed through the anal orifice. This is by Milne Edwards considered the 21st somite; but it carries no appendages; it is unrepresented by an undoubted somite in other Crustacea, and it is not developed like the rest, but subsequently form a dorsal expansion of the 20th somite backwards.* Along with the appendages of 20, it forms the powerful swimming tail of the Macrurous Crustacea.

Compare this preparation with those of an Insect (1343), an Arachnid (1380), and a Myriopod (1386): also with the table given at p. 214.

1397[5]. Early stage of reproduction of lost claw of Lobster.

---

* See, however, note by M. A. H. Garrod, Jour. Anat. and Phys., May, 1871.

1397^{10}. Lobster's claw dissected, showing further stage of reproduction.

1398. Exoskeleton of Lobster, disarticulated.

1398^{5}. Branchia of Lobster.

1398^{10}. Dissection of the nervous system of a female Lobster, from the abdominal surface.

Compare this with preps. 1345, 1386^{10}.

1398^{12}. Digestive system of Lobster, dissected in situ.

Notice the large, racemose, symmetrical liver, and the simple, straight intestine.

1398^{15}. Dissection of stomach of Lobster.

Notice the three brown-coloured pyloric teeth.

1398^{20}. Visceral skeleton of stomach of a Lobster, showing the three teeth and part of the calcified muscular skeleton.

1398^{25}. The first abdominal somites of the female Lobster, showing the filiform appendages characteristic of the sex.

Compare this with prep. 1397 (15).

1399. Sea Cray-fish (*Palinurus vulgaris*).

1399^{5}. Dissection of generative organs of male Cray-fish.

The spermatic tubes are seen, together with the two limbs of the last thoracic somite. A probe is passed through the genital orifice at the base of each limb.

Cf. Rymer Jones: fig. 162.

1399^{10}. Another of the female Cray-fish.

The two ovaries are seen separated, with probes passed through the genital orifices in the coxopodite of the third abdominal somite.

Cf. Rymer Jones: fig. 163.

1400. River Cray-fish (*Astacus fluviatilis*).

See Rolleston: Forms of Animal Life, pp. 91—139, and plate vii.

1401. A smaller specimen; dissected from ventral surface to show the gangliated nervous cord, and also the nerves to its stalked eyes.

The left side of the cephalo-thorax is removed to show the three plumose gills.

1402. Two large Prawns (*Palaemon cristatus*).

1402^{5}. Phyllosoma.

This, which was formerly put in the following order, Stomapoda, was shown to be a decapod by Kölliker, and all the species appear to be immature forms of *Palæmon* and its allies. *Phyllosoma commune* (Leach) has been proved by Van Beneden to be the larva of the great Spiny Lobster or Sea Cray-fish (*Palinurus vulgaris*).

Stomatopoda.

1403. *Squilla mantis.*

These eyes are pedunculated (Podophthalmous), but, instead of five pair of ambulatory legs, there are seven, the first of which are compressed and toothed. The gills also are not covered as in the Decapoda, but are free on the abdominal limbs.

1403[5]. A smaller specimen.

1403[15]. *Erichthus vitreus.*

The species thus named by Latreille is the *Squilla vitrea* of Linnæus, and has been placed in the sub-genus *Smerdis* by Leach.

Amphipoda.

1404. Common Sand-hopper (*Talitrus saltator*).

Beside the sessile eyes, characteristic of all the lower Crustacea; the group, of which this is an example, has seven segments, not united into a cephalothorax, beside the "tail." The body is usually compressed.

Isopoda.

1404[30]. Common Wood-louse (*Armadillo* sp.).

These Crustacea, though living in damp places inland, breathe by modified branchia in the abdomen or "tail." The "trunk" or thorax has seven somites and seven pair of undivided feet. Another species (*A. officinarum*) from the South of Europe, was formerly used in pharmacy under the name Millipes.

1404[40]. *Cymothoe œstrum.*

The short antennæ, two eyes, and seven pair of hooked thoracic feet are seen. This animal is parasitic.

1404[50]. Large marine Isopod (*Anilocra*).

Læmodipoda.

1404[90]. *Caprella* sp. Microscopical preparation.

There are only six thoracic segments, and to these the gills are attached. The abdomen is rudimentary.

Copepoda natatoria.

1405. Four-branched Monoculus (*Cyclops quadricornis*). Microscopical preparation.

The single eye is peculiar to this genus. It resembles the rest of the group in its oarlike feet. The bifurcated caudal appendage is a larval character, which persists in this as in many other of the lower Crustacea. Cyclops is very common in all fresh water.

CRUSTACEA.

Copepoda epizoa v. *Ichthyophthira.*

1405[5]. *Cecrops Latreillii:* parasitic on the Tunny.

The egg-sacs are twisted and hidden under the thorax.

1405[10]. *Dichelesthium sturionis:* from the gills of the Sturgeon.

One pair of antennæ is provided with chelæ as in *Limulus* and *Scorpio.*

1405[15]. *Nicothoe astaci* ♀ : from the gills of the Lobster. Microscopical preparation.

The two sacs seen behind are filled with eggs.

Ostracoda.

1406. *Cypris fusca* ♂ and ♀ : Microscopical preparation.

The cephalothorax forms a kind of bivalve shell with a dorsal hinge. Cypris has only a single eye like Cyclops, and like it inhabits fresh water. Notice the sac of eggs, hanging on each side of the tail of the female. Also the bifurcated telson.

Cladocera.

1407. Water-flea (*Daphnia pulex*). Microscopical preparation.

The eight branchial feet are enclosed in the horny carapace. The antennæ are branched, and there is only a single compound eye. It swarms in stagnant water.

Phyllopoda.

1408. *Branchipus stagnalis.*

The eleven leaf-like feet bear gills. It inhabits fresh water.

Trilobita.

1409. *Encrinurus punctatus:* from the Wenlock Limestone.

The head is covered by a carapace or shield; the thoracic segments are unconsolidated, and allowed the animal to roll itself up. The tail (= postabdomen?) is provided with a dorsal shield called *pygidium.* The limbs are unknown.

This remarkable group first appears in the Cambrian rocks, is very abundant in the Silurian and Devonian strata, and completely disappears before the Mesozoic period.

Its true position among other Crustacea is still disputed.

Cirripedia.

1410. *Pollicipes,* growing with a colony of Hydroid polyps.

This genus of pedunculated barnacles has a rough, scaly stalk, and a compressed shell with thirteen or more valves.

1410[10]. *Pollicipes,* sp.

1411. Pedunculated barnacles (*Lepas v. Pentalasmis anatifera*).

The two pair of valves of the "Capitulum," which are symmetrical, are called *scuta* and *terga*. The single valve, which completes the shell of the capitulum, is the *carina*. The "peduncle" consists of the larval antennæ with cement glands, and the front of the cephalothorax greatly produced.

1411[10]. Another large bunch with shorter peduncles, attached to a piece of cork.

1411[15]. Barnacles.

1411[20]. A barnacle with one tergum and scutum removed so as to display the animal.

The head is towards the peduncle, and so attached in this, the adult, state. The cirri or feelers, thrust out of the shell, as here seen, are the abdominal legs.

1412. Acorn-shells (*Balanus balanoides*).

In these sessile Cirripedia, the peduncle seen in *Pollicipes* and *Pentalasmis* is represented by the "basis" of attachment. The terga and sterna form an "operculum," which is enclosed in an external shell, consisting, beside the carina where the cirri are thrust out, of an opposite azygos valve (the "rostrum"), and a variable number of "lateral" valves on each side.

1412[5]. Large sessile barnacle upon a mussel-shell.

The jointed legs are seen protruding from the shell as in *Pentalasmis*.

For another specimen growing on an ascidian, see prep. 1340[65].

1412[10]. Four enormous acorn-shells (*B. giganteus*), removed from the bottom of a ship after return from a voyage to Australia.

The largest and longest compartment or valve is the carina, opposite is the rostrum, and between them two lateral compartments, carinolateral and lateral proper, the third or rostrolateral being absent. The intermediate pieces are either alae or radii.

The operculum is gone, with the animal it contained. Inside the shell are seen the serrated sutures of the valves with the calcified basis. Round the external edges, one or two accidental fractures show a number of minute tubes which run from the centre of the basis to the circumference, and communicate with vertical tubes in the compartments. These tubes, discovered by Poli, are now ascertained to be ovarian. (Darwin: Cirripedia, pp. 100, 101.)

Xiphosura.

1412[50]. Small Molucca King-Crab (*Limulus*, sp). East Indies.

Notice the two portions of which the carapace is composed, the tergal spine, and, on the opposite surface, the articulated limbs.

Class ANNULATA.

Syn.—Annelides * (Lamark). Vers à sang rouge (Cuvier).

Char.—The ringed Worms agree with Arthropoda in their bilateral symmetry and in segmentation of the body, but the rings are more in number than the somites. Limbs are sometimes absent, and when present are never jointed.

They agree with the last four classes in the fundamental structure of the nervous system and its relative position to the alimentary canal (which also is always proctuchous), as well in the development of the embryo with its dorsal surface to the yelk.

But, beside absence of articulated limbs, they are distinguished by little or no consolidation of the segments or of the corresponding viscera taking place in adult life. Cilia are always present in the larvæ and frequently in adults. There is a "pseudo-hæmal" system of vessels containing a coloured fluid. Usually no special respiratory organs are developed; if any, they are branchial.

Peculiar structures, known as "segmental organs," are frequently present.

In the development of the ovum the primitive streak does not precede the appearance of the body of the embryo. Many of the Annulata are hermaphrodite. There are several instances of reproduction by gemmation or division.

Distr.—The Annulata are chiefly marine, but there are numerous freshwater species, and some (Terricola) live in moist earth. None are strictly parasitic, though one Order (Suctoria) feeds on the blood of other animals.

Pal.—The absence of hard parts prevents our knowing much of the previous history of this class. The remains of the habitations of Tubicola are, however, found as early as the Silurian period.

Affinities.—The Ringed Worms were placed by Cuvier with the four

---

* This French word has been sometimes transformed into a barbarous Latin form "Annelida." The diminutive *Annellata* is used by some writers instead of the more usual Annulata.

preceding classes under the general title Annulósa, and this arrangement is continued by Prof. Huxley and many other naturalists. But in Germany it has long been usual to divide them more sharply from the Arthropoda, and Gegenbaur unites them with the next class Scolecida and some other groups under the old Linnæan term "Vermes." The Annulata have undoubted affinities to the Arthropoda on the one hand, and to the Nematoid Worms on the other. Perhaps the best way at present is to leave them as a separate class between these two groups, but not included in any larger division.

Classification.—The Annulata may be divided into the following Orders:—

Chætophora *	Polychæta †	Vagantia §	*Eunice, Aphrodite.*
		Tubicola ‖	*Serpula, Sabella.*
	Oligochæta ‡	Terricola ¶	*Lumbricus.*
		Naida	*Nais.*
Gephyrea			*Sipunculus.*
Suctoria v. Discophora		Hirudinia	*Hirudo.*

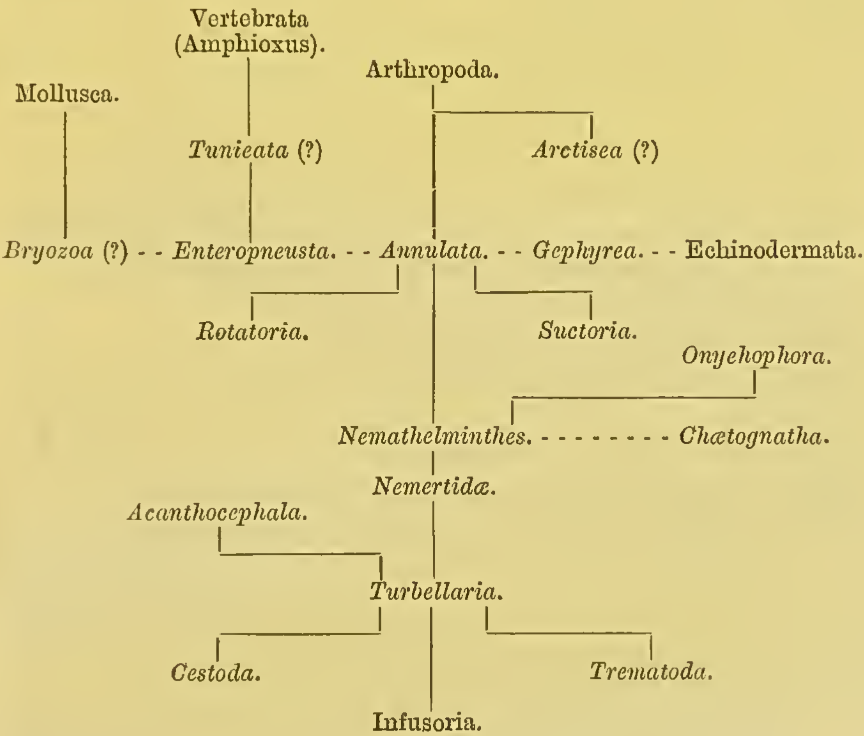
Several aberrant genera are thrown in among the Annulata by various authors, each with an order or sub-class made to receive it. Thus the single species *Sagitta bipunctata* is placed in the group "Chætognatha," and classed with Annulata or with Nematoid Scolecida, or alone. *Balanoglossus*, a Mediterranean worm, forms an order of Annulata as "Enteropneusta," and *Tomopteris* is made into a sub-order of Chætopoda as "Gymnocopa." It would, perhaps, be better to leave such genera isolated until a more satisfactory classification of the "mob" of Vermes has been made. This is at present wanting, and the position of many Orders is still unsettled. Thus the Gephyrea, now usually associated with Cuvier's Ringed Worms, were classed by him with Echinodermata, and the Leeches (Suctoria) are by Leuckart and Hæckel placed among the Scolecida.

---

* Syn. Setigera.
† Syn. Branchiata v. Chætopoda.
‡ Syn. Drilomorpha.
§ Syn. Errantia, Dorsibranchiata.
‖ Syn. Cephalobranchiata.
¶ Syn. Abranchiata.

ANNULATA.

The following Table exhibits the relations of "Vermes" according to most German authors. All the names in Italics are included in this group by Gegenbaur :—



Polychæta errantia.

1413. *Eunice gigantea.*

A slight depressed line runs along the centre of the abdominal surface. On each side of this are seen the pairs of tubercles and setæ with which each somite is provided, while on the dorsal surface a double row with corresponding setæ is seen, each also bearing a ramified vascular tuft.

1413[2]. Sea-mouse (*Aphrodite* v. *Halithea aculeata*), dissected from ventral surface to show the thick-walled muscular crop and long straight alimentary canal.

Notice also diverticula which pass off from this as delicate tubes, each of which expands into a bladder-like extremity, in which an opaque brown mass is seen.

1413[3]. Another specimen.

Dissected to show the alimentary canal from outside, and also the deep implantation of the tubercles of the spines, with the muscles which project them.

1413[4]. Another specimen.

Dissected to show the ventral, gangliated nervous cord, and on the dorsal surface the intestinal diverticula in situ.

1413[5]. *Arenicola piscatorum.*

Notice the branchial tufts on each side.

1413[10]. Large Annelid.

1413[15]. *Ophelia*, sp. Mediterranean Sea.

Notice its iridescent surface, as in the last specimen.

Polychæta tubicola.

1413[50]. Sand-binder (*Amphitrite ventilabrum*).

1413[55]. Calcareous tubes of Serpulæ. (*Siliquaria* sp.) Red Sea.

Oligochæta.

1414[5]. Two Fresh-water Worms, belonging to the genus *Nais.*

1414[6]. Common Earth-worm (*Lumbricus terrestris* ♂).

The thick collar is the *clitellus*, or saddle-like thickening of the dorso-lateral parts of a variable number of rings, subservient to the generative function. Notice also the double row of lateral spines, corresponding to those of *Eunice* (1413), but only two setæ represent each *fasciculus* in the latter. There is also a double row of ventral spines representing the tubercular feet and bristles of *Eunice.*

For this and the following preps. see Rolleston: Forms of Animal Life, pp. 119—126, and pl. viii. For a general account of *Lumbricus* see E. R. Lankester: Q. Jour. Micr. Sc. 1864, 1865.

1414[7]. Dissection of the nervous system of the same species.

The abdominal cord, and the circle it forms around the mouth, are both displayed. Notice that in the middle portion the separate ganglia are more distinct, those anterior and posterior being more or less fused.

1414[8]. Dissection of generative system.

A bristle is placed in the orifice of the vas deferens which opens in the fifteenth ring. The large pendulous vesiculæ seminales are seen on each side in front of the crop, and outside them the so-called "capsulogonous" glands. The four testes and two ovaries are too small to be well seen.

1414[9]. Dissection of alimentary system.

The mouth opens into a large pharynx, to which muscular bands are attached outside. Then comes the œsophagus, about half an inch long, next the large crop, next the gizzard, and lastly the straight intestine, ending in the terminal anus. There are three pairs of glands, called *glandulæ calciferæ*, opening into the œsophagus.

Suctoria.

1414[10]. Cast of alimentary tube of Leech (*Hirudo medicinalis*) in red wax.

The upper part of the cast represents the mouth, then follow seven divisions with bilaterally symmetrical diverticula, and lastly one with two long cæca, which run side by side, and conceal between them the slender intestine. For this and the following preps. see Rolleston: loc. cit., pp. 127—137, and pl., ix.

1414[15]. Nervous system of Leech.

The ventral gangliated cord separated from the body.

1414[17]. Egg capsules of the Leech.

Each of these coccoons or capsules contains from five to fifteen eggs floating in a brownish, albuminous fluid.

1414[20]. Horse Leech (*Hirudo* v. *Hæmopis sanguisuga*).

Notice the oral sucker cut open to show the mouth, the caudal sucker immediately behind the anus, and the protruded penis on the ventral surface.

Gephyrea.

1414[50]. *Sipunculus* (v. *Syrinx*) *nudus.*

This specimen was given me by Mr. Ray Lankester, who brought it from Naples where it is very common. It also occurs occasionally on the S.W. coast of England. See fig. in Forbes's British Star Fishes.

The proboscis, sometimes described as a pharynx, which is protruded in search of food, is here seen retracted within the body; it is furnished with a circle of short tentacles. The alimentary canal beyond (filled with dark sand), is seen to be undifferentiated and to end anteriorly. The skin is muscular, divided into square reticulations and unprovided with suckers, spines or bristles.

This animal and its allies were formerly classed as vermigrade Echinodermata, and form a bridge between that group and the ringed worms.

Class SCOLECIDA.

Syn.—Vermes, in restricted sense. Helminthes.

Char.—This class, which can only be regarded as provisional, has intimate alliances with the Annulata through its higher Nematoids families, which were united with them by Cuvier as Annulosa, and by its lower members (Turbellaria) with Infusory animalcules. See the table of "Vermes," p. 249, and Huxley: Introd. pp. 77—81. Most of the class are parasitic, and this has led to adaptive modifications, which render their true affinities still more obscure. The following are the natural groups which may be included under the title Scolecida.

Nemathelminthes	Gordiacea (Hair Worms)		*G. aquaticus.*
	Nematoda* (Round or Thread Worms)		*Ascaris, Trichina.*
	Acanthocephala* (Thornheaded Worms)		*Echinorrhyncus.*
Platyelminthes	Trematoda* (Flukes)		*Fasciola, Distoma, Bilharzia.*
	Turbellaria	Nemertidæ (Band Worms)	*N. Borlasii.*
		Planariæ	*P. torva.*
	Cestoidea* (Tape Worms)		*Tænia, Bothriocephalus.*

With these the Rotifera (Rotatoria) or wheel animalcules are often included. They are clearly distinct from the true Infusoria, with which they were once united, and have affinities with Crustacea, with Annulata and with Scolecida.

Lit.—Rudolfi: Entoz. Hist. Nat., 1808. Dujardin: Hist. Nat. Helminthes, 1845. Bremser: Icones Helminthum, 1823. *Cobbold: Entozoa* (coloured plates), 1864. Diesing: Syst. Helminthum, 1850. Von Siebold: Die Band und Blasen Würmer, 1854. Leuckart: Menschliche Parasiten, 1862. Van Beneden: Mem. sur les Vers Intestineaux, 1858, 1861.

---

* Parasitic. These groups were formerly united under the name "Entozoa."

Order Tæniada.

Syn.—Cestoda.

Char.—These are all parasitic. They have no alimentary canal (*Sterelminthes*), and no nervous system, a very simple watervascular and highly developed generative system. The sexes are united. The following Tæniada are human parasites :—

Tænia solium inhabits the small intestine in the *Strobila* form, the brain, eye, &c., in the cystic form.		
T. mediocannellata inhabits the small intestine in the *Strobila* form only.		
Bothriocephalus latus ,,	,, ,,	,,
Tænia echinococcus ,,	solid viscera in the cystic form.	

A. *Scolices of Tæniada, known as Hydatids Cystic, or Bladder Worms.*

These are the the result of metamorphosis from the larvæ or *proscolices*, which issue from true ova, and give rise by gemmation to broods of *deuto-scolices*. If, however, the scolex is swallowed by a suitable host, it attaches itself to the intestine as a "head," and buds off successive "joints," or *proglottides*, so as to form a compound "Tape Worm" or *strobila*.

1415. Cysticerci in liver and diaphragm of Sheep.

This is the encysted scolex of *Tænia solium*, without deuto-scolices.

1415[5]. Another specimen, with the cyst partially calcified, from the liver.

1416. Heart of Bear, with cysticerci.

Cf. Cobbold, fig. 51.

1417. Cysticercus from liver of Sheep, with the cyst, which it had formed around it. From Sir Astley Cooper.

1418. Cysticerci attached to liver of a Rabbit.

Notice the small opaque "head" and "neck" with the large dilated bladder-like "tail," whence the generic name. The latter is only developed after the scolex has wandered to some solid organ and become encysted.

1420. Cysticerci, with peritoneal covering, from near the stomach of a small species of Antelope.

1421. *Cysticercus pisiformis*, probably from a Rabbit.

This is the Bladder Worm or wandered scolex of *Tænia serrata*, one of the Tape Worms found in the Dog's intestines. It was on this species that Leuckart proved experimentally the real relation between Tape-worms and Bladder-worms.

1422. Two Cysticerci, dried on glass.

Cf. Rymer Jones, fig. 34.

1423. Cysticerci from a Sheep.

"They distinctly contracted and expanded on being removed from the body of the Sheep." (Note in the Catalogue of the late Mr. Bryant's Museum, from which this specimen was obtained.)

1424. Measly Pork. The cysticerci are seen in the muscle and subcutaneous fascia.

1425. Cysticercus.

1426. Acephalocyst Hydatid, with its capsule.

This "headless Bladder-worm" is the wandered scolex of *Tænia echinococcus* called Acephalocyst, because the head is inverted after the scolex has become encysted, and therefore is no longer visible. The hydatid itself is opened, and shows on its outer surface some of the loose connective tissue which united it with the adventitious cyst, due to inflammation, which is placed above it.

1427. Echinococcus in its cyst.

Both have been opened: the capsule is partly calcified by secondary degeneration of the inflammatory exudation.

1428. Capsule of a large encysted hydatid, from liver of Bullock.

1429. Hydatid, opened to show the sessile daughter cysts (deuto-scolices) lining its interior.

1430. Another specimen.

1431. Hydatid (cysticercus), unopened.

1432. Partially calcified Hydatid (cysticercus), dried.

1433. Compound Hydatids.

1436. Deuto-Scolices from the interior of a Cysticercus.

1437. Hydatid, with a piece of Monkey's intestine, from which it was taken.

1438. Acephalocyst Hydatids, removed from the thigh of a patient in Lydia Ward, by Mr. Morgan.

1441. Hydatids: one turned inside out, to show a multitude of deuto-scolices on the interior.

1442. Piece of hydatid cyst, with a bunch of deuto-scolices growing from its inner surface.

1443. Portions of hydatids, found dead in a contracted hepatic cyst, all thickened and deformed.

1444. Degenerated multiple hydatid cyst of liver, cut open to show the deuto-scolices within, which have apparently died from mutual pressure.

1445. Deutoscolices of *Echinococcus* from human liver : micr. prep.

Notice the rostellum with its circle of hooks and the strongly refracting calcareous corpuscles.

1446. Part of the liver of Pig, riddled with hydatid cysts.

1448. Lung of Kangaroo, with hydatids.

1450. Compound hydatid cyst, among the muscles of the hind leg of a Rabbit.

1452. *Cœnuri.*

The wandered Scolices of one of the Tæniæ of the Dog. The buds are produced externally, and so, instead of a "head" with a single bladder-tail, as in Cysticercus, there is one common bladder-tail and several heads.

Cœnurus cerebralis is the cause of "staggers" when it infests the brain of sheep.

B. Strobilæ of Teniada, called Tape-worms.

These are compound organisms: the head is the *Scolex*, the joints the successive buds it produces called *proglottides*, capable of producing eggs.

1453. The Broad Tape Worm of Russia and Switzerland. (*Bothriocephalus latus.*)

This is the largest human cestode. The strobila may be 25 feet long and each mature polyglottis nearly an inch broad. Head elongated, without suckers, hooks, or pigment, but with two symmetrical longitudinal fossæ, or grooves (whence the generic name). Anterior joints very narrow; first ripe one about the 600th from head (Leuckart). Reproductive orifices on ventral surface. Uterus a single folded tube. The cystic form of this worm is unknown, but probably will be found in fresh-water fish.

Notice (holding it to the light) the simple rosette-like uterus in the centre of each proglottis, and the absence of any projections on either edge, from the reproductive tubercles being in this genus situated on the surface of each joint.

SCOLECIDA.

1454. The Beef Tape Worm (*Tænia mediocanellata.*—Küchenmeister.)

Intermediate in size between *Bothriocephalus* and *T. solium.* Head with pigment spots, but no rostellum or hooks; four suckers. Uterine processes more numerous but less branched than in *T. solium.* First ripe proglottis about 450th from head (Leuckart); 360-400 ripe ones. Very liable to deformities of the joints, as seen in this specimen. Nearly as common as *T. solium* in this country according to Dr. Cobbold. It is derived from the cystic scolices of the Ox.

1455. *Tænia mediocanellata.*

Notice the numerous parallel uterine processes, and the abnormally coalesced joints.

1456. Two other specimens of *T. mediocanellata.*

Presented by Dr. Cobbold.

1457. The common Maw Worm (*Tænia solium*), without the head.

The proglottides appear to be destitute of ova. Notice their large proportional length. Hold it against the light and notice the uterine diverticula beginning simply in the midddle of the 4th fold from the head and becoming more and more complicated in the succeeding segments. Notice also that the reproductive tubercle is situated on the left margin of the last 8 proglottides, on the right of the 5 succeeding ones, and then again on the left.

Tænia solium forms a strobila of 10—20 feet, or even longer; the widest proglottides are about 1-3rd inch broad. Head with 4 suckers, rostellum, and 22-28 chitinous hooks in a double circle. Uterus branched; reproductive papillæ at right or left edge of joint.

This worm is derived from the cystic scolices of the Pig.

1458. *Tænia solium*

The head is seen at the lower end of the uppermost right-hand segment. To this follow segments which gradually become longer, and then the uteri and reproductive papillæ appear, and in the last two folds become filled with ova. The last joint but one is deformed.

1460. Another specimen, showing the gradual ripening of the joints.

1461. Another specimen.

The uteri packed with ova show well.

1463. Separate proglottides of *Tænia solium.*

1464. Strobila of *Tænia solium.*

The uterus in the ripe proglottides, with branched but not very numerous or closely packed processes, shows well when held up to the light.

1469. Portion of a Tape Worm, with the joints remarkably long, and the uteri very distinct.

1470. *Tænia solium.*

The head is seen at the upper end of the left hand fold.

1471. Another specimen, showing the lateral and transverse water-vascular canals injected with mercury.

1473. Detached joints of Tape-worm.

Each is a proglottis, i.e. a complete hermaphrodite, self-impregnating individual, the result of external gemmation from a scolex, which has been swallowed with its host by a carnivorous animal.

1474. Tænia, from Greyhound.

1475. Tape-worm from Cat (*Tænia crassicollis*).

The preparation, when held up to the light, shows the unimpregnated uterine cavities.

This is the strobila of the *Cysticercus fasciolaris* found in the livers of Mice. Cf. 1479.

1479. *Cysticercus fasciolaris*, encysted in liver of Rat.

This is the encysted scolex of the Tape-worm of the Cat.

There is the same relation between *Cysticercus cellulosæ* in the Pig and *Tænia solium* in man, the hydatid of the Ox, and *Tænia mediocanellata* in Man, *Cysticercus pisiformis* in the Rabbit, and the Tape Worm of the Fox.

1482. Two short, flat, tænioid Worms, from the Colon of a Horse.

Order Trematoda.

Char.—These Worms, known as "Flukes," are flat in shape (*Platyelminthes*) but have an intestine (*Cœlelminthes**), which is aproctous and ramified. They go through various transformations, some while free, others as parasites. Some of these earlier forms are known as *Cercariæ*, or King's-yellow Worms, one species of which is, when adult, a trematode parasite on the common Fresh-water Snail (*Limnæa stagnalis*). These transformations were dis-

* As, however, they have no perivisceral cavity, they were classed by Cuvier as "parenchymatous," and so are sometimes included under the term "sterelminthes."

covered by Steenstrup: see his "Alternation of Generations," translated for the Ray Society by Mr. Busk (1845).

Trematoda have a watervascular and nervous system. The sexes are united as a rule, but distinct in *Bilharzia*.

The Liver Fluke (*Fasciola hepatica* v. *Distoma hepaticum*) is occasionally found in man. More important is *Bilharzia hæmatobia*, which inhabits the pelvic veins and gives rise to hæmaturia. It is found in Egypt and Natal.

See the two coloured figures in the frontispiece to Cobbold's Entozoa.

1483. Gall bladder of a Sheep with several flukes (*Fasciola hepatica*), some still attached, injected with mercury.

The injection shows the ramified alimentary canal characteristic of these parasites.

1484. Liver fluke (*Fasciola hepatica*).

1485. Fluke from bileduct of Sheep.

1485[5]. *Distoma clavatum.*

Order Acanthocephala.

This small group of parasitic Worms is allied to Tæniada, but they are more highly organised, and do not form compound strobilæ. The sexes are distinct. None affect human beings.

1486. Thorn-worm (*Echinorrhyncus*, sp.) attached to the intestine of a Fish.

Several have been broken off, leaving the hooked proboscis and menisci (organs of doubtful use, perhaps excretory) attached. See also the microscopical preparation 1486[5].

Like the rest of the Order, this Worm is a "sterelminth"—i.e. it has no digestive cavity. But it possesses a distinct ganglion, and, in shape, approaches the Nematoid rather than Cestoid Worms.

Order Nematoidea.

Syn.—Round worms; also called Nemathelminthes and Nematodes, under which title Acanthocephala and Gordiacea are sometimes united with them.

SCOLECIDA.

Char.—These Vermes have an alimentary canal and perivisceral cavity (*Coelelminthes*), a nervous ganglion, watervascular system, and elaborate sub-cutaneous muscles. The sexes are distinct, the males being smaller and less common than the females. There is only sexual reproduction.

The following are human parasites :—

Ascaris lumbricoides	inhabits the	Small Intestine.
Oxyuris vermicularis..................	,,	Rectum.
Trichocephalus dispar	,,	Cæcum.
Dracunculus medinensis	,,	Subcutaneous Tissue.
Trichina spiralis	,,	Striated Muscle.
Eustrongylus gigas (?)	,,	Pelvis of Kidney.
Sclerostoma (v. *Anchylostoma*) *duodenale*	,,	Duodenum.

1487. Common round Worm (*Ascaris lumbricoides*). Two specimens.

The more tapering extremity is the head, which has no hooks, but three suckers surrounding the mouth. The rings of the chitinous integument do not extend deeper, as is the case in Leeches and other true Ringed-worms.

1488. Another specimen.

1490. Female Ascaris, dissected.

The head is above. From it the brown almost uniform alimentary canal passes down to the sub-terminal anus. To the right of this is seen the slender ventral nervous cord; and, opening halfway down, the long convoluted uterine tubes and the more slender ovarian tubules.

Cf. Rymer Jones, fig. 44 (left hand).

1492. Another specimen, with part of the ovaria and a uterine tube protruding.

1494. }
1495. } Two other specimens.

1496. *Ascaris lumbricoides* ♂, dissected to show the digestive and and genital organs.

Cf. Rymer Jones, fig. 44 (right hand).

1496[5]. Another specimen, with the spermatic tubes dissected out.

1496[10]. The spermatic tubes, the vesiculæ seminales, and tail, with spicular penis, of a male Ascaris.

1497. Transverse section of *Ascaris lumbricoides.* Microscopical preparation.

The subcutaneous muscles are seen under the chitinous skin, the alimentary canal in the middle, on each side of it the large uterine tube, one of which is full of eggs, and around, the ovarian tubules.

1499. Thread-worm (*Oxyuris vermicularis*).

The broader end is the head. Cf. Huxley, loc. cit., fig. 23.

1500. Hair-worm (*Trichocephalus dispar*).

The males are smaller and curved, the females straight.

1501. Guinea-worm (*Filaria* v. *Dracunculus medinensis*) ♀

The Long Worm is found in the water tanks of India and other hot countries. The male has not been discovered, nor is the mode of development ascertained.

1502. Two Dracunculi, from the scrotum of a healthy man, wound upon cardboard.

This is the way in which they are gradually extracted in order to avoid breaking them.

1503. Guinea-worm. From Mr. T. E. Bryant's Museum.

"Removed from the instep of an African Prince, at school at Clapham." Note in Old Catalogue.

1504. Another specimen, extracted at Haslar Hospital. Presented by Mr. R. Stocker.

1505. Guinea-worm—tail blackened in the process of extraction—15 inches long.

1506. *Filaria*, sp.?

1507. *Filaria bronchialis,* from lungs of Boa Constrictor. Presented by Mr. Bell.

1510. Long cylindrical parasites in bronchial passages of a Dolphin's lung.

Notice also that there are large cavities in the lung filled with these filariæ.

1511. *Strongylus armatus,* in an aneurismal sac of the mesentery of an Ass.

These parasites often cause abdominal aneurisms in the Horse.

1511[5]. Proventriculus of an Adjutant, with the gastric follicles filled with strongyli.

1512. Pancreas of a Fish affected with nematoid parasites.

1513. Muscle-worms (*Trichina spiralis* ♀). Microscopical prep.

The male is only half as long. The head is the narrower end. The Worm is viviparous, and it is the larvæ which, when swallowed by a warm-blooded animal, seek the voluntary muscles and thereby cause the disease known as trichiniasis. When they have reached the muscle and become encysted they produce no further symptoms.

1514. Muscle affected with trichiniasis.

The seed-like bodies seen scattered through the fasciculi are lemon-shaped calcareous capsules, each containing a trichina coiled up.

Order Gordiacea.

These Worms are partially parasitic, chiefly in insects, but not in man. The sexes are distinct. There is no anus, and in some cases no mouth. The Paste-worms and Vinegar-eels (*Anguillulidæ*) may be added to this group.

1515. Hair-worm (*Gordius aquaticus* ♂). From Switzerland.

This animal is common in moist earth and tanks as well as in running streams. The bifid tail is characteristic of the sex. It is here unravelled from the curious knot into which it is frequently found twisted.

Class ECHINODERMATA.

This class, placed among Cuvier's Radiata, is well defined in itself, and has no obvious alliances with Protozoa, Cœlenterata or Mollusca. But it has numerous affinities with Annulata and Vermes, so that Professor Huxley unites it with Scolecida under the name Annuloida. Most German naturalists regard Echinodermata as a primary division of the Animal Kingdom, and the orders as classes.

Chars.—Symmetrical, partly bilaterally, partly radially, in the latter case by multiples of five.

A more or less complete calcareous exoskeleton.

An alimentary canal distinct from the body cavity, and, in all but one genus, proctuchous.

A system of vessels partly respiratory, partly locomotive in function, and known as the Ambulacral System.

In most, a rudimentary hæmal (or pseudo-hæmal) system.

A radiate nervous system.

Reproduction only sexual; diœcious; a peculiar process of metamorphosis in many cases.

All the Echinodermata are marine. Very few living species are fixed, and of course (from absence of gemmation), none are compound.

Clas.—The following are the existing orders or sub-classes) of Echinodermata, beginning with those most nearly allied to the Annulata.

Holothuroidea (cirrovermigrade)................	Sea-cucumbers.
Echinoidea (cirrospinigrade)....................	Sea-urchins.
Asteroidea (cirrograde)	Star-fish.
Ophiuroidea (spinigrade)	Sand-stars.
Crinoidea (pinnigrade or sessile)................	Feather-stars.

Pal. — Two other orders, Blastoidea and Cystidea, became extinct before the end of the Palæozoic period. The former, also known as Pentremites, are most abundant in the Carboniferous strata, the latter in the Silurian rocks. The Crinoidea were also most abundant in the Palæozoic Period, but were still numerous in Secondary strata, mostly as sessile species. At the present day they are only represented by *Comatula*, *Pentacrinus* and *Rhizo-*

crinus. Asteroidea, Ophiuroidea and Echinoidea have existed since the Silurian period, the latter most numerously in Mesozoic and Cænozoic times. Of these the majority are divisible into the two groups of "regular" Sea-urchins, with the mouth and anus at opposite poles and "perfect" ambulacra, and "irregular" with an unsymmetrical anus and "petaloid" ambulacra.

Ref.—Sharpey: Art., Echinodermata, in Todd's Cycl. Rolleston: loc. cit., pl. x. and description. Forbes: British Star-fishes, 1841.

Holothuroidea.

1516. Snail Sea-cucumber (*Psolus phantopus*).

In this genus the suckers, or ambulacral feet, are seen to be confined to the ventral surface, where they form three rows.

1516[5, 10]. Two specimens of the common Sea-cucumber (*Cucumaria communis*) from Cornwall; one dissected.

Notice the ambulacral suckers, the oral tentacles, the intestine and respiratory tree, and the muscles of the integument seen from the inside.

Echinoidea.

1517. Large purple-spined Sea-urchin (*Echinus sphæra*).

The apex, placed upwards, as during life, is occupied by the vent, the mouth is at the opposite pole. The ambulacra run from one pole to the other. Beside these family characters, the spine-tubercles are imperforate. *E. esculentus*, common in the Mediterranean, is a distinct species.

1517[3]. Green variety of the same species.

1517[4]. Corona of *Echinus*, with the spines removed, to show the tubercles with which they articulate.

The apical disk, which with the corona forms the complete test, has been removed. Notice the five double ambulacra (best seen from within) and the five double interambulacral rows of plates bearing imperforate tubercles. Also the *rotulæ* for attachment of "lantern" muscles, seen within the large oral orifice.

1517[5]. Young specimens of the green variety of the same species.

1518. Another specimen, in section, to show mouth and teeth.

Two of the large ovaries are also seen.

1519. Teeth of Echinus, known as "Aristotle's Lantern."

The five converging points are the biting organs. The smooth parts below give attachment to the muscles which move them. Cf. 1521.

1520. *Echinus sphæra*, purple variety.

Suspended in the natural position, i.e., with oral pole downward and anal upward. Notice the numerous protruded suckers.

1520[5]. Apical half of a large green Echinus (*E. sphæra*, var.), dredged in 20 fathom water off Lee, Devon.

Notice the madreporic tubercle eccentric to the anus; also, on the inner surface, the five interambulacral ovarian orifices, and the five ambulacral ocular plates, both surrounding the anal orifice.

1521. Echinus, showing muscles of "Aristotle's Lantern."

Cf. Rymer Jones, figs. 70 and 71. The original description is by Cuvier: Leçons d'Anat. Comparée iii. 329.

1522. Two pieces of the calcareous shell of a large purple Echinus.

The larger fragment is a hemisphere containing three narrow ambulacral and two broad double interambulacral plates. The smaller one has been broken to show the zig-zag suture between the two inter-ambulacral plates.

1522[3]. Long Echinus spine, imbedded in the Gault.

1522[5]. A fossil Cidarite (*Hemicidaris* sp.) from the Coralline Crag.

The spines have been lost. This family differs from *Echinidæ* in the spines being not all of the same form, and also, as here seen, in the larger tubercles being perforated.

1522[10]. Two Heart-urchins, from the chalk.

The smaller one (*Micraster cor-anguinum*) is a natural cast in flint of the inside of the shell. They show the heart-shape, the unsymmetrical mouth and supra-marginal anus, and the five circumscript dorsal ambulacra, which characterise the *Spatangidæ*, and are arranged in a "petaloid" or rosette shape round the apex.

1522[15]. Large *Spatangus*, from tertiary deposits in Malta.

1522[50]. Two specimens of the genus *Galerites*, from the chalk.

The mouth is central, anus excentric, ambulacra complete and narrow.

Asteroidea.

1523. Two dried specimens of large Star-fish (*Pentaceros*).

1523[10]. Spiny Cross-fish (*Uraster glacialis*).

1524. Common Cross-star (*Uraster* v. *Asterias rubens*).

Notice on the dorsal surface the eccentric madreporic tubercle, on the ventral surface the central oral orifice, and along the arms the protruded suckers.

1525. Star-fish, dissected from the dorsal surface.

In the centre is seen the five-lobed stomach, in one of the arms its two cæcal diverticula, and in the two opposite ones the double ovaries. The remaining dissected arm has one of its ovaries cut away to display the row of vesicles, which run in a double series down each arm to communicate with corresponding suckers.

1525[5]. The same, a deeper dissection.

The stomach is here opened from its dorsal aspect, and the Polian vesicles in the arms are well displayed.

1526. Two arms of a Star-fish.

Dissected from the dorsal surface to show the Polian vesicles, a pair of cæcal diverticula, and the deeper membranous dorsal appendages which have been termed salivary glands.

1527. *Uraster rubens.*

Showing unequal growth of arms after mutilation—a sixth has appeared.

1528. Five arms of common Sun-star (*Solaster papposa*).

Dissected from dorsal surface, and showing the cæcal diverticula.

1529. Nine-armed Star-fish.

1530. Gibbous starlet (*Asterina gibbosa*).

The madreporic tubercle is seen on the dorsal and the ambulacral canals on the ventral surface.

1531. Bird's-foot Star (*Palmipes membranaceus*).

Notice the madreporic tubercle on the dorsal surface, and the five narrow ventral grooves with their suckers.

1532. Sand-star (*Ophiura texturata*).

1533. Grey Brittle-star (*Ophiocoma neglecta*), microscopical preparation.

1533[5]. Brittle-star (*Ophiocoma rosula*).

1534. Shetland Argus or Gorgon's head (*Astrophyton scutatum*).

Crinoidea.

1535. Two Rosy Feather-stars (*Comatula* v. *Antedon rosacea*).
Cornish Coast.

The upper specimen shows the ventral aspect. Two of the ten feathered arms have been broken short, but it will be seen that these are formed by the five primary arms dividing each into two. The sub-central mouth and eccentric tubular anus are also seen.

The lower specimen shows the dorsal aspect. Here the ten arms are perfect, and the short cirri which cover the back of the disc are well seen.

This is the adult condition. In an earlier stage it is attached to a long stalk and was described as a separate genus under the name "Pentacrinus." The other two members of the order, *Pentacrinus Caput-medusæ* from the West Indies, and *Rhizocrinus* from the coast of Portugal, appear to be perfectly sessile, like the fossil Encrinites.

1535[5]. Fossil Encrinite or stone-lily (*Encrinus liliiformis*), from the Muschel-kalk of Saxony.

This is the "head," corresponding to the free Comatula of the last preparation. It, however, appears to have remained attached to the stalk during its whole life.

Notice the "calyx" or central disk, and the five, jointed, double arms, provided with pinnules on their upper (ventral) surface.

1535[10]. Jointed stem of Encrinite (*Actinocrinus simplex*), from the Wenlock Limestone of Dudley.

Each joint is perforated by a canal, and the whole formed a flexible peduncle, the proximal end of which was attached by an expanded base or by prehensile cirri. Cf. 1341[20].

Sub-Kingdom CŒLENTERATA.

Syn.—Zoophyta, Nematophora. The name Cœlenterata was given by Frey and Leuckart* to these animals, when they separated them from the Radiata of Cuvier, in which (along with the Bryozoa) they made up the classes Polypi and Acalephæ.

Char.—As in all the preceding classes, the protoplasm of the embryo becomes differentiated, so as to produce distinct tissues—cells (endoplasts) and intercellular substance (periplast); and in some cases muscles, and even nervous fibres and ganglia.

In all, the blastoderm (or germinal membrane) of the egg is developed into endo- and ecto-derm, but there is no distinction into "serous" (neural) and "mucous" (hæmal) layers.

There is always a distinct alimentary canal, aproctous and opening freely into (or identical with) the general body-cavity.

Thread cells, or nemato-cysts, are developed; a circum-oral circle of tentacles is nearly as characteristic. Symmetry is radial.

Reproduction is sexual, by fission and by gemmation.

All Cœlenterata are aquatic, and almost all marine.

Text-book.—Greene: A Manual of the Sub-Kingdom, Cœlenterata, 1863.

* Beiträge zur näheren Kenntniss wirbelloser Thiere, 1847.

Class HYDROZOA.

Syn.—Acalephæ of Cuvier (in part), Hydromedusæ.

Char.—Beside possessing the characters common to Cœlenterata, Hydrozoa have an alimentary canal identical with, or at least not separated by its own walls from, the general somatic (perivisceral or peritoneal) cavity. The reproductive organs are developed externally.

All Hydrozoa but two genera (*Hydra* and *Cordylophora*) are marine. None are microscopic, but most small. Sexes generally distinct (*Hydra* is hermaphrodite). Reproduction sexual and by fission and gemmation. Compound organisms (polypidoms) are common, and may be either fixed or free, floating by a pneumatophore, and swimming by nectocalyces. One or two are parasitic on (or live along with*) others of the same class. In a polypidom some polyps may be simply prehensile, others digestive, others offensive, others locomotive, and others reproductive.

Distr.—The fixed Hydrozoa are most common below low-water mark, but do not range so deep as Anthozoa. They are common in all climates, but the large, free-swimming species are most abundant in tropical seas.

Owing to the absence of skeleton, little is known of the previous history of this Class; but the Silurian *Graptolitidæ* probably belong to it.

Class.—The following are the chief families of the Hydrozoa, but no ordinal arrangement has yet been generally accepted.

Hydroida *v.* Hydrophora.	Hydridæ	(fixed)	*Hydra.*
	Corynidæ †	,,	*Coryne, Tubularia.*
	Sertularidæ †	,,	*Sertularia, Campanularia, Plumularia.*
Siphonophora *v.* Physograda	Calycophoridæ †	(free-swimming)	*Diphyes.*
	Physophoridæ †	,,	*Velella, Porpita, Physalia.*
Discophora *v.* Pulmonigrada	Medusidæ (?) †	,,	*Steenstrupia, Aequoria.*
	Lucernaridæ ‡	,,	*Lucernaria, Rhizostoma.*

* "Commensalisme" of Van Beneden. The English term "commensality" owns the respectable parentage of Sir Thomas Browne.

† With free-swimming reproductive zooids (Medusæ), naked-eyed (gymnophthalmous) and craspedote.

‡ With free zooids, steganophthalmous and acraspedote.

Ref.—Forbes: British naked-eyed Medusæ, 1848, figs. Huxley: Oceanic Hydrozoa, 1859 (Ray Soc), figs. Allman: Monograph of Tubularian Hydroids, 1871 (Ray Soc.), col. figs.

Hydroida.

1536. *Corymorpha nutans*, dredged off Foulah Island.

This is one of the Tubularidæ and closely allied to the Corynidæ. It is, unlike most of that group, a simple organism, the hydrosoma presenting a hydrorhiza by which it fixes itself in the mud.

1537. *Sertularia abietina*, growing on an oyster-shell.

A compound sessile hydrosoma, distinguished from Corynidæ and Tubularidæ by the polyps having each a sheath, polyp-cell, or hydrotheca.

1537[5]. Three Sertularidæ:—

1. *Antennularia antennina.*
2. *Sertularia sp* (?).
3. *Plumularia.*

All these were dredged off the North Coast of Devon.

1537[10]. *Campanularia;* microscopical preparation.

Polyp-cells stalked.

1537[20]. A remarkably large Hydroid Medusa: a reproductive zooid.

1537[50]. Fossil Graptolites, from the Lower Silurian of Skiddaw.

Calycophoridæ.

1538. A nectocalyx of *Diphyes*. Pacific Ocean.

This compound Hydrozoon consists of two swimming-bells, so similar and so easily separated that they were once supposed to form two distinct organisms.

Physophoridæ.

1539. Portuguese Man of War (*Physalia*).

British Seas, Mediterranean and Tropics.

This is an oceanic compound organism or polypidom. The large bladder above is the float, or pneumatophore, with a median crest; the long processes which hang down from it are individuals modified so as to form single tentacles armed with thread-cells, and the shorter bodies are digestive polypites without tentacles. There are no swimming-bells in this genus.

1539[2,3]. Two other specimens.

1539[5]. Another specimen, with the float cut open.

1539[10]. Another specimen.

1540. *Velella mediterranea.* Naples.

This compound Hydrozoon also occurs occasionally on the English coast.

Notice the tentacles depending in a circle from the under surface of the horizontal disc, and the crest on the opposite dorsal surface. There are no nectocalyces, and only a single polypite without tentacles which hangs from the centre of the horizontal disc, while between it and the marginal tentacles depend reproductive zooids, which give birth to Medusæ.

1540[5]. Skeleton of *Velella*.

Notice its concentric ribs, its division into four lobes, and the dorsal crest rising at right angles to its upper surface. This disc is the pneumatophore, the pneumatocyst being placed in it where the "crest" is attached.

1541. *Porpita Forskalii* (?). Mediterranean.

In this genus the physophore is flat, and the tentacles and polypites depend from it without any bracts (hydrophyllia) or swimming-bells (nectocalyces).

Discophora.

1542. An acraspedote Medusa (*Aurelia* sp).

Above is seen the large umbrella, below, the fringed processes of the central stalk.

1544. Another steganopthalmous Medusa (*Chrysaora* sp).

Class ANTHOZOA.

Syn.—Actinozoa, Polypi, Coralla, Coralligena.

Char.—Beside the characters common to this class and Hydrozoa (for which see p. 266), the Anthozoa are distinguished by (1) the body-cavity being separated by a process of the endoderm from the digestive cavity, with which, however, it communicates freely; (2) the reproductive organs being internal.

A nervous system and muscular fibres have been demonstrated in some families. Reproduction is sexual and non-sexual, but there is no alternation of generation. Usually diœcious.

All Anthozoa are marine, and most are compound. Most of the polypidoms in this class possess a non-vascular, calcareous, sometimes horny, skeleton, which may be interstitial (sclerodermic), or a mere excretion on the surface of the foot or "anthorhiza" and of the cœnosarc or common connecting flesh of the colony (sclerobasic). Hence, though outside each polyp, the latter comes to form a solid core covered by the living cœnosarc and polyps.

It is of the skeletons of Anthozoa that "coral" is composed, and the coral reefs and islands built up. For a sketch of their mode of formation, see Greene, pp. 191—195, and Nicholson, pp. 129—133.

Distr.—This class is found in all climates, from high water mark to 200 fathoms and more. Being all sessile, they are only occasionally found attached to other bodies in the open sea. The coral-making families are confined to the Mediterranean, the Caribbean Sea, and the Pacific and the Indian Oceans, including the Red Sea.

Pal.—Corals are abundant in the Silurian and other Palæozoic rocks, chiefly belonging to the Order Rugosa. The Alcyonaria are common from the chalk to the present time. Most fossil Zoantharia are sclerodermic, and are found as early as the Silurian period.

Clas.—The Anthozoa are divided into the following Orders :—

Zoantharia *v.* Polyactinia *v.* Hexacoralla.

a. Malacoderma .... *Actinia.*

β. Sclerobasica .... *Antipathes.*

γ. Scleroderma .... *Fungia, Madreporidæ.*

Alcyonaria *v.* Octactinia *v.* Octocoralla.. *Alcyonium, Pennatula, Gorgonia.*

Rugosa *v.* Tetracoralla (extinct) .... *Stauria.*

The Ctenophora, free swimming, simple Cœlenterates, without any skeleton, were classed by Cuvier with the Acalephæ. By Huxley and Greene they are made a fourth Order of Anthozoa; and by Gegenbaur and Haeckel a third class of Coelenterata. To this group belong *Beroe, Cestum Veneris, &c.*

Zoantharia.

1551. Common Sea-anemone (*Actinia mesembryanthemum*).

Notice the marginal tentacles, and the disc, with its oral opening. The ectoderm has been removed from two sides, and shows the vertical lines.

1552. Another specimen, with the mouth closely contracted.

1553. Another specimen, opened by a vertical incision so as to display the mesenteries within, which support the ovaries.

1554. Pink Coral; a compound, branching, sclerobasic corallum of *Stylaster sanguineus* v. *Aulopora rosea.* West Indies.

Each of the minute cups on the branches contained a polyp, by the secretion of the foot of which the entire skeleton was formed.

1555. Calcareous skeleton of the compound genus *Fungia.*

This is a sclerodermic or tissue-secretion. The whole surface is covered with a thin coenosare and only a few tentacles and polyps.

1555[5]. Another small *Fungia.*

1556. A brain stone, skeleton of *Mæandrina cerebriformis.*

A sclerodermic coral belonging to the family *Astræidæ* of the Zoantharia.

1557. Skeleton of *Pavonia.*

A sclerodermic coral of the fam. *Madreporidæ.*

1558. Skeleton of *Scaphophyllia.*

1559. Skeleton of *Galaxea.*

1561. Skeleton of Devonshire Cup-coral (*Cyanthina* v. *Caryophyllia Smithii*).

A sclerodermic coral belonging to the fam. Caryophyllaceæ of Zoantharia.

1562. *Balanophyllia calyculus.*

A fossil coral allied to *Cynthia* and other Caryophyllacea. *B. regia* is a living British species.

Alcyonaria.

1563. Organ Coral (*Tubipora musica*). Two specimens. Indian Ocean.

This is a sclerodermic coral with thecæ but without septa, one of the Alcyonaria. The polyps are green and white. See figs. 8 and 9 in Rymer Jones.

1564. Sea-pen (*Pennatula grisea*).

The thick proximal end of the cœnosarc is fixed in the mud, and the polyps cover the barbs of the feather.

1565. Another species (*P. phosphorea*).

The fleshy stem has been divided so as to show the calcareous sclerobasis within.

1566. Part of the central axis of one of the *Pennatulidæ.*

The stem of which this formed part was about five feet long tapering, with longitudinal cracks, and of the precise colour and apparent texture of a willow-wand. It was sent over from British Columbia as the spinal column of a fish.

1567. The Red Coral of Commerce (*Corallium rubrum*).

This is a sclerobasic or foot secretion, and has therefore a smooth, surface. During life it forms the calcareous axis of a soft cœnosarc covered with polyps.

1568. An Alcyonian Coral, with a soft corallum.

1569. *Renilla.* America.

Here the stalk is a hollow cœnosarc which expands into a disc, on the surface and edges of which the polyps are. It belongs to the family *Gorgonidæ* of Alcyonaria.

Rugosa.

1570. A Fossil Corallite (*Cyathophyllum Stutchburii*), from the carboniferous limestone, cut lengthwise and polished.

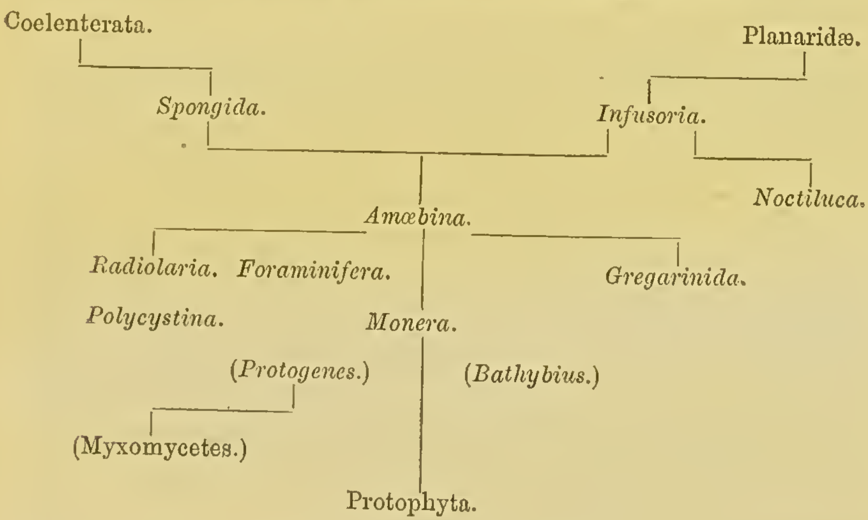
The hollow calyx is seen above; the septa are incomplete.

Sub-Kingdom PROTOZOA.

Syn.—Amorphozoa : Oozoa.

Char.—Unicellular, usually microscopic, organisms, without alimentary canal, nervous or muscular system. Simple and compound.

The classes Spongida and Infusoria, which are conveniently placed in this sub-kingdom, differ from other Protozoa in possessing cilia and sexual reproduction, the former having affinities with Coelenterata and the latter with Vermes. The remaining forms fall into certain natural groups, the lowest of which are indistinguishable from the simplest plants (Protophyta) and hence have been united with them by Professor Haeckel under the common title Protista. The following table shows the relations of these groups :—



Refs.—Ehrenberg: Die Infusionsthierchen, 1838. *Greene: Protozoa*, 1863. Haeckel: Die Radiolarien, 1862 and Studien über Moneren, 1870. Pritchard: Infusoria, 1871, plates.

Class PORIFERA.

Syn.—Spongida, Spongiaria.

Char.—Sponges differ from all the higher animals, and resemble the other Protozoa in having no differentiation of tissue, i.e., no cells, fibres, &c.*; their body being "unicellular," i.e., consisting of more or less dense protoplasm or sarcode. Like the others they have no alimentary canal, and like them (except the Infusoria) have not even a mouth.

They may be defined as social, ciliated, amœbiform Protozoa.

They are all aquatic, and all but the genus Spongilla marine. They secrete a horny, siliceous or calcareous skeleton. They reproduce by gemmation and encystment, but also by true sexual generation.

Affinities.—Sponges were regarded as plants by Linnæus and many later naturalists. After their animal nature was clearly proved by Lieberkühn and Grant, they were regarded as belonging to the Cœlenterata by Leuckart in 1854, and though this author afterwards left them out from his new sub-kingdom, Professor Haeckel has again united them with Hydrozoa, Anthozoa, and Ctenophora. This view requires us to regard each "hillock" of a sponge as an individual, of which the sponge animalcules are the component cells, and the pores and cavities the alimentary canal. Even then the absence of tentacles and thread-cells would widely separate sponges from the other classes. Most English observers, however, and Gegenbaur and Oscar Schmidt in Germany, regard sponges as compound Protozoa.†

Distr.—This class is widely distributed in tropical, temperate, and even arctic seas. Those found at great depths are usually siliceous. One genus (*Cliona*) inhabits passages which it makes in shells.

---

* Recent observations make it doubtful whether these, as well as other protozoic characters, are applicable to all sponges.

† On this question see Lankester in Ann. and Mag. Nat. Hist., July, 1870

Sponges are found in the Silurian and all subsequent formations. They are most abundant in secondary rocks, especially the chalk, where their siliceous spicules have been one source of flints.

Clas.—The group is divided as follows by Professor Hæckel:—

Myxospongiæ, without a skeleton .... *Halisarca.*
Fibrospongiæ, including Ceratosa with horny skeleton, Silicea with flinty skeleton, and numerous mixed forms,
Euspongia, *Spongilla*, *Euplectella.*
Calcispongiæ *v.* Petrospongiæ, with chalky skeleton .... *Grantia.*

Lit.—Grant: Obs. and Exp. on str. and funct. of Sponges, Edin. Phil. Jour., 1825-1827. Bowerbank: Monograph of British Spongiadæ, 2 vols., pl., (Ray Soc.) 1864-66. Oscar Schmidt: Spongien des Adriatischen Meeres, 1862-68, and Grundzüge einer Spongienfaune des atlantischen Gebietes, 1870. Haeckel: Die Kalkschwämme, 3 vols., pl., 1872.

1571. Horny skeleton of the common Bath Sponge (*Euspongia officinalis*). Levant and W. Indies.

Notice the large funnel-shaped openings (infundibula) at the apices of the mamillary projections, The small pores scattered over the whole surface admit the water; the infundibula, or oscula, give it exit. It grows with the mamillary hillocks depending into the water.

Cf. Rymer Jones, fig. 2,

1572. Alveolated Sponge.

1573. Calyciform Sponge.

1574. Siliceous skeleton of Venus' Flower-basket (*Euplectella speciosa* sive *aspergillum*). Philippine Islands.

1575. Neptune's Cup (*Raphyrus patera*).

This sponge-skeleton consists of minute folted siliceous spicules.

1576. Common Skull-sponge (*Tethea cranium*), in section.

There are no apparent oscula. The spicula are siliceous. See fig. 7 in Greene's Protozoa, with description.

1577. *Polymastia mammillaris.*

The oscula are situated on the mamillary processes or "fistulæ" which cover the free surface.

1578. *Halichondria suberea.*

Class RHIZOPODA.

Char.—Protozoa without cilia, with no differentiation of tissues except that some have a *nucleus* ("cells"). Others are without even this ("cythodes"). They all have *pseudopodia*, and most, *vacuoles*. Reproduction is by fission, gemmation or "encystment," never by true generation. Many inhabit the sea (Radiolaria, or Thalassicollida), others fresh-water (Amoebina or Lobosa). Many are naked, but a large number of both recent and fossil families form beautiful siliceous or calcareous shells (Polycystina and Foraminifera or Reticularia), perforated by openings through which they thrust their pseudopodia. These are both marine in habit.

The ciliated Protozoa (Infusoria) and parasitic (Gregarinida) have no hard parts.

Palæontology.—Foraminifera are found from the Silurian period onwards, often in great abundance. Chalk is almost entirely composed of their shells, and a similar deposit is now taking place in certain parts of the deep Atlantic. The largest Nummulites belong to Eocene and other tertiary strata.

Ref.—Joh. Müller: Thalassicollen, Polycystinen u. Acanthometren, 1858. Williamson: Recent British Foraminifera (Ray Soc.). 1858, plates. Carpenter: Introd. to the study of the Foraminifera (Ray Soc.), 1862, plates.

1580. A fossil Nummulite (*Nummulina*). Egypt.

These large Foraminifera, so named from their resemblance to coins, form the greater part of the stone of which the Pyramids are built. Others are more distinctly whorled, and thus resemble Ammonites and other Cephalopoda, with which they were confounded before Dujardin demonstrated their real character.

1581. Two Nummulites. Torres Straits.

1582. *Orbitolites complanatus.* Fam. *Nummulidæ.* Seychelle Islands.

These specimens (given the writer by Mr. H. B. Brady, of Newcastle, with the following examples of Foraminifera) were dredged in eight fathom water off Port Victoria. Use a low power or good pocket lens, and compare Carpenter, loc. cit., pl. ix.

1583. *Rotalia Beccarii.* Fam. *Globigerinidæ.*

From the sand on tho Northumbrian coast. Some of these specimens show beautifully tho flat, multilocular spiral shell which so curiously mimics that of tho Nautilus (Williamson, pl. ix).

1584. *Vaginulina linearis.* Fam. *Lagenidæ.*

These were dredged off Berwick in thirty to fifty fathoms water. The shells resemble twisted ropes. This genus, made by D'Orbigny, is a variety of *Dentalina* (Williamson) or of *Nodosarina* (Rupert Jones and Parker). Cf. Williamson, pl. ii., fig. 40.

1585. Half of a gigantic compound Foraminifer, belonging to the genus *Parkeria.* Fam. *Lituolinidæ.*

The test here is arenaceous. For details of structure see Carpenter and Brady (Phil. Trans., 1869, p. 721, with plate lxxii).

1586. Testa of *Difflugia* ; micr. prep.

This "carapace" or "lorica" is membranous, and covers all but a small part of the sarcode where the pseudopodia are thrust out.

1587. Testæ of *Polycystina* ; micr. prep.

The siliceous shells contain a dark mass of protoplasm in their upper part, which sends out pseudopodia through the foramina here seen.

Part III. — PATHOLOGICAL SPECIMENS FROM THE LOWER ANIMALS.

Series I.—DISEASES OF BONES.

1601. Femur of Rabbit, sixteen days after fracture.

This, and the twenty preparations which follow, form a series illustrating Mr. Bransby Cooper's experiments on the repair of fractures.

See Guy's Hospital Reports, vol. ii., p. 179; vol. iii., p. 111.

1602. Another specimen.

1603. Femur of Rabbit, 4 weeks after fracture.

1604. Femur of Rabbit, 5 weeks after fracture.

1605. Another specimen.

1606. Femur of Cat, 6½ weeks after fracture.

1607. Femur of Rabbit, 7½ weeks after fracture.

1608. Femur of Rabbit, 8½ weeks after fracture.

1609. Femur of Rabbit, 9½ weeks after fracture.

1610. Femur of Cat, 10 weeks after fracture.

1611. Femur of Cat, 11½ weeks after fracture.

1612. Fracture of tibia of Dog (wet).

1613. Badly fractured femur (longitudinal section), epiphyses ununited.

1614. Badly fractured femur—firm osseous union.

1615. Fractured femur—bony union.

1616. Fractured femur of Hare, with normal femur in contrast.

1617. Fractured femur.

1618—22. Preparations illustrating mode of repair in Dog after removal of parts of bone.

1618. Repair after 1 inch of radius removed.

1619. Another specimen.

1620. Radius 1 inch removed and ulna fractured.

1621. Radius partly removed.

1622. Radius two inches removed.

1623. Case with ten specimens of fractured femur of fœtal foal.

1624. Compound fracture of humerus of horse (injected).

1625. Ungual phalanx of horse with the anterior superior edge broken off.

1626. Fractured tibia and fibula of Dog.

1627. Fractured tibia—longitudinal section.

1628. Fractured humerus of Duck. Presented by Mr. Thomas Silk.

1629. Specimens of fractured ribs of Horse.

1630. Fractured rib of a Pig.

1631. Ancylosed ribs.

1632. Exostosis of femur of Cat.

1633. Bony tumour of rib of Sheep. Presented by Mr. Bawtree.

1634. Metacarpal bone of Calf with large exostosis.

1635. Humerus of Horse, longitudinal section.

1636. Diseased humerus of Horse, longitudinal section (wet).

1637. Vertebræ of Horse, with large exostosis and extensive ancylosis.

This has apparently been chiefly due to ossification of the anterior common ligament.

1638. Knee (carpus) of Horse, ancylosed, and with exostosis.

1639. Another specimen, with very large bony growth.

1640. Third metacarpal (shank-bone), with the "styloid" or splint-bonos (2nd and 4th metacarpals) ancylosed.

1641.
1642. Two other specimens, with exostoses.

1643. Exostosis of the first phalanx (cannon bone or pastern).

The joints appear to be froe from disease.

1644. Exostosis of pastern, not affecting the joint.

1645.
1646. Large exostosis of pastern.

1647.
1648. Two specimens with the joints largely implicated.

1649. First and second phalanges ancylosed, with numerous exostoses.

1650—1655. Six similar specimens.

This chronic arthritis, with eburnation of the articular surfaces and formation of osteophytes and bony ridges, is apparently of the same character as the disease known in human pathology as Osteo-arthritis longa, improperly called "Rheumatic gout," "*arthrite sèche*" of the French, "*arthritis deformans*" of the Germans.

1656. The three phalanges of a Horse's digit (pastern, coronal, and coffin bones), all affected with exostoses.

1657. Another specimen, with ancylosis between the first two.

1658. Another specimen—very large exostosis on coffin bone.

1659. Two specimens of coffin bones (ungual phalanges) affected by the same disease.

Here the ligaments have become extensively ossified, forming what are called "ring bones."

1660. Tarsus diseased in the same way. Presented by Mr. Charles Clarke.

"This was the near hock of a bay pony, which worked several years with both hind legs thus diseased. Ho died from diseaso of the heart."

1661. Tarsus, with ancylosis and exostosis.

1662. Scaphoid and oxtornal cuneiform bones (ossa planiformia superius and inferius) ancylosed.

1663. Exostosis of third metacarpal bone of hind leg.

1664. Bones of foot of Bird with exostoses.

1665. Cystic tumour of bone of Horse.

1666. Ossification of perforans tendon and suspensory ligament of flexor profundus digiti in the Horse.

Series II.—DISEASES OF THE ALIMENTARY CANAL.

1667. Œsophagus of Ox—enormously dilated and affected with so-called fungoid disease.

1668. Stomach of a Dog, the subject of rabies.

1669. Intestine of Dog, after application of a ligature.

1670. Another specimen.

1671. Intestines of Rabbit, showing the process of repair after being wounded; presented by Mr. Morgan.

1672. Malignant disease of intestine of Cat.

1673. Nodules in intestine of Sheep.

1674. Diseased mesenteric gland of Monkey.

1675. Enlarged mesenteric glands of Rabbit.

1676. Thickened omentum of Horse.

1677. Omentum of Horse, affected with melanosis.

1677^5. Calcareous deposits in peritoneum of Cow.

1678. Three hair-balls from the stomach of a Cow.

1679. Large hair-ball from stomach of Cow, with another still larger in section.

1680. A smaller hair-ball in section.

1681. Bezoar from the stomach of a Goat.

These concretions were formerly used in pharmacy. They contain either Ellagic Acid, which is also procured from gall-nuts, or Lithofellic Acid, a crystalline compound, resembling Cholesterine.

1682. Two enormous calculi from the stomach of a Horse, both in fragments.

1683. Two other large calculi from stomach of Horse.

1684. A third in section.

1685. Earthy calculus from stomach of Horse.

The nucleus was formed by a brass button.

1686. A similar gastric calculus from stomach of Horse.

In this case the nucleus consisted of a fragment of iron.

1687. Lithic acid calculus from stomach of Horse.

1688. A similar specimen.

1689. Other gastric calculi of Horse.

1690. An enormous gastric calculus from a Horse, composed of phosphate of lime.

1691. A smaller similar calculus.

1692. A calculus consisting of chloride of ammonium and ammonio-magnesian phosphate.

1693. Large intestinal calculus of Horse, like that removed from the stomach (1690).

1694. Intestinal calculus of Horse, in section.

1695. Several intestinal calculi of Horse.

1696. Similar calculi.

1697. Pin found transfixing the gizzard of a Duck.

1697[5]. Double cloaca and rectum of a Fowl.

1698. Pieces of charcoal from the stomach of a Crocodile.

1699. Liver, with dilated gall-ducts, of Ox.

1700. Cancer of liver of a Sheep.

Series III.—DISEASES OF THE ORGANS OF RESPIRATION, &c.

1702. Larynx of Dog plugged with tripe, epiglottis ulcerated.

1703. Larynx of Horse which died of Hydrophobia.

1703[5]. Part of a tuberculous lung of an Ox; from Mr. Lacey.

"Each nodule appears to be a fibrous tumour with caseous deposit within."

1704. Pneumonia in the Ox.

1705. Melanosis of lung of Calf.

1706. Disease of lung of Horse (5000).

1707. Melanosis of lung of Horse.

1708. Another specimen.

1709. Another specimen (5030).

1710. Another specimen of melanosis of lung of Horse.

1711. Four specimens of morbid enlargement of Thyroid.

1711[20]. Thyroid of Ox, greatly enlarged by malignant disease; presented by Mr. B. N. Dalton.

Series IV.—DISEASES OF THE ORGANS OF CIRCULATION.

1712. Calcified pericardium of Sheep; presented by Dr. Addison.

1712[5]. "Fungoid disease" of pericardium of Ox.

1713. Another specimen from a Cow.

1714. Another specimen.

1715. Part of the ventricle of the same animal.

1716. Malignant nodules from heart of Ox.

1717. Aneurysm of abdominal aorta of Horse.

Series V.—DISEASES OF THE NERVOUS SYSTEM.

1719—1728. Ten dissected specimens, illustrating experiments by Mr. Hilton on the reunion of nerves after section.

1729. Fungoid disease of eye of Horse; from the Royal Veterinary College.

"The capsule of the lens was rendered distinct by the disease."

1730. Another specimen of the same disease.

1731. Malignant tumour of eye of sheep.

Series VI.—DISEASES OF KIDNEY AND BLADDER.

1732. Lardaceous disease of kidney of Bullock.

1733. Kidney of Sheep affected with hydro-nephrosis.

1734. Bladder of Horse with two cysts opening into it.

1735. Mulberry calculus from kidney of Horse.

1736. Renal calculi from Sheep.

1737. Calculus from bladder of Horse.

1738. Several calculi from bladder of Horse.

1739. Numerous calculi from bladder of Bullock.

1740. Fusible calculi from Dog's bladder.

1741. Calculi from bladder of Pig.

Series VII.—DISEASES OF THE ORGANS OF GENERATION.

1742. Imperfect male organs of Sheep.

1742[5]. Allantois and chorion of fœtal Calf, showing a partial, but very firm, adhesion between the two.

1742[10]. Small rodent, with a double funis connecting it with two discoid placentæ.

There is also a large blood-vessel passing from one to the other.

1743. Ovarian disease in a bird.

1744. Section of the diseased ovary of a Hen; presented by the late Treasurer, Mr. Harrison.

1745. A similar specimen.

1747. Double egg, already calcified, of Hen.

1748. Section of egg of Hen with double yelk.

1749. Egg of Fowl with double yelk.

1750. Case with wax models, showing the way in which twin ducklings and their yelk-sacs are packed in the shell.

1750[5]. "Membranes found on egg of Fowl."

Series VIII.—FŒTAL MALFORMATIONS.

1751. Kitten with one head and two bodies.

1752. Bicephalic Kitten.

1753. Monophthalmic Kitten.

1754. Skeleton of fœtal kitten with two skulls partially fused.

1755. Puppy with single head and two bodies.

The heart is single, but the abdominal viscera are all duplicate.

1756. Puppy with two heads; viscera dissected.

1757. Skeleton of fœtal Puppy; face entirely absent.

1758. Skeleton of two fœtal Pigs; partially united, the skull being single.

1759. A similar larger specimen; the skull more perfectly single.

1760. A similar specimen; the two skulls only partially fused.

1761. Double skull of fœtal Pig, partially fused; calvarium wanting.

1762. Monstrous fœtal Pig dissected; abdominal parietes absent.

1763. Fœtal Pig, with malformation of face.

1764. A similar specimen.

1765. Fœtal Pig, with lower jaw deficient.

1766. Fœtal Pig, with lower jaw deficient, and otherwise malformed

1767. Skull of fœtal Pig, monophthalmic, and with malformed jaws.

1768. A somewhat similar specimen.

The malformation of its jaws is still greater here.

1769. Five fœtal Pigs united together.

Three were found external to uterus.

1770. Fœtal Calf with two heads.

1770^{5}. Skeleton of fœtal Calf with two heads and spina bifida; presented by Sir A. Cooper.

1771. Fœtal Lamb, with the abdomen and posterior extremities double. Partly dissected.

1772. Fœtal Lamb, with four ears, double body and single head, dissected.

1773. Malformed foot of Calf.

1774. Two Chicks with separate yelk-sacs; very partially united.

1775. Two Chicks ununited, but with the yelk-sacs fused together.

1776. Double Chick.

1777. Duck with two heads.

1778. Duck with four legs.

Series IX.—TUMOURS, &c.

1779. Section of an adventitious horny growth from a Sheep.

1780. Tumours on legs of Magpie.

1781. Foot of Goose; showing an inflammatory swelling, produced by a thorn.

INDEX GENERUM.

[Those printed in *Italics* refer to Fossil Specimens.]

*** For the meanings of the names of Classes and other divisions, see the Glossary at the end of Huxley's Introduction to Classification.

INDEX GENERUM.

72