POPULAR GUIDE

to the

Geological Collections

in the

Indian Museum, Calcutta.

No. 4.—PALÆONTOLOGICAL COLLECTIONS, by OTTOKAR FEISTMANTEL, M.D., *Palæontologist, Geological Survey of India.*

GOVERNMENT CENTRAL PRINTING OFFICE.

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PREFACE.

IN issuing this Popular Guide to the Palæontological[1] Gallery, it is hoped that it will prove of some use to the visitor, for although the collections contained in the Gallery are not yet completely arranged in detail, they are approximately in the order which they will occupy after the detailed arrangement is perfected, at least for a long time to come.

As regards the general biological series, the arrangement of the plant remains is based upon Prof. Schimper's system in the recent Hand-book of Palæontology [2] and in his Traité de Paléontologie végétale, 1869-1874.

The animal collection is in general arranged according to the system in the last edition of Nicholson's Manual of Palæontology, 1879; but besides this other works have been used, as Milne Edwards' and Haimes' works on "palæozoic corals," and the Monograph of the British fossil corals; Zittel's Hand-book of Palæontology, part Echinodermata and Brachiopoda; the Catalogue of Echinodermata in the Museum of the Geological Survey of India, published 1865; Barrande's Silurian system, part Trilobita; Prof. Oppel's Palæontologische Mittheilungen, for macrurous crustacea from Solenhofen; Woodward's Manual of Mollusca; Quensted's Petrefactenkunde, 2nd edition; S. A. Miller's

[1] Παλαιὸς (Gr. palaios)=old, ancient, ὢν-ὀντὸς (Gr. on-ontos), the being, *i. e.*, remains of plants and animals, which are contained in the strata composing our earth's crust.

[2] Handbuch der Palæontologie; by Zittel and Schimper, Vol. II, 1879-1880.

Catalogue of American Palæozoic Fossils, 1877; R. Etheridge's Calalogue of Australian Fossils, 1878; Catalogue of Cephalopoda in the Museum of the Geological Survey of India, published 1866; Owen's Extinct Birds of New Zealand, 1878. I have not yet had sufficient leisure to arrange the *Spongida* according to Prof. Zittel's recent works on this difficult order.

The Indian fossils are arranged according to the Manual of Geology of India, 1879, and according to the papers contained in the Palæontologia Indica.

As it is the intention in this Guide to give only a general idea of the classes, orders, and families of the fossils in the collection without entering into the details of minute division and classification of the genera and species, it is hoped it will be looked at from this point of view.

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The palæontological collections, except the main series of the tertiary vertebrate animals,[1] are placed in the upper northern gallery.

There are two collections in this gallery:—

(*a*) A general collection of fossil plants and animals arranged biologically; aud

(*b*) A collection of Indian fossils, arranged stratigraphically.

A.—THE GENERAL BIOLOGICAL SERIES.

This collection is placed in the large upright cases running along both side-walls of the gallery and numbered 1 to 50; the numbering (No. 1 case) begins at the west end of the south side of the gallery.

The fossils of all formations combined are arranged in these cases in ascending biological order, from the lowest to the highest, through all classes, orders, families, &c., of the vegetable and animal kingdoms; so far the classification is now carried out.

[1] This collection will be found in the western gallery on the lower floor to the left (north) of the chief entrance to the Museum, and a guide to it was written by Mr. Lydekker.

The further detailed arrangement will exhibit the species of each genus in stratigraphical order, *i.e.*, placed according to the formations in which they are known to occur, proceeding from the lowest to the highest.

Within several classes this arrangement has already been effected; but others, such as the *Brachiopoda*, *Lamellibranchiata* and *Gasteropoda*, await still this detailed grouping of the species. It is a tedious operation and cannot be accomplished for some time.

Cases. Each wall case contains five shelves. The uppermost shelf with a horizontal board, at present mostly empty, is used for duplicate specimens of the general collection, or for occasional large specimens. It will not be taken into consideration in the present description.

The next four shelves with inclined boards are distinguished in descending order, as 1, 2, 3, and 4.

Labels. The several biological groups are distinguished in order of magnitude or rank by labels printed in different sizes of type.

The labels in largest type, placed outside the cases at the top, indicate the largest division, that of a sub-kingdom or branch.[1]

The next smaller type indicates the classes, the next one the orders, and a fourth one the families.

These three last-named labels are placed within the case, and are fixed on the margin of the respective shelves.

To illustrate this take the following instances :—

(*a*).—Amongst the plants—

Gymnosperms is a sub-kingdom.
Coniferæ is a class.
Abietaceæ is an order.
Walchieæ or *Voltzieæ* is a family.

(*b*).—Amongst the animals five groups had to be distinguished, as between the sub-kingdom and the class in several instances another name, that of a division, had to be intercalated. As an instance may be mentioned—

Annulosa represents a sub-kingdom.
Arthropoda a division.
Crustacea a class.

[1] It was not thought necessary to distinguish the largest division as "plants" and "animals."

Decapoda an order.
Macrura or *Brachyura* a family.

The names of genera are at present on written labels on each shelf, but ultimately they also will be printed and fixed in small stands.

I.—General Collection of Fossil Plants.

This collection is contained in the wall cases No. 1 to No. 12, beginning at the west end on the south side to the left of the entrance from the corridor.

Thallophyta[1]—*Algæ*.

Case 1, Shelf 1. *Algæ*.

Representatives of the lowest class of plants—the *Thallophyta*. They comprise the *Algæ* (including *Characeæ*)[3] and *Fungi*[4] (including *Lichenes*[5]). The former only are here represented. The seaweed family now living is very numerous. In the fossil state it is poorly represented, and generally in badly preserved specimens. In certain marly shales of the Alps and Carpathian mountains (Flysh and Vienna sandstone) certain forms of seaweeds are, however, very numerous and constant; the best known are *Chondrites targioni*, Bgt., and *Chondr. intricatus*, F. O. There are several specimens on this shelf.

On the same shelf there are also a few representatives of the *Characeæ*, a sub-division of the seaweed family.

Pteridophyta. —*Equisetaceæ*.[7]

On the next shelf we find the beginning of a new sub-kingdom of plants, that of the *Pteridophyta*, which includes the *Equisetaceæ*, *Filices*,[8] *Lycopodiaceæ*,[9] and some other extinct orders.

Case 1, Shelf 2. *Equisetaceæ*. *Asterophyllitea*.

The *Equisetaceæ*, which in present times are represented by the herbaceous "horsetails," were in geological times more numerous and various, of larger dimensions and represented by several orders.

[1] Θάλλος (thallos)=a frond; φυτὸν (phyton)=a plant.
[2] Seaweed family.
[3] Called so from the genus *Chara*.
[4] Mushroom family.
[5] The Lichen family.
[6] Πτέρις (Gr. pteris)=a fern; φυτὸν (Gr. phyton)=a plant.
[7] Horse-tail family.
[8] Fern family.
[9] Club-moss family.

On this shelf there are of the order *Equisetaceæ* at first a few specimens of *Equisetum* (true horse-tail). Next to this genus is *Phyllotheca*,[1] which has, like *Equisetum*, the leaflets joined to a sheath. It has an interesting geological range, from carboniferous in Australia through several other formations, to jurassic in Siberia, Europe, &c.

Several specimens from Australia are exhibited from the Newcastle beds.

To the *Equisetaceæ* also belongs the genus *Schizoneura*,[2] the leaves of which were at first joined to a sheath, but split during the growth of the plant into two or more portions or into the leaflets. It is a genus which occurs in Europe in triassic and rhætic rocks. In India it is very numerous (at least locally) in the coal measures, especially in the higher portion. No specimens are exhibited here, as no foreign examples are at hand; those from India will be found elsewhere.

Case 1, Shelves 3 and 4. *Asterophylliteæ.*

On the same shelf the order *Asterophylliteæ*[3] comes in, with the genera *Asterophyllites*, *Annularia*,[4] and *Sphenophyllum*;[5] the former two are palæozoic only; the third is also chiefly palæozoic, but has also a representative, *Trizygia*, (leaflets arranged in three pairs), in the Indian coal-beds. There are also some specimens of fructification, which were described as *Volkmannia*,[6] *Bruckmannia*,[7] &c., and which belong to the *Asterophylliteæ*.

Case 2, *Calamarieæ.*

In this case the visitor will find (on all four shelves) specimens of articulated stems, ribbed and lined on the surface. They are known by the name of *Calamites*, Suck.,[8] and are placed in the order *Calamarieæ*, which, however, also belongs to the *Equisetaceæ*.

They are most numerous in carboniferous rocks, in which period they attained great dimensions and contributed largely to the formation of the coal seams.

[1] Φύλλον (Gr. phyllon)=a leaf; θήκη (Gr. theke)=a sheath.

[2] Σχίζω=to split; νεῦρον=the vein (nerve). When Prof. Schimper first established this genus he thought that the sheaths split along the veins; hence the name. This was, however, found later by Prof. Schimper himself to be erroneous, the splitting taking place along the sutural lines. The name, therefore, is not quite appropriate.

[3] Ἀστήρ (aster)=a star; φύλλον (phyllon)=a leaf.

[4] *Annulus*=a ring, referring to the arrangement of leaves.

[5] Σφήν (sphen)=a wedge; φύλλον=a leaf.

[6] & [7]. From proper names.

[8] *Calamus*=a cane.

PTERIDOPHYTA.—*Filices.*

The fern family displays in the present day a great number and variety of forms as regards the size of individuals, form of leaves and manner of fructification. Cases 3–6.

Ferns are equally numerous in geological times, especially in the carboniferous period.

Only those ferns which are found with the fructification can, with some certainty, be classed with orders of recent ferns, while those in which the fructification is unknown (or known imperfectly) have to be classed in separate orders. The ferns in our collection have been arranged according to this distinction, and those of which the systematical place, with regard to living ferns, is known certainly or approximately, are placed first.

They are, however, not many. The *Gleicheniaceæ* of the recent flora, the typical genus of which family is *Gleichenia*, which also is found in the fossil state, are represented by a specimen of the genus *Didymosarus*,[1] hitherto known from cretaceous rocks only. Case 3, Shelf 2. *Gleicheniceæ.* *Schizæaceæ.* *Marattiaceæ.* *Cyatheaceæ.*

Next to *Didymosarus* is *Lygodium*,[2] as representative of the family *Schizæaceæ;* it is a recent genus and found fossil in cretaceous aud tertiary rocks.

Several forms, which were formerly placed with the *Tænitopterideæ*, are now classed (by Prof. Schimper) with the *Marattiaceæ;* the type genus, *Marattia*,[3] is represented in our collection by several specimens, and is found in rhætic and liassic beds of Europe; it is also a living genus.

With the *Marattiaceæ* are also placed by Prof. Schimper a number of fructificating ferns of the coal period, which he classes under the head *Angiopecopterideæ*. The genus *Oligocarpia*[4] represents in our collection this family.

The next family represented is that of the *Cyatheaceæ*. Here we have the genus *Cyathea* itself, which comprises certain fossil ferns from the coal-basin of Kusnezk (jurassic) in the Altai mountains of Siberia.

Adjoining this are representatives of the family *Polypodiaceæ* (so called from the genus *Polypodium*); first a

[1] Δίδυμος (Gr. didymos)= double; σῶρος (Gr. soros)=a heap, referring to the arrangement of the fruit heaps (*sori* or *sporangia*) in the leaflets.

[2] Λυγώδης (lygodes)=like a willow-twig.

[3] Marattia=a living genus.

[4] Ὀλίγος (Gr. oligos)=few; καρπὸς (Gr. karpos)=fruit.

tertiary *Pteris;* then several specimens of *Asplenium.* This comprises most of those mesozoic forms which were placed with *Alethopteris,*[1] and which latter were joined to the "group of *Alethopteris whitbyensis,* Göpp;" in this sense *Asplenium,* as fossil, would commence in the rhætic formation.

These are all the representatives of recent families, and the forms following are of uncertain systematical position.

Case 3, Shelves 2 and 3. *Sphenopterideæ.*

At first we find the *Sphenopterideæ* (shelf 2) with the type genus *Sphenopteris,*[2] Bgt. This genus is especially palæozoic and has been divided into several sub-genera, according to the shape and segments of the pinnæ. In our collection there are forms from carboniferous and permian rocks, and from the Australian Newcastle beds (on shelf 3). With the *Sphenopterideæ* is also placed the interesting genus *Rhacopteris,*[3] Schimp., which is a palæozoic fern, occurring in lower (Culm) and upper carboniferous rocks of Europe, and lower coal measures of New South Wales, from where I have first described several species of this genus.

Case 4, Shelves 3 and 4. *Palæopterideæ.*

Next to *Rhacopteris* is the genus *Palæopteris*[4] as the type of the *Palæopterideæ,*[5] which, as the name implies, are all ancient forms. The best known species is *P. hibernica*[6] from the old-red in Ireland. These forms were formerly classed by Schimper with the following family (the *Neuropterideæ*), but are now made the types of a separate family.

In the middle of the lowest shelf we find representatives of the *Neuropterideæ* with *Neuropteris,*[7] which is a palæozoic genus, being most numerous in carboniferous rocks. But there is a representative of the palæozoic genus in the European trias, which has a single-pinnate leaf, and which was distinguished by Prof. Schimper by the name of *Neuropteridium.* (Analogous forms will be mentioned in the Indian portion of the collections from the Karharbári beds.)

Case 3, Shelf 4. *Neuropterideæ.*

A sub-family of the *Neuropterideæ* is that of the *Dictyoneuropterideæ,* represented by the palæozoic *Dictyopteris.*[7]

[1] Ἀλήθης (Gr. alethes)=true; πτέρις (Gr. pteris)=fern.

[2] Σφὴν (Gr. sphen)=wedge; πτέρις (referring to the wedge-shaped form of the last segments of the frond).

[3] Ῥάκος (Gr. rhakos)=a rug; πτέρις, referring to the ruggy appearance of the pinnulæ.

[4] Παλαιὸς (Gr. palaios)=ancient.

[5] =Irish.

[6] Νεῦρον (Gr. neuron)=a vein.

[7] Δίκτυον (Gr. diktyon)=a net (the net fern).

Cardiopteris,[1] also palæozoic, is here placed with the *Neuropterideæ*.

The family *Odontopterideæ* concludes shelf 4 of case 3. Case 3, Shelf 4. *Odontopterideæ*.

The type genus is *Odontopteris*,[2] a palæozoic genus, mostly carboniferous.

Formerly the genus *Thinnfeldia*[3] used to be classed either with the *Neuropterideæ* or *Odontopterideæ*; but at present it is placed in a separate family, the *Lomatopterideæ*, and specimens of it are placed in the beginning of shelf 2, case 4. Case 4, Shelf 2. *Lomatopterideæ*.

In this same shelf we also find the beginning of the large family *Pecopterideæ*, which includes various genera, the type genus *Pecopteris*[4] occupying the rest of shelf 2, the entire shelf 3, and the beginning of shelf 4. Case 4, Shelves 2, 3, 4. *Pecopterideæ*.

On the same shelf (4) there are other genera of *Pecopterideæ*, all mesozoic.

In the next case also representatives of *Pecopterideæ* are contained, the genus *Alethopteris* being especially conspicuous, mostly of the palæozoic epoch. The mesozoic forms of *Alethopteris* were already mentioned with *Asplenium*. Case 5, Shelves 2, 3, 4. *Pecopterideæ*.

In a sub-family of the *Pecopterideæ* is now placed the genus *Callipteris*,[5] of the permian period, and which formerly used to be classed with the *Odontopterideæ*, and also with the *Neuropterideæ*. Representatives of it are found on the lowest shelf (4) at the beginning.

Next follow two specimens of the *Tæniopterideæ* representing two genera *Tæniopteris*[6] and *Oleandridium*.[7] The *Tæniopterideæ* are ribbon-like ferns of various sizes, with a distinct mid-rib and with straight, single, or dichotomous secondary veins. (Many more representatives of this family will be found in the Indian portion of the collections from the Rájmahál group of rocks.) Case 5, Shelf 4. *Tæniopterideæ*.

In the same shelf we find an interesting group of forms, that of the *Glossopterideæ*.[8] Prof. Schimper classed them recently as a sub-family of the *Tæniopterideæ*. The only genus is the famous *Glossopteris*, Bgt., so numerous in the Case 5, Shelf 4. *Dictyotæniopteridæ* or *Glossopteridæ*.

[1] Καρδια (Gr. kardia)=the heart (referring to the heart-shaped leaves).
[2] Ὀδούς (Gr. odus)=a tooth.
[3] From a proper name.
[4] Πέκω (Gr. pekō)=to comb; πτέρις (pteris)=a fern.
[5] Κάλλος (Gr. kallos)=beauty.
[6] Ταινία (Gr. taenia)=a ribbon.
[7] Oleandra=a living fern.
[8] Γλῶσσα (Gr. glossa)=tongue; πτέρις (referring to form of the leaf).

Australian coal measures and in the lower portion of the Indian Gondwána system ; and occurring also in South Africa ; it is also known from the Upper Gondwánas in India, so that it has a known range from lower carboniferous (Australia) into jurassic (India). It has leaves of various sizes and shapes with a distinct mid-rib, and the secondary veins running out at various angles and anastomosing, forming areolæ of various sizes and shapes.

Case 6, Shelves 2, 3.

The family *Dictyopterideæ*,[1] with which *Glossopteris* was formerly classed, has its representatives in the next case, on shelf 2 and in the beginning of shelf 3.

The most characteristic forms of this family are met with in mesozoic rocks, and especially in rhætic and liassic beds of Europe.

Of special interest is *Sagenopteris*,[2] a fern with a fingered leaf, the single leaflets showing only an indication of a mid-rib at the base and having the rest of the venation areolated.

Case 6, Shelf 3. *Schizopteris.*

On the same (third) shelf there are also one or two specimens of a peculiar (palæozoic) genus, known as *Schizopteris*,[3] Bgt., or *Rhacophyllum*,[4] Schimp. The true nature is not always quite clear; some of them are leaflets, *pinnæ adventiliæ*, developed at the base of the pinnæ in certain ferns, and find then their analogy in similar forms on recent ferns.

Case 6, Shelf 4. Stems and rhizomes.

The lowest shelf contains specimens of stems and rhizomes of fossil ferns. Some of the former are familiar under the name *Psaronius*;[5] the best preserved specimens are in silicious rock of the permian formation, and when polished they show prettily the structure of the stem. Several specimens are exhibited. They are known from carboniferous and permian rocks.

Of rhizomes (underground stems of fern) several specimens from the German "Brown coal formation" (miocene) are exhibited.

[1] Δίκτυον (Gr. diktyon) = a net.

[2] Σαγήνη (Gr. sagene) = a net.

[3] Σχίζω (schizo) = to split, lacerate.

[4] Ῥάκος (Gr. rhakos) = a rug ; φύλλον (Gr. phyllon) = leaf.

[5] Ψαρὸς (Gr. psaros) = speckled, variegated, referring to the speckled appearance when polished.

PTERIDOPHYTA.—*Lycopodiaceæ*.[1]

With case No. 7 another important class of the *Pteridophyta* begins, that of the *Lycopodiaceæ*. It is especially important, as two of its orders, which are extinct now, contributed largely during the carboniferous period to the formation of that valuable fuel, coal (Europe and America). Case 7.

In the present flora this class is represented by some dwarfish forms only, such as *Lycopodieæ*,[2] and *Selagineæ*,[3] representatives of which are also found in the fossil flora in various formations; several specimens are exhibited in the first half of the second shelf.[4] Case 7, Shelf 2. *Lycopodieæ*. *Selagineæ*.

But in the fossil flora we find other much larger representatives of this class, the *Lepidodendreæ*,[5] which attained the size of large trees. Case 7, Shelves 2, 3. *Lepidodendreæ*.

They occur especially in carboniferous rocks. Their trunks are covered with scars arranged in spiral lines, but generally only portions of their bark lie in the shales accompanying the coal, or in the coal itself. The scars are impressions left by the base of the fallen leaves and show various forms. *Cyclostigma*,[6] Haught., which is another genus of the *Lycopodiaceæ*, is a plant which was found at Kiltorkan, in Ireland, in Bear-Island and in New South Wales on about the same geological horizon. There are several other forms, not represented in our collections.

The other important order also placed with the *Lycopodiaceæ* is that of the *Sigillarieæ*,[7] which was most abundant in the carboniferous epoch (Europe and America), and which contributed as largely to the formation of coal as the *Lycopodiaceæ* did. Case 7, Shelf 4. *Sigillarieæ*.

The bark is also covered with the leafscars, but they are further apart from each other and are arranged generally in vertical columns.

The *Sigillarieæ* also attained a great height. On the same shelf we find some other stems of a root-like appearance, covered with small circular scars, arranged in spiral lines;

[1] Club-moss family.
[2] *Lycopodium* = the club-moss.
[3] *Selago* = another kind of club-moss.
[4] The first shelf contains large specimens.
[5] Λεπὶς (=ἰδος) = a scale; δένδρον (Gr. dendron) = a tree.
[6] Κύκλος (Gr. kyklos) = a circle; στίγμα (Gr. stigma) = a mark.
Sigillum = a seal; from the seal-like scars on the surface of the bark.

they are commonly known as *Stigmaria,*[1] Bgt., which by a number of authors are considered as roots of *Sigillaria,* while others again see in them roots of *Lepidodendreæ,* and others again consider them still as a peculiar group.

Case 8, Shelf 1. The first shelf of case 8 contains large specimens, some of which are still of *Sigillarieæ.*

Gymnospermæ.[2] — *Cycadeaceæ.*[3]

Shelves 2, 3. *Cycadeaceæ.* With the next shelf a new sub-kingdom begins, that of the *Gymnospermæ,* which comprises two classes, the *Cycadeaceæ* and *Coniferæ.*[4]

The former we find on shelves 2 and 3, chiefly represented by the order of *Zamieæ.*[5] Most of the genera are especially of mesozoic times, where they were much more numerous than in present days. The best known and most numerous amongst the fossil *Zamieæ* is the genus *Pterophyllum,*[6] Bgt., and *Otozamites,*[7] Braun, the former of which reaches from permian to cretaceous times, while the latter belongs to the rhætic and jurassic formations. Specimens of both are exhibited.

In India, in the upper portion of the Gondwána system, *Zamieæ* are also numerous, and especially one genus known as *Ptilophyllum,*[8] Morr., is very characteristic: numerous specimens of it will be found in the local collection.

With the *Cycadeaceæ* (*Zamieæ*) we find also the genus *Nilsonia,*[9] Bgt., which for a time was classed with the ferns: it chiefly occurs in rhætic beds in Europe. I have also placed with the same class certain fossil leaves which formerly were included in the order *Nöggerathieæ.*[10] This latter has, however, been recently found to contain very heterogeneous plants; some of its constituents belong to ferns, others to *Coniferæ* and others to *Cycadeaceæ.* With this latter are placed certain oblongly spatulate leaves found in Australia,

[1] Στίγμα=a mark.
[2] Γυμνὸς (Gr. gymnos)=naked; σπέρμα (Gr. sperma)=the seed.
[3] The Cycad family.
[4] *Conus*=the cone; *fero*=to bear,
[5] *Zamia*=a living plant.
[6] Πτερὸν (Gr. pteron)=a feather; Φύλλον (Gr. phyllon) =a leaf.
[7] Οὖς, ὠτος (Gr. us-otos)=the ear, and *Zamites* (fossil Zamia).
[8] Πτιλὸν (Gr. ptilon)=a feather; Φύλλον (Gr. phyllon)=leaf.
[9] From a proper name.
[10] From a proper name.

India and Siberia, which were at first also described as *Nöggerathia*, but recently were separated from this genus by distinct names. The Australian and Indian forms I distinguished with the name of *Nöggerathiopsis*;[1] for the Siberian forms (from the Altai, &c.) the generic name *Rhiptozamites*,[2] was established by Prof. Schmalhausen in Kiew: they appear, however, to be very closely allied.

Several specimens from Australia and one from Siberia are exhibited.

The carboniferous genus *Cordaites*,[3] Stbg., is also left with the *Cycadeaceæ*, although it very possibly belongs to the *Coniferæ*.

GYMNOSPERMÆ.—*Coniferæ*.

With shelf 4, case 8, the other class of the *Gymnospermæ* begins, and they occupy also the whole next case, No. 9. Case 8, Shelf 4 and Case 9. *Coniferæ*.

Remains of *Coniferæ* are found with certainty already in carboniferous rocks, and they may be said to range through all formations up to present times.

In older geological times they appear to have occupied rather a subordinate position amongst the other plants, but still we find characteristic forms for most of them, as for instance *Walchia*,[4] Bgt., for the permian; *Voltzia*,[5] Bgt., for lower triassic; *Palissya*,[6] Endl., for rhætic, &c.

Their greatest development is attained in newer geological times (tertiary-miocene) when they appear to have contributed largely to the deposition of another kind of important fuel in Europe called brown-coal. Sometimes big stems are found with their wooden structure completely preserved so that they can easily be sawn and cut, and this wood will even take good polish. Roots and branches are also found.

Many specimens are exhibited in the lowest shelf of case 9.

In the first shelf of case 10 we find some large specimens of *Coniferæ*; in the next case begins the last subkingdom of plants, that of the *Angiospermæ*,[7] which comprises two large classes, *Monocotyledones* and *Dicotyledones*. Case 10, Shelf 1.

Nöggerathia; and ὄψις, appearance.

[2] Ῥίπτω, to cast off (the leaves) and *Zamites*.

[3] From a proper name.

[4], [5], [6] Taken from proper names.

[7] Ἀγγεῖον (angion)=any small vessel; σπέρμα = the seed, the seeds of these plants being enclosed into a seed vessel or pericarp.

ANGIOSPERMÆ.—*Monocotyledones.*

Case 10, Shelf 2. *Monocotyledones.*

The first of these is that of the *Monocotyledones*[1] which in the living flora comprises the grass family (to which also the bamboo and sugar-cane belong), the lily family, the ginger family, the cane family, orchid family, the palms and others.

Case 10, Shelf 2. *Palmaceæ.*

In the fossil flora the *Palmaceæ* only are of some importance; they are, with certainty, known from the cretaceous and tertiary formations only; from the latter several fragments of palm-leaves (resembling those of the living fan-palm) are exhibited in shelf 2, case 10.

ANGIOSPERMÆ.—*Dicotyledones.*[2]

Case 10, Shelves 3, 4. Cases 11—12. *Dicotyledones.*

The second large class of *Angiospermæ* is that of the *Dicotyledones*, which comprise all the leaf-trees of our forests and most of our flowering plants.

Amongst the fossil plants the representatives of this order appear first in the chalk formation, and were very numerous in the tertiary epoch when they contributed considerably to the deposition of the thick seams of the brown coal. We meet mostly with the leaves of the trees of that period, some of them wonderfully well preserved, with all the minute details of the venation. Seeds and nuts are also frequently met with.

Many representatives of this class are exhibited; amongst these I especially mention the genus *Credneria*[3] (case 11, shelf 3) as the best and oldest known cretaceous leaves, and the various leaves of *Acer*, the maple tree (case 11, shelf 4; case 12, shelf 2), some of them very nicely preserved.

At the end of case 12 numerous seeds and nuts are laid out.

II.—GENERAL COLLECTION OF ANIMAL FOSSILS.

This portion of the general collection is contained in cases 13—50. It begins again with the lowest organisms, the *Protozoa*.

[1] Μονὸς=one; κοτυληδὼν=seed-leaf.
[2] Δὶς (Gr. dis)=twice; and *kotyledon*.
[3] From a proper name (Credner).

PROTOZOA.[1] — *Rhizopoda*.[2]

Case 13, Shelves 1, 2, *Foraminifera*.

The first shelf of case 13 contains the beginning of the class of *Rhizopoda*, commencing with the *Foraminifera*.[3] The little shells of these, to a great extent microscopically small animals, form at present a great proportion of the sand of certain seas, especially tropical and sub-tropical. They can generally be seen only with the aid of a lens or microscope, and their form is, therefore, best exhibited by enlarged models, for which purpose such a collection of models of living *Foraminifera* is exhibited on the first and part of the second shelf.

Representatives of the *Foraminifera* are known in great number and variety from various formations of the sedimentary rocks; several forms amongst these attained a large size. I have to mention only the well-known genus *Nummulites*[4] (Nummulina), coin-like fossils of various sizes and forms, attaining a diameter of more than 3 inches; they are especially characteristic of the eocene formation (lower tertiary) where they sometimes completely fill the limestones, showing, when a piece of it is polished, various sections.

Numerous specimens are exhibited and others will be found among the Indian tertiaries.

Another large *Foraminifer* is *Alveolina*,[5] Bosc., which is known from cretaceous, but especially from eocene, rocks. (*Loftusia*,[6] an allied form to *Alveolina*, occurring in eocene limestone of Persia, attains a length of two inches.)

Fusulina,[7] Fisch., an elliptically cylindrical *Foraminifer* of the carboniferous limestone, also belongs to the conspicuous forms of *Foraminifera*.

With the *Foraminifera* is also placed that singular form called *Eozoon*,[8] which some authors consider as organic, and, therefore, as the oldest known organism, as it occurs in the lower Laurentian metamorphic rocks; other authors, however, believe it to be inorganic.

[1] Πρῶτος (Gr. protos)=first, primary; ζῶον=an animal.
[2] Ῥίζα (Gr. rhiza)=a root; πους-ποδός (pus-podos)=a foot.
[3] *Foramen*=an aperture; *fero*=to bear.
[4] *Nummulus*=a small coin.
[5] *Alveolus* (Lat.)=a small chamber.
[6] From a proper name.
[7] A diminutive of *fusus*, a spindle.
[8] Ἠως (Gr. eos)=the dawn; ζῶον (Gr. zoon)=an animal.

four families, of all of which we find representatives exhibited. These families are—

Case 15. Shelves 2, 3,4. (*a*) *Aporosa.*

(*a*) *Zoantharia aporosa, i.e.* corals in which the wall surrounding the visceral chamber[1] is complete, or very rarely perforated by apertures or pores.

Specimens of this family are exhibited on this fourth shelf (of case 14), as also in the second, third, and in the beginning of the fourth shelf of case 15 (the first shelf of this case containing large specimens of various corals).

Of this family may be mentioned as best known the *Astræideæ*,[2] or star corals, which are represented almost through all formations, and are also very numerous at present times, occupying a prominent place amongst the "reef-building" corals.

In palæozoic time they are very rare; their great development begins with the trias, whence they become very numerous. The representatives of many genera are exhibited.

Case, 15, Shelf 4, *b.* (*b*) *Perforata.*

(*b*) *Zoantharia perforata.*—The unperforated corals end on shelf 4 of case 15, and next to them are found, on the same shelf, a few representatives of the second family—the "perforated corals" in which the coral-wall is always perforated. These corals are especially developed in tertiary and present times. The best known are the *Madreporidæ*,[3] which are also largely represented amongst present reef-building corals.

Case 15, Shelf 4 *c.* (*c*) *Tabulata.*

(*c*) *Zoantharia tabulata* or "tabulate corals," which are characterised by their visceral chamber being divided by well developed "tabulæ" in as many distinct stories. The most characteristic representatives of this family are to be met with in the palæozoic rocks from silurian to carboniferous.

Case 16. Shelves 2, 3.

The best known genera are *Favosites*[4] *(Columnaria)*,[5] which is chiefly found in silurian and devonian rocks: *Chaetetes*[6] in silurian, *Halysites*[7] or *Catenipora*,[8] occurring especially in upper silurian, although not absent in lower

[1] The visceral chamber is the internal space of the coral which is included within the external wall. This space is divided into two portions, the upper or calice, and a lower portion which is sub-divided by calcareous plates (*septa*) into several compartments.

[2] Genus Astræa (ἀστήρ aster)=the star-coral.

[3] From Genus Madrepora.

[4] *Favus* (Lat.)=a honeycomb.

[5] *Columna*=a column.

[6] Χαίτη (chaete)=a hair.

[7] Ἅλυσις (halysis)=a chain.

[8] *Catena*=a chain.

silurian. Of all these, specimens are exhibited on shelves 2 and 3 of case 16.

Following Prof. Nicholson's classification I have placed with the "Tabulata" also the genus *Syringopora*,[1] which is a coral widely distributed in silurian, devonian, and carboniferous rocks, specimens of which are exhibited in shelf 4 of case 16.

(*d*) *Zoantharia tubulosa*.—In the same shelf is also placed the last family of the *Zoantharia*, that of the tubulous corals which form only a very small family and are entirely palæozoic. Case, 16, Shelf 4, (*d*) *Tubulosa*.

The best known genus is *Aulopora*, which grows parasitically on other bodies and which ranges from silurian to carboniferous.

In Prof. Zittel's new Hand-book of Palæontology quite a different place is assigned to this last family together with the above-mentioned *Syringopora*, but I preferred for the present to follow Prof. Nicholson's Manual.

Annuloida.[4]—*Echinodermata*.[5]

With case 17 a new sub-kingdom begins, that of the *Annuloida*, which includes two large divisions, that of the *Echinodermata* and *Scolecida*.[6] Only of the former are remains found in the various formations.

In the beginning is placed the peculiar and extinct order of *Blastoidea*;[7] this is an entirely palæozoic order, which reached its greatest development in the carboniferous period (mountain-limestone). The best known genus is *Pentremites*[8] (contraction of Pentatrematites), so called from there being five openings at the summit of the body; this genus also has the most bud-like (βλαστός, a bud) appearance, from which character the name of the order was taken. It is chiefly developed in the carboniferous limestone of North America. Several specimens are exhibited. Case 17, Shelf 3. *Blastoidea*.

[1] Σύριγξ (syrinx) = a pipe.
[2] Tubulus = a small tube.
[3] Αὐλὸς (aulos) = a flute.
[4] *Annulus* (Lat.) = a ring; εἶδος (gr.) = form or appearance.
[5] Ἐχῖνος (echinos) = sea-urchin, hedgehog; δέρμα = a hide, skin.
[6] Σκώληξ (Skolex) = a worm.
[7] Βλαστός (blastos) = a bud, a blossom; εἶδος (eidos) = appearance.
[8] Πέντη (pente) = five; τρῆμα (trema) = a hole.

Adjoining to this order is placed that of the *Cystoidea*,[1] another extinct group of palæozoic forms, which for the most part are silurian; they have generally a sphæroidal body, with a rudimentary development of the arms, and the plates of the body in many cases perforated.

The genus *Echinosphærites*,[2] specimens of which are exhibited, is the type of the order. *Echinosphærites aurantium*[3] is a widely-spread characteristic fossil in the lower silurian beds (orthoceras-limestone) in Sweden, Norway, and Russia.

Case 17. Shelves 3, 4.

Case 18, Shelf 2. *Crinoidea.*

In the same shelf is the beginning of another order, the *Crinoidea*,[4] the sea-lilies; these are *Echinodermata*, the body of which is generally cup-shaped, provided with branched arms (five to ten in number), and in most cases fixed to the sea-bottom by a jointed flexible stalk. This group is still represented by several forms in the present seas amongst which *Alecto* (a Comatula) and *Pentacrinus*[5] *caput Medusæ* are the most noteworthy.

In former times the *Crinoidea* were much more numerous; they are found in all formations, but their maximum of development lies in the palæozoic rocks, where they have various forms. The silurian limestones of Dudley (Wenlock-limestone) and of the Gotbland island, the devonian limestone of the Eifel (Eifeler Kalk), and the mountain-limestone of England, Belgium, Germany, and North America are the chief deposits of these "sealilies." Here we find the genera *Cyathocrinus*,[6] *Poteriocrinus*,[7] *Actinocrinus*,[8] *Rhodocrinus*,[9] *Haplocrinus*,[10] *Cupressocrinus*,[11] *Crotalocrinus*,[12] *Amphoracrinus*,[13] and other genera, representatives of most of which and of several others are exhibited.

In mesozoic times the *Crinoids* were not so numerous as in palæozoic formations; but to the mesozoic forms belongs

[1] Κύστις (kystis) = a bladder; εἶδος = the appearance.
[2] Ἔχῖνος (echinos) sea-urchin; σφαῖρα (sphæra) = a ball.
[3] Like an orange.
[4] Κρῖνος (krinos) = a lily; εἶδος (eidos) = appearance.
[5] With a pentagonal stalk.
[6] Κύαθος (Kyathos) = a cup.
[7] Ποτήριον (poterion) = a goblet.
[8] Ακτῖν (Aktin) = a ray or thorn.
[9] Ῥόδον (Rhodon) = a rose.
[10] Ἁπλόος (Haploos) = single.
[11] Cupressus = Cypress (tree).
[12] Κρόταλον (Gr. Krotalon) = a rattle, cymbal.
[13] Amphora = a jar. (All these names refer to the shape of the fossil.)

the best known and geologically most important *Crinoid, i.e.* the well-known *Encrinus liliiformis*, which is the type of "petrified sea-lilies," and the chief characteristic fossil of the Muschelkalk (middle trias). Several specimens are in case 17, shelf 4, and in the upper (No. 1) shelf of case 18.

Of other mesozoic *Crinoidea*, the liassic *Pentacrinus briareus* is the most noteworthy; specimens of it are exhibited in shelf 2 of case 18.

At end of the *Crinoids* a few representatives of the free forms of *Crinoidea* are placed. The best known is the genus *Saccocoma*,[1] Ag. (formerly placed with *Comatula*, Goldf.); it is very numerous in the lithographic shales of Solenhofen. Several specimens are exhibited.

Case 18, Shelf 2. *Ophiuroidea.*

In the same shelf will also be found the beginning of the sea-stars comprising two orders, the *Ophiuroidea*,[2] the brittle stars or sand-stars, and *Asteroidea*,[3] the ordinary star-fishes.

The former have a more clearly marked body, from which the free arms radiate (generally five in number); they are special processes for prehension and locomotion. They appear in the silurian period and are numerous in the present seas. *Protaster*[4] (a silurian genus) and *Ophioderma*[5] (liassic) may be named as representatives, and specimens of them are exhibited.

Case 18, Shelf 3. *Asteroidea.*

The *Asteroidea*, the ordinary star-fishes, have a more star-like body; the body (or central disc) is not so distinctly separated as in the former; the arms appear more as lobes, are hollow, and contain prolongations of the stomach in their interior. Amongst the fossils these also make their appearance in the silurian period and have many representatives in the present seas. The most known forms are *Palæocoma*[6] (silurian); *Goniaster*[7] (jurassic and cretaceous); *Asterias*[8] (devonian, liassic); and some others, more or less doubtful. Specimens of those named are exhibited.

[1] Σάκκος (Sakkos) = a sack; κόμη (Koma) = branch, foliage.

[2] Ὄφις (Gr. Ophis); a snake; οὐρὰ (Gr. ura) a tail; εἶδος (Gr. eidos) = appearance.

[3] Ἀστὴρ (aster) = a star.

[4] Πρῶτος (protos) = first, earliest; Ἀστήρ (aster) = star.

[5] Ὄφις (Ophis) = a snake; δέρμα (derma) = a skin.

[6] Παλαιὸς (Palaios) = old, primæval; κόμη (Gr. kome) = branch, foliage.

[7] Γωνία (Gr. Gonia) = an angle; ἀστὴρ (Gr. aster) = a star.

[8] Ἀστὴρ (Gr. aster) = a star.

Case 18, Shelf 3, *Echinoidea.*

Next to the *Asteroidea* we find (in the same shelf 3, case 18), the beginning of the large order of the *Echinoidea.*[1] These are for palæontological investigations more important than any of the other orders of the *Echinodermata,* partly because their sphæroidal or discoidal test, composed of numerous calcareous plates, was well adapted for fossiliration, and partly because they are more widely distributed.

The calcareous plates of the test are arranged in ten zones (each containing two equal rows of plates). Five of these zones are narrower, and their plates perforate by pores, through which little tubes, the "ambulacral tubes"[2] are emitted, which serve for locomotion; these zones are therefore called "ambulacral zones." The other zones are broader; their plates not perforated; these are the interambulacral[3] zones, or zones between the ambulacral zones.

The surface of the test is besides covered with spines of various kinds, movably attached to "tubercles," which in fossil specimens are generally exposed, the spines being detached.

The *Echinoidea,* however, show a reverse relation of distribution when compared with the *Crinoids,* these latter being most numerous in palæozoic formations, while the former show their maximum in newer formations and in the present seas.

They are divided according to their form into two divisions, "regular" and "irregular" Echinoids.

Case 18, Shelves 3, 4. Regular Echinoids.

The regular Echinoids are sphæroidal or nearly so, sometimes depressed above and below, the mouth and vent central (the mouth below and the vent on the summit). The ambulacral areas are narrower (as a rule much narrower) than the interambulacral zones, and each of the zones is generally provided with two rows of larger (primary) tubercles.

The best known genera, representatives of which are exhibited, are: *Diplocidaris,*[4] which is found in jurassic formations; *Cidaris,*[5] which begins in triassic times and lives still in the present seas; *Hemicidaris*[6] ranges from upper trias to lower cretaceous; *Pseudodiadema*[7] from liassic to tertiary; *Cyphosoma*[8] (=Phymosoma[9]) begins in lower

[1] Ἐχῖνος (Echinos)=sea-urchin.
[2] Ambulacrum=a walk, planted with trees (avenue).
[3] Inter=between, and ambalacrum.
[4] Δίπλόος (diploos)=double; κίδαρις (kidaris)=turban.
[5] Κίδαρις (kidaris)=turban.
[6] Ἡμι=(hemi) half; kidaris=turban.
[7] Ψεύδω (Pseudo)=to deceive; διάδημα (Diadema)=a royal headdress.
[8] Κυφὸς (Kyphos)=bent, curved; σῶμα (soma)=a body.
[9] φῦμα (Phyma)=a tumour; σῶμα (soma)=a body.

cretaceous and continues into eocene; *Temnopleurus,*[1] middle tertiary and living; *Diademopsis,*[2] from the lias (lowest jura); *Codechinus*[3] (now Leiopedina[4]) is eocene, *Acrosalenia*[5] from lias to lower cretaceous; *Salenia,*[6] chiefly in upper cretaceous, rare in lower cretaceous, eocene, miocene, and living in deep seas.

In shelf 4 there is also the beginning of the next division, *viz.*, the irregular Echinoids. Case 18, Shelf 4. Irregular Echinoids.

These have the test generally oblong, heart-shaped, elliptical, or conical, sometimes also roundish. The vent is excentrical (outside the apical portion, either on the lower surface or marginal), mouth central or excentric. The tubercles in these forms are smaller than in the regular Echinoids.

The irregular Echinoids are much more numerous than the regular ones, and many a characteristic fossil is amongst them. Many of the most typical ones are represented in our collection. They are—

Pygaster,[7] jurassic and cretaceous; *Holectypus,*[8] jurassic and lower cretaceous; *Discoidea,*[9] throughout the cretaceous formation; *Galerites*[10] (*Echinoconus*), which is cretaceous. Case 18, Shelf 4.

The next case contains in the uppermost shelf large specimens of Echinoids and then the rest of the irregular Echinoids. Case 19, Shelf 2. Irregular Echinoids.

Collyrites,[11] in the middle and upper jurassic and lower cretaceous (? lias); *Laganum,*[12] miocene and pliocene (? eocene) also living; *Clypeaster,*[13] contains the largest hitherto known forms of Echinoids; the test is large, thick, and scute-like. Eocene, miocene, and pliocene and numerous in present

[1] Τέμνω (temno) = to cut; πλευρὰ (pleura) = the side.

[2] Διάδημα (diadema) = see above; ὄψις (opsis) = appearance.

[3] Κώδη = (Kode) = fruit of the poppy; ἐχῖνος (echinos) = sea-urchin.

[4] Λεῖος leios = smooth; πεδινός (pedinos) = flat.

[5] Ἄκρος (akros) = sharp; Salenia, a conventional name.

[6] A conventional name.

[7] Πυγὴ (pyge) = anus; ἀστήρ (aster) = star.

[8] Ὅλος (holos) = entire; ἔκτυπος (ektypos) = impressed, expressed.

[9] Δίσκος (diskos) = disc, plate; εἰδέα or ἰδέα (idea) = appearance, likeness.

[10] *Galerum* (Lat.) = helmet-like covering for the head.

[11] Κολλύρα (Kollyra) = a small cake.

[12] Λάγανον (Laganon) = a kind of thin cake.

[13] *Clypeus* (Lat.) = shield; *aster* (Latin) = star = (Lamark's star-shield, 1801).

seas; *Pygaulus*,[1] lower and middle cretaceous; *Echinobrissus*,[2] numerous in the middle and upper jura and lower cretaceous, also one living species; *Clypeus*,[3] middle jurassic; *Catopygus*,[4] lower, middle and upper cretaceous, also tertiary, and one living species; *Cassidulus*,[5] cretaceous and tertiary; *Echinolampas*,[6] numerous in tertiary rocks and present seas; *Conoclypus*,[7] large conical forms, numerous in eocene, rare in cretaceous and in miocene. At the end of this shelf we find also a portion of the large genus *Ananchytes*,[8] which continues into the next shelf. It is upper cretaceous where it is the most numerous and characteristic form; *Holaster*[9] found in the whole cretaceous formation, and in tertiary rocks; *Toxaster*,[10] numerous in lower, rather rare in middle cretaceous. The last genus in this shelf is *Micraster*,[11] numerous representatives of which are also found in the beginning of the next shelf; it is a very widely distributed genus and numerously represented in the middle and upper cretaceous, where the specimens are generally very well preserved, also in tertiary rocks; *Spatangus*,[12] in tertiary rocks and in the present seas. Another genus very widely distributed in cretaceous and tertiary formation is *Hemiaster*;[13] it is also living in the present seas. With this and other few genera ends the large class of sea-urchins, and we arrive at a new sub-kingdom.

Case 19, Shelf 3.

Case 19, Shelf 4.

Up to here the systematical sequence adopted is in agreement with that of most continental writers, but the order observed in our arrangement of the succeeding groups differs somewhat from that generally adopted by palæontologists on the continent. In Quensted's "Handbuch der Palæontologie" we find that after the "Echinodermata" follow in sequence the *Mollusca*, then *Vermes*, *Crustacea*, &c. Much the same

[1] Πυγὴ (pyge) = anus; αὔλος (aulos) = a tube.
[2] Ἐχῖνος (Echinos) = sea-urchin; Βρίσσος (Brissos) = a sea-urchin.
[3] *Clypeus* (Lat.) = shield.
[4] Κάτω (Kato) = beneath; πύγη (pyge) = anus.
[5] *Cassis, Cassidis* (Lat.) = a helmet.
[6] Ἐχῖνος as above, and λάμπας (lampas) = a lamp.
[7] *Conus* (Lat.) = a cone; *Clypeus* (Lat.) = a shield.
[8] Ἀνανκιτις (Anankitis) = an unknown precious stone.
[9] Ὅλος (holos) = entire; ἀστὴρ (aster) = star.
[10] Τόξον (toxon) = arch; ἀστὴρ
[11] Μικρὸς (mikros) = small; ἀστὴρ
[12] Σπάταγγος (Spatangos) = a kind of sea-urchin.
[13] Ἡμι (Hemi) = half, in compounds; ἀστὴρ, as above.

system is adopted in the "Lethæa Geognostica" as well as in D'Orbigny's works and in Pictet's "Traité de Paléontologie." In the excellent "Handbuch der Palæontologie," by Messrs. Schimper and Zittel, which is under publication, we find after the *Echinodermata* the *Vermes* (worms), then the *Mollusca*, and only then the *Crustacea*,[1] &c. The same system is also in Franz Ritter von Hauer's work "Die Geologie" &c., 1878. In the "Palæontologia Indica," Dr. Stoliczka (Vol. IV, introduction, pages 1 and 2) and Dr. Waagen (Salt-range Fossils, part I) have also adopted the same systematical sequence, placing the *Arthropoda* (*Crustacea*, &c.) after the *Mollusca*, and just before the *Vertebrata*. Bronn, in his "Classen und Ordnungen des Thierreiches," has also a similar classification, placing the *Arthropoda* (*Crustacea*, &c.) after the *Malacozoa* (*Mollusca*).

English systematists, however, observe a somewhat different classification, placing the sub-kingdom *Annulosa (Articulata)* before that of the *Mollusca* (*Malacozoa*); and this classification is also that adopted by Prof. Nicholson in his Manual of Palæontology, which I have followed in the arrangement of the fossils, and consequently of this Guide also.

Sub-kingdom: Annulosa.[2]

Two divisions can be distinguished:—

Division I.—*Anarthropoda.*[3]

This comprises all the various kinds of worms; but only some representatives of the class of *Annelida*[4] are found in a fossil state. In this class the *Tubicola*[5] (tube-worms) inhabit tubes which are calcareous or chitinous, or consist of cemented sand-grains of various sizes and forms, wider at one end, narrow and closed at the other; and these were the only parts adapted for preservation in a fossil state. *Serpula*[6] is the best known and most widely distributed genus of these tube worms in the fossil state; forms of it are known from almost all formations, most numerously, however, in jurassic, cretaceous, and tertiary formations. Many specimens of *Serpula* tubes are exhibited in case No. 20, shelf 1.

Case 20, Shelf 1. *Annelida.*

[1] For explanation of this and the other terms used here see further on.

[2] *Annulus* (Lat.) = a ring.

[3] 'A (A greek) expresses a negation; ἄρθρος (arthros) = a joint and πούς πόδος (pous-podos) = foot, animal's, in which there are no articulated appendages.

[4] *Annulus* (Lat.) = a small ring.

[5] *Tubus* (Lat.) = a pipe or tube; *colo* (Lat.) = to inhabit.

[6] *Serpo* (Lat.) = to creep, crawl.

Division II.—*Arthropoda.*[1]

This division comprises the well-known classes of *Crustacea*[2] (barnacles, crabs, lobsters, &c.); *Arachnida*[3] (the spider family); *Myriapoda*[4] (centipeds), and true insects.

The most important of these are the *Crustacea*, comprising very various forms.

Case 20, Shelf 2. *Crustacea. Ostracoda.*

We begin with some representatives of the small bivalved forms, belonging to the *Ostracoda*[5] (waterfleas), small animals the body of which is covered with a bivalved shell; they already occur in palæozoic times (silurian), and are still at present living, some in fresh water, others in brackish water, and again others in the sea. Some are very numerous in certain formations, as, for instance, certain forms formerly placed with the genus *Cypridina*[6] (now Entomis), from which a stratum of shales in the devonian rocks of Germany has received its name "Cypridina shale."

Case 20, Shelf 2. *Trilobita.*

Next to the *Ostracoda*[7] we find the beginning of a very important and large order of *Crustacea*, that of the *Trilobita*.[8] These are entirely palæozoic *Crustacea* and are easily distinguished by their usually more or less three-lobed body, consisting of a cephalic shield, a thorax, and a caudal shield.

The maximum of their development is in the silurian period, although they already appear in upper cambrian and are still found in lower carboniferous. Some of the more known genera, representatives of which are exhibited, are—*Agnostus*,[9] upper cambrian—silurian; *Paradoxides*,[10] one of the largest genera, reaching a length of two feet and more. It is characteristic of the "primordial fauna" (upper cambrian — Barrande's étage C., lower silurian); *Cono-*

[1] Arthropoda—see note No. 3, page 23.

[2] *Crusta* (Lat.) = a hard crust.

[3] Ἀράχνη (Arachne) = a spider.

[4] Μυρία (Myria) = numberless; πούς = as above.

[5] Ὄστρακον (Ostrakon) = a shell.

[6] Κύπριδα (Cyprida) synonym of Κύπρις (Cypris) = a mythological name, surname of the goddess Venus.

[7] In natural order we should have quoted still the order of *Phyllopoda* (leaf-feet Crustacea) to which the genus *Estheria* belongs; but as there are no representatives in the collections at present I did not mention this order.

[8] *Tres-tria* (Lat.) three; *lobus* (Lat.) = a lobe.

[9] Ἄγνωστος (Agnostos) = unknown.

[10] *Paradoxus* (Lat.) = wonderful.

cephalites,[1] very numerous in upper cambrian; *Ellipsocephalus*,[2] the same formation; *Remopleurides*,[3] lower and upper silurian; *Asaphus*,[4] rare in upper cambrian, chiefly in lower silurian; *Ogygia*,[5] also lower silurian; *Illænus*,[6] lower silurian; *Trinucleus*,[7] silurian; *Ampyx*,[8] lower silurian; *Dionide*,[9] silurian; *Sphærexochus*,[10] silurian and devonian; *Calymene*,[11] this is a genus very numerously represented in lower and upper silurian rocks; *Homalonotus*,[12] silurian and devonian; *Phacops*,[13] a very frequent genus in silurian and devonian rocks; *Lichas*,[14] a silurian genus, characterised by having its body generally tuberculated all over; *Prœtus*,[15] ranging from lower silurian to carboniferous; *Phillipsia*,[16] carboniferous; *Acidaspis*,[17] a characteristically upper silurian genus, with a highly ornamented and spinose crust; *Bronteus*, a silurian and devonian genus, characterised by the caudal shield being as large as (or larger than) the head and always more or less fan-shaped; *Harpes*,[19] a genus with a broad and horseshoe-shaped margin of the cephalic shield, lower and upper silurian.

Case 20, Shelf 3. *Trilobita.*

Case 20, Shelf 4. *Trilobita.*

[1] Κῶνος (konos) = a cone; κεφαλὴ (kephale) = head, called so from the conical form of the middle portion of the cephalic shield.

[2] Ἔλλειπσις (ellipsis) = a geometrical figure, ellipse; κεφαλὴ head.

[3] *Remus* (Lat.) = an oar; πλευρὰ (pleura) = the side, the rib.

[4] Ἄσαφὴς (asaphes) = obscure, uncertain.

[5] A mythological name.

[6] Πλαίνω (plaino) = to squint, referring to the shape of the eyes.

[7] *Tri-nucleus* (Lat.) = three kernels, referring to the three protuberances of the cephalic shield.

[8] Ἄμπυξ (ampyx) = head-band, referring to the long prolongation on the sides of the head shield.

[9] Διώνη (Dione) = mother of Aphrodite (mythological names).

[10] Σφαῖρα (sphaira) = a ball; ἔξοχος (exochos) = noted, prominent, referring to the prominent eyes.

[11] Proper name.

[12] Ὅμαλος (homalos) = flat; νῶτος (notos) = the back.

[13] Φακὸς (phakos) = lentils; ὤψ (ops) = the eye, referring to the shape of the eye.

[14] Λιχὰς (lichas) = steep, referring perhaps to the very convex head.

[15] Mythological name.

[16] From a proper name (Phillips).

[17] Ἀκὶς (akis) = a spear, point; ἀσπὶς (aspis) = a shield, referring to the spinose nature of the crust.

[18] Βρονταῖος (brontaios) = thundering (an epitheton of Zeus).

[19] Ἅρπη (harpe) = a sickle, referring to the horseshoe-like margin of the head shield.

Case 20, Shelf 4b. *Merostomata.*

Adjoining the *Trilobita* we find in the same shelf a few representatives of the next order, that of the *Merostomata*,[1] comprising two sub-orders, the *Xiphosura*,[2] and *Eurypterida*;[3] of the first one there are living representatives in the genus *Limulus* (king-crabs); a genus apparently identical with this living one is not rare in the (jurassic) Solenhofen lithographic slates. Specimens of it are exhibited.

[Of the second division (the *Eurypterida*) there are no specimens exhibited in this shelf, but a large specimen of *Pterygotus*[4] will be found in the uppermost shelf of the next case (No. 21), where also some other specimens of *Limulus* are placed]

Case 20, Shelf 4. *Decapoda Macrura*, (cray-fish, &c).

In this shelf (No. 4) we also find the beginning of the next great order of the *Crustacea*, that of the *Decapoda*.[5] These are sub-divided again into three tribes, two only of which, however, are of importance in palæontology. We begin with the *Macrura*, long-tailed *Decapoda*, to which belong, among the living forms, the common river cray-fish, lobsters, shrimps, prawns, &c. Amongst the fossils we find representatives of the long-tailed Decapods already in carboniferous times where the best known representatives belong to the genus *Anthrakopalæmon*.[6] More numerous forms are found in the mesozoic epoch and especially in the jurassic formation; in cretaceous rocks they are also very numerous.

The best known jurassic form is *Eryon*,[7] which begins in liassic rocks and is mostly developed in the Solenhofen lithographic slates, wherein altogether numerous genera of long-tailed decapods are found.

Case 21, Shelf 1. *Macrura.*

Specimens of *Eryon* are exhibited also in the beginning of the first shelf of the next case (No. 21).

[1] Μηρός (meros) the thigh; στόμα (stoma) = a mouth, referring to the circumstance that the terminations of the mandibles and maxillæ of the mouth become walking or swimming feet.

[2] Ξίφος (xiphos) = a sword; οὐρα (ura) = the tail, referring to their terminal segment being ensiform.

[3] Εὐρὺς (eurys) = broad; πτέρον (pteron) = a wing, a fin, referring to the broad lamellar appendages upon their ventral surface.

[4] Πτέρυξ (pteryx) = a fin; οὖς-ὦτος us-otos) = an ear.

[5] Δέκα (deka) = ten; ποῦς-ποδὸς (pus-podos) = foot. "Ten feet."

[6] Ἄνθραξ (anthrax) = coal; Παλαίμων (Palaimon) = mythological name of a sea-god.

[7] Proper name.

Others of the better known genera are *Glyphæa*,[1] jurassic formation; *Mecochirus*,[2] which also is a jurassic genus (lias—upper jura). Representatives of this genus are also in the beginning of the second shelf; *Penæus*,[3] a living genus, but already represented in the upper jurassic shales of Solenhofen; *Bylgia*,[4] in the lithographic shales of Solenhofen; *Aeger*,[5] restricted to the lithographic shales of Solenhofen; specimens of this are also contained in the next shelf; *Acanthochirus*,[6] also of the lithographic shales of Solenhofen only; *Callianassa*[7] a cretaceous genus of which mostly the claws (chele) are met with; *Meyeria*,[8] of the lower green sand in England; *Astacus*[9] from jurassic times up to the present day. Case 21, Shelf 2. *Macrura.* Case 21, Shelf 3. *Macrura*

Next to these forms of long-tailed decapods are a few representatives of the *Brachyura* (short-tailed Decapods), generally known as "crabs;" here the rudimentary tail (abdomen) is tucked up beneath the body (cephalothorax); there are only two genera in the palæozoic epoch (permian and carboniferous); the greatest number is in mesozoic (secondary) and kænozoic (tertiary) rocks. We have exhibited, *Brachyurites*,[10] a genus found in cretaceous and tertiary rocks, *Xanthopsis*,[11] tertiary. In the eocene rocks of England crabs are very numerous; several specimens will hereafter be found also in the Indian portion of the collection amongst the tertiary fossils from Sind. Case 21 Shelf 3. *Brachyura.* (crabs).

The class of *Annulosa* is concluded in this shelf with a few representatives of *Arachnida* (spider family) and *Insecta* (insects). Case 21, Shelf 3. *Arachnida Insecta.*

Sub-kingdom: Mollusca.[12]

With shelf 4 of case No. 21 the large sub-kingdom of *Mollusca* begins, and representatives of this sub-kingdom are Case 21, Shelf 4. *Mollusca.*

[1] Γλύφω (glypho) = to carve.

[2] Μῆκος (mekos) = length; χεὶρ (cheir) = hand, extremity, referring to the length of the first pair of legs.

[3] Mythological name: Πηνεῖος (Peneios) = a river god.

[4] Mythological name.

[5] Proper name.

[6] Ἀκανθα (akantha) = a thorn; χεὶρ (cheir) = extremity.

[7] Καλλή (kalle) = handsome; ἄνασσα (anassa) = queen.

[8] From a proper name.

[9] Ἀστακὸς (Greek) = a lobster.

[10] Βραχὺς (brachys) = short; οὐρὰ (ure) = tail. "Short-tailed animal."

[11] Ξανθὸς (xanthos) = yellow (also the name of a Crustacean genus); ὄψις (opsis) = appearance.

[12] *Molluscus* (Lat.) = soft.

contained in all subsequent cases up to case 46 (inclusively). They are sub-divided into two large sections: *Molluscoida*[1] and *Mollusca Proper;* these latter comprise all those forms which are generally known as "shells" or "conchylia."

These shells of the Mollusca and of a portion of the Molluscoida are the most important organisms for palæontological researches, for, on the one hand, they were in consequence of their hardness very fit for preservation, and, on the other hand, they are found in all formations in great numbers and in great variety of forms.

Section: *Molluscoida.*

This section includes again two classes, representatives of which are found amongst the fossils, *viz.*, *Polyzoa*[2] or (*Bryozoa*[3]) and *Brachiopoda.*[4]

Class: *Polyzoa.*

Case 21, Shelf 4. *Polyzoa.*

The *Polyzoa,* specimens of which are placed in the lowest shelf of case 21 and in the first-half of the first shelf, case 22, are generally dendritic, retiform, or tuber-like bodies, which in their general appearance remind one of certain hydroid corals with which they formerly used to be classed, hence also their name of moss-corals. But the organisation of the *Polyzoa* differs greatly from that of the hydroid corals, and brings them closer to the *Mollusca,* with which they are now placed.

Case 22, Shelf 1. *Polyzoa.*

The *Polyzoa* can be said to be represented abundantly in all formations, from lower silurian up to the present day, where they are found in sea and fresh water. Their chief development, however, is in the cretaceous and tertiary epochs; the cretaceous tufa of Mæstricht (near Aix-la-chapelle) alone yielded hundreds of species, and the coralline crag (pliocene) takes its name from the great number of *Polyzoa.*

Amongst the palæozoic *Polyzoa,* the best known genus is *Fenestella,*[5] which has a range from lower silurian to permian. This form is generally fan or funnel-shaped, and reticulated, specimens of which are exhibited. There are also exhibited several other genera, but they need not be mentioned here.[6]

[1] The former word, and εἶδος (eidos) = appearance.

[2] Πολύς (polys) = many; ζῶον (zoon) = animal.

[3] Βρῦον (bryon) = a moss; ζῶον.

[4] Βραχίων (brachion) = arm; πούς-πόδος (pus-podos) = a foot.

[5] *Fenestella* (Lat.) dim. of *fenestra* = window = a small window, referring to the areolated appearance of the fossil.

[6] In the second half of shelf 1, case 22, there are some large specimens of *Brachiopoda.*

Class: *Brachiopoda.*

The second more important class of the *Molluscoida*, also found as fossils, is that of the *Brachiopoda*. Although externally (as regards the shell) very much resembling the bivalved shells of the real Mollusca, yet the anatomical organisation places them near to the *Polyzoa*, for which reason they are, with these, joined under the common heading *Molluscoida*.

Case 22, Shelf 2. *Brachiopoda.*

Brachiopods are, especially for the palæozoic times, of great importance.

They have, as already mentioned, shells similar to, but differing from those of the bivalved Molluscs, by being "inequivalve"[1] and generally "equilateral,"[2] while in the bivalved Molluscs the shell is, as a rule, equivalve, but generally "inequilateral." The valves of the shell are also distinguished as "ventral" and "dorsal," and, as a rule, the larger valve (of the two) is the ventral, and the other the dorsal valve. The ventral valve is generally produced in a prominent beak, in which, or close to which in many cases, there is a smaller or larger aperture (the foramen) to let through the muscular peduncle, by which the shell is attached to other bodies. In other cases a different arrangement occurs. Between the beaks of the ventral and dorsal valves there is in many cases a wider or narrower space, the hinge area, and in front of the foramen there is commonly a triangular plate called Deltidium.[3] The shells are of various forms, outside smooth or variously ribbed and striated. Inside there is in many Brachiopods a peculiar calcareous framework or skeleton, by which are supported the lateral prolongations of the margin of the animal's mouth, the "arms" from which the class has received its name. This skeleton exhibits various (constant) forms and is another character of distinction.

Many specimens of this widely distributed class are exhibited in the three shelves of case 22, and in cases 23 and 24.

Cases 22, 23, 24. *Brachiopoda.*

According to the form of the shell, of the beak, whether there is a foramen or not, whether there is an area and deltidium, according to the form of the arm-skeleton and other characters, the *Brachiopoda* are sub-divided into several families, according to which our specimens are arranged.

At first are placed the typical *Brachiopods*, the *Terebratulidæ*, the forms of which have their ventral valve with a prominent beak, which is perforated just at the apex (this distinguishes them from *Rhynchonella*, which commonly is confused with *Terebratula*, the foramen in *Rhynchonella* being

Case 22, Shelves 2, 3. *Terebratulidæ.*

[1] One valve larger than the other (generally the ventral valve is larger).

[2] Equal-sided. If a vertical is drawn from the beak of the shell to its base, it would divide it into two equal halves; oblique *Brachiopoda* are a very rare exception.

[3] Diminutive of Delta, meaning the Greek letter Δ (delta).

generally smaller and below the apex of the beak). The arm skeleton has generally the form of a loop.

Terebratula[1] is the most typical and most widely spread genus of the family; representatives of it fill the second and third shelves of case 22: it commences in devonian, and is found in a few forms in present seas, at great depths however.

Case 22, Shelf 4.

In shelf 4 there are still some specimens of *Terebratula* and then follow other genera of the *Terebratulidæ*; those worthy of notice are *Waldheimia*, (sub-genus of *Terebratula*)[2] distinguished by the very long loop; appears first in the trias and lives at present; *Terebratella*,[3] which begins in cretaceous and is found still living; *Magas*,[4] which is cretaceous, shows in the dorsal valve a median ridge. A very characteristic genus is *Stringocephalus*,[5] which, however, appears to slightly differ from the *Terebratulidæ* proper by the foramen not being in the apex of the beak; it is a characteristically devonian species: in the *Stringocephalus*-limestone of Westphalia, Nassau, the Harz mountains, as also of Plymouth, Bradley, &c.

Case 22, Shelf 4. *Thecididæ.*

Next follow the *Thecididæ*, represented by one genus only, *Thecidium*;[6] it appears first in the upper trias, is numerous in jurassic and cretaceous formations, and is represented by one living species.

Case 22, Shelf 4 Case 23, Shelves 1, 2, 3. *Spiriferidæ.*

In this same shelf is also the beginning of the third family, the *Spiriferidæ*, so called from the typical genus *Spirifer*;[7] in this family the arms are greatly developed and supported by a thin, shelly, spirally rolled lamella. The forms of this family are mostly found in palæozoic rocks, although some also pass into secondary rocks. The best known genus is *Spirifer*, which has a range from silurian to trias; representatives of it are exhibited at the end of shelf 4, case 22, in shelf 2, and beginning of shelf 3, case 23.[8]

[1] *Terebratus* (Lat.) = perforated.

[2] Proper name.

[3] Diminutive of *Terebratula*.

[4] Μαγὰς (Gr. magas) = bridge of a lyre.

[5] Is a name formed from a Latin (*strix*, *strigis*=owl) and a Greek word (κεφαλὴ *kephale*=head). The name should, therefore, more correctly be *Strigocephalus*.

[6] A small pouch, from the ventral valve being deeply excavated.

[7] *Spira* (Lat.) = spire, and *fero* (Lat.) = to bear, to have, referring to the spiral arm skeleton.

Shelf 1 contains unclassified large specimens of *Brachiopoda*.

Next to *Spirifer* is *Spiriferina*,[1] which differs from this by having the shell punctate; this genus is chiefly mesozoic. *Athyris*[2] is pre-eminently palæozoic, beginning in silurian rocks, but mostly developed in devonian and carboniferous; its beak, in young specimens at least, is perforated on the apex, like in *Terebratula*, but the arm skeleton is that of *Spirifer*; in *Uncites*,[3] which is a devonian fossil, the beak of the ventral valve is produced tapering and incurved at its extremity and perforated, in young specimens at least, with an oval foramen. Following Mr. Davidson's classification of *Brachiopoda*, I have placed at end of the *Spiriferidæ* the genus *Atrypa*,[4] while Mr. S. P. Woodward, in his Manual of Mollusca, has placed it with the *Rhynchonellidæ*. The name indicates that the beak is without a foramen, but this is not strictly the case, the beak being perforated in the young state at least; the arm spires have a different form from the majority of the *Spiriferidæ*, being vertical and directed upwards towards the centre of the (dorsal) valve. It is a palæozoic genus, the best known form of it being the silurian and devonian *Atrypa reticularis*.[5]

Case 23, Shelf 3. *Spiriferidæ.*

In the same shelf also begins the next family of Brachiopoda, that of the *Rhynchonellidæ*, so named from the typical genus *Rhynchonella*;[6] this genus is often confused with *Terebratula*, but in specimens where the beak is preserved the distinction is very easy, the beak is more pointed, and the foramen is beneath the apex of the beak. *Rhynchonella* ranges from silurian through all formations, and is still represented by two living species: representatives of it are in the second half of shelf 3 and in the first half of shelf 4, case 23.

Case 23, Shelves 3, 4. *Rhynchonellidæ.*

Next to *Rhynchonella* is placed *Pentamerus*,[7] a genus containing large-sized forms of *Rhynchonellidæ*; its name is derived from the circumstance that there is in the ventral valve a median plate[8] extending from the beak to a greater

[1] Diminutive of *spirifer*.

[2] A (Gr.) = indicates a negation; θύρα (Gr. thüra) = a door, referring to the absence of a deltidium.

[3] *Uncus* (Lat.) = a hook.

[4] Ἀ (Gr. negative) = without; τρύπα (Gr. trypa) = a hole.

[5] *Reticulum* (Lat.) = net, referring to the reticulated surface.

[6] Ῥύγχος (Gr. rhynchos) = a beak.

[7] Πέντε (Gr. pente) = five; μέρος (Gr. meros) = a portion (divided into five parts).

[8] Produced by coalescence of two vertical septa.

or less distance; in the dorsal valve there are two separate septa. One or two specimens showing these septa are exhibited. *Pentamerus* has a range from silurian to carboniferous.

Case 24, Shelf 1. Case 24, Shelves 2, 3, *Orthidæ*.

Passing by shelf 1 of case 24, which contains some larger forms and specimens of unclassified *Brachiopods*, we find in the next shelf (2) the beginning of another family of *Brachiopoda*, that of the *Orthidæ*, which continues into the third shelf. The name of the family is taken from the typical genus *Orthis*,[1] from the straight hinge-line of the valves; the hinge-line is shorter than the width of the valves, which are generally more or less transversely oblong, and each of them has an area. The shell is seldom flat, one valve usually more convex than the other. *Orthis* is one of the oldest forms, begins already in cambrian rocks, is very numerous in silurian and devonian, and appears to terminate in the carboniferous. A sub-genus of *Orthis* is *Streptorhynchus*;[2] here the beak of the ventral valve is more produced, the area, therefore, somewhat larger, the beak besides generally twisted, and thus the entire form resembling a *Spondylus*, amongst the bivalves (see further); it is known from devonian, carboniferous and permian rocks. This genus is also numerous in the carboniferous rocks of India, especially of the Salt-range, and is represented there by two species. The next allied genus is *Strophomena*,[3] in which the shell is depressed, semi-circular, widest at the hinge-line; double hinge area. This distinguishes them sufficiently from *Orthis*; but, like this latter genus, *Strophomena* is one of the oldest forms of animal life, abounding in lower and upper silurian, and has not been found above carboniferous.

Case 24, Shelf 3, *Orthidæ*.

At the beginning of shelf 3 we still find representatives of *Strophomena*, which are followed by forms of *Leptæna*,[4] which some authors regard as a peculiar genus, while others consider it a sub-genus of *Strophomena*, which it resembles very much; it is, however, generally smaller, the shell more transversely elongated, the valves bent, the ventral valve is convex, while the dorsal one is concave.

This form also begins in lower silurian, but has been found also in liassic rocks of England, France and Germany.

[1] Ὀρθὸς (Gr. orthos) = straight.

[2] Στρεπτὸς (Gr. streptos) = curved; ῥύγχος Gr. (rhynchos) = the beak.

[3] Στρόφος (Gr. strophos) = a bent; μήνη (Gr. mene) = the moon-crescent, referring to the halfmoon-like shape of the shell.

[4] Λεπτὸς (Gr. leptos) = thin.

In shelf 3 of case 24 we also find the greater portion of the next important family of *Brachiopoda*, that of the *Productidæ*, called so from the typical genus *Productus*.[1] This is a genus characteristic of the carboniferous rocks, although it occurs also in devonian and permian formations; in the latter, also represented by several widely distributed species; it also passes into triassic rocks. The shells are more or less transverse, generally winged, with a straight hinge area, and are bent, the ventral valve being convex, the dorsal concave; the beak of the ventral valve large and very incurved; on the surface of the shell there are found spines, varying in number and size, and regularity of the arrangement, and they are especially well developed on the auricular expansion.

Case 24, Shelf 3. *Productidæ.*

Next to *Productus*, specimens of which are found still at the beginning of shelf 4, is *Strophalosia*,[2] which differs from the former, especially by the valves articulating by teeth and sockets. It ranges from devonian to permian rocks, in which latter it attained its greatest development.

Case 24, Shelf 4. *Productidæ.*

The family of the *Productidæ* is concluded by the genus *Chonetes*,[3] which has on the margin of the hinge area of the ventral valve a series of tubular spines; it ranges from silurian to carboniferous rocks, in which latter it reached its highest development.

The end of this shelf (4) contains the rest of the *Brachiopoda*, *i. e.*, some representatives of the *Craniadæ*,[4] *Discinidæ*,[5] and *Lingulidæ*; of these the latter only deserve some notice here. The family bears the name from the typical genus *Lingula*;[6] this genus is found already in lowest silurian rocks, and has continued uninterruptedly till the present day; the shell is thin, oblong, oval or sub-pentagonal, truncate below, the apex of the ventral valve pointed; both valves slightly convex, but depressed; surface smooth or concentrically striated. Another genus is *Obolus*, which is characteristically silurian; the shell is orbicular, slightly transverse, depressed and smooth. This concludes the *Molluscoida*.

Case 24, Shelf 4. *Craniadæ.* *Discinidæ.* *Lingulidæ.*

[1] *Productus* (Lat.) = produced, referring to the beak.

[2] Στροφάω (Gr. strophaō) = to turn, to move about, to articulate.

[3] Χώνη (Gr. chone) = smelting vessel, a cup.

[4] From the typical genus *Crania* (*cranium* Lat. = skull). The "skull-shell."

[5] From the genus *Discina* (diminutive of *discus* = disc), small disc-like shell.

[6] *Lingula* (Lat.) = a littletongue, referring to the shape of the shell.
Obolus (Lat.) = a small Greek coin.

Section: *Mollusca Proper.*

Cases 25—46, *Mollusca Proper.*

This section comprises all the objects generally known as "shells," such as oysters, scallops, mussels, river mussels, cockels, venus-shell, boring shell, the snails, pearly nautilus, &c. There are certain anatomical characters which distinguish the animals of the Mollusca Proper from those of the *Molluscoida*, but of which the palæontologist cannot avail himself; there are, however, sufficient characters by which to distinguish the shells themselves from any of the preceding forms.

According to the characters of the shell and the organisation of the animal, four classes of Mollusca are distinguished, all of which are represented amongst the fossils, and we may indeed say that Molluscs form the most abundant remains of animal life imbedded in our earth's strata as may be seen from our collection, where they occupy almost half of the entire number of the wall cases—22 out of 50 (cases 25—46)

Class: *Lamellibranchiata*[1] (*Bivalves*).

Cases 25—32. *Lamelli-branchiata.*

These are shells with two valves, which differ from those of the *Brachiopoda* by being almost generally "inequilateral," but "equivalved" (with very few exceptions). Each shell shows a margin and an apex; the apex, termed generally "umbo," occupies the upper side of the shell and is generally turned more or less on one side (towards that side where in living forms the mouth of the animal lies). This side towards which the umbos are turned is the "anterior" side, consequently the opposite one is the "posterior," and then one of the valves is right, the other left. The shells are joined on the umbonal side by an articulation of "teeth" and besides this by a "ligament." The teeth are important characters in fossil shells, although in some forms they are absent. There are inside the shell some other marks of importance. Close to the margin there runs generally a line, called the "pallial line," where the margin of the sack or mantle,[2] which enclosed the animal, while living, was attached. In some of the bivalves the two halves of the mantle are united; in this case water is admitted to the gills[3] by two longer or shorter tubes called "siphons" coming out from the posterior part.

In many forms these siphons are long and can then be retracted within the shell, and in these forms the "pallial line" is deflected inside, passing round the siphons; it forms the "pallial sinus."

These characters, whether the shells are "siphonate" or not, whether the pallial line is entire or forms a "sinus," are used by English authors as characters of the sub-divisions.

Continental writers use another character for the great sub-division. In order to enable the animal to shut its shells at will, there are inside

[1] *Lamelli branchia* (Lat.) = lamellar gills (organs of respiration).
[2] *Pallium.*
[3] Respiratory organs.

the shell one, in other forms two muscles connecting the valves, and by the contraction of which the shell is closed; the points of attachment of those muscles are marked by distinct impressions after the animal is removed, so that in any shell one can say whether there was only one or whether there were two muscles; according to this the *Mollusca* were sub-divided into two great groups, "*Monomyaria*" [1] and "*Dimyaria*," [2] the latter being further sub-divided into shells with "entire pallial lines" and those with a "sinuated pallial line."

I follow the English classification—

(*a*). Asiphonate bivalves[3]—(these include all the Monomyaria and a portion of Dimyaria.

(*b*). Siphonate bivalves—(including the remaining portion of the Dimyaria,)—

(α). with entire pallial line;

(β). with sinuate pallial line.

Order: *Asiphonida.*[4]

The beginning of this order will be found in case 25. It commences with a generally known family, that of the *Ostreidæ*, called so from the most typical genus *Ostrea* (an oyster). In this genus the shell is very irregular; it is one of the instances where the valves are unequal, this being caused prominently by the circumstance that the shell is attached by one of the valves (the left); in this case this left valve can also be called the lower one and is convex, while the upper one (the right) is concave or flat; the surface of the shell either scaly (generally the lower one, in some instances both), or foliaceous. *Ostrea* ranges from carboniferous through all formations and is still numerous in present seas. Forms of this genus are found in shelves 2 and 3, and in the beginning of shelf 4, case 25.

Cases 25—28, 29, Shelves 1, 3. Case 25, Shelves 1—4. *Ostreidæ*.

The other portion of shelf 4 contains two sub-genera of *Ostrea, i. e. Gryphæa*[5] and *Exogyra*,[6] of which in the former the left valve possesses a prominent very curved umbo, while in the latter the umbones are subspiral and turned to the posterior side, *i. e.* reversed; both of them are found in mesozoic rocks.

Case 25, Shelf 4 (*b*).

[1] Μόνος (Gr. monos)=one; μυὼν (Gr. myon)=a muscle.

[2] Δὶς (Gr. dis)=twice; μυὼν=a muscle.

[3] Bivalves without siphons.

[4] Without a siphon.

Γρυπὸς (Gr. grypus)=curved, hooked.

[6] Ἔξω (Gr. exo)=out, outside; γυρὸς (Gr. gyrus)=curved, bent.

Case 26, *Ostreidæ.*

While the first shelf of case 26 contains large specimens of *Ostreidæ,* we find in the beginning of the second still some specimens of *Exogyra* ; adjoining to it are two other genera of less importance.

Case 26, Shelves 2, 3, 4.

In the middle of the second shelf, the large genus *Pecten*[1] begins and fills also the entire third shelf and beginning of the fourth ; the Pectens are as well known shells as the Oysters ; they comprise the scallops. The shells are generally distinctly ribbed and the beaks are furnished with ears ; the anterior ear larger. The genus *Pecten* is represented in secondary and tertiary rocks, and is numerous in present seas ; and if we take the sub-genus *Aviculo-Pecten* into consideration, then the range of *Peclen* would go as low down as carboniferous.

Case 26, Shelf 4.

Other sub-genera are *Hinnites*[2] and *Janira*[3] (Neithea),[4] and adjoining these there is in the fourth shelf, case 26, the beginning of the genus *Lima* ;[5] here the valves are free, equal and eared, obliquely oval ; their umbones apart ; it ranges from carboniferous to the present day.

Case 27, Shelf 1.

The first shelf in case 27 contains large specimens of *Ostreidæ.*

Case 27, Shelf 2.

In the second we find the continuation of *Lima,* and then beginning of another genus, *Spondylus,*[6] in which the valves are unequally eared, radiately ribbed or foliaceous, and covered with spines and articulating by well-developed teeth ; range from jurassic up to present days.

Case 27, Shelf 3.

In the next shelf we find in the beginning still some *Spondyli ;* adjoining to it is *Plicatula,*[7] resembling *Spondylus,* but having no ears ; ranges from trias to the present day, and is most numerous in cretaceous.

Case 27, Shelf 3. *Aviculidæ.*

In the same shelf is also the beginning of the next family, the *Aviculidæ,* from the genus *Avicula,*[8] which has an obliquely oval shell, very inequivalve and eared.

[1] *Pecten* (Lat.)=a comb, referring to the ribbed surface.

[2] *Hinnus* (Lat.)=a mule.

[3] Ἰάνειρα (Gr. Janeira)=a mythological name, of a daughter of the Okeanos.

[4] Νηΐς (Gr. neis)=a well nymph ; θεά (Gr. thea)=goddess.

[5] *Lima* (Lat.)=a file.

[6] Σπόνδυλος (Gr. spondylus)=vertebra, a joint, referring to the articulation of the valves.

[7] *Plicatus* (Lat.)=plaited.

[8] *Avicula* (Lat.)=a little bird, referring to the shape of the shell.

It occurs already in silurian rocks. I may here mention that the pearl oysters (Meleagrina[1]) belong to the *Aviculidæ*.

There are several sub-genera of *Avicula*, the more important of which are *Aucella*,[2] in which the left valve is earless, in permian and secondary rocks; *Cardiola*[3] probably also comes here; it is palæozoic. The valves are equal, obliquely oval, with prominent umbones, radiately and concentrically ribbed; *Plerinea*,[4] very oblique and broadly winged, with anterior beaks; lower silurian to carboniferous; *Monotis*[5] resembles *Avicula*, but has compressed shells, anterior side short and rounded, and the posterior only slightly eared; occurs in permian and triassic rocks; *Posidonomya*,[6] with a very thin shell, which is equivalve and earless, concentrically furrowed; from carboniferous to trias. Case 27, Shelf 4.

Large specimens of bivalves fill the first shelf (case 28); the second and third contain the continuation of shells belonging to the *Aviculidæ*; of these may be mentioned, in the second shelf, *Gervillia*,[7] shell long and very oblique with the posterior ear winglike; especially mesozoic; *Perna*,[8] with a compressed subquadrate shell, with a broad hinge area, containing oblong closely-set groves to receive the cartilages by which the shells join; it begins in trias and is still living. Case 28, Shelf 1. Case 28, Shelf 2.

Here also begins *Inoceramus*,[9] differing from *Perna* chiefly in form; the shell is concentrically furrowed and has prominent umbones; begins in lias, but is most numerous in cretaceous.

The first half of shelf 3 still contains *Inoceramus*; next to it is the genus *Pinna*,[10] a peculiar wedge-shaped shell, with the umbones pointed and the posterior side truncate. It ranges from devonian rocks to the present day. It forms a passage to the next family, that of the *Mytilidæ*, which fill shelf 4 of case 28. Case 28, Shelf 3.

This family contains first the genus *Mytilus*[11] the well-known sea-mussels; it has a range from permian, and Case 28, Shelf 4. *Mytilidæ*.

[1] *Meleagris* (Lat.)=the pearl fowl.
[2] Diminutive of *avicula*.
[3] Diminutive of *cardium* (name of a shell).
[4] Πτέρινος (Gr. pterinos)=winged.
[5] Μόνος (Gr. monos)=one: οὐς-ὦτος (Gr. us-otus)=ear.
[6] Ποσειδῶν (Gr. Poseidon)=Neptunus.
[7] From a proper name (Mr. Gerville).
[8] Perna=name of a shell-fish.
[9] Ἰς-ινὸς (Gr. is)=fibre; κέραμος (Gr. keramos)=shell.
[10] *Pinna* (Lat.)=a fin, referring to the shape of the shell.
[11] Μύτιλος (Gr. mytilos)=the sea-mussel.

is very numerous in the present seas, being an extensive article of food for the dwellers on the coast; next to it is *Modiola*,[1] "the horse-mussels," which commences in liassic rocks and extends to the present day.

Lithodomus[2] (the rock-boring mussel); their shell is cylindrical, inflated in front and wedge-shaped behind; they bore into shells, corals, and the hardest limestone rocks; as fossil it is found already in the oolite and lives in present seas.

Dreissena[3] (or Congeria) concludes the *Mytilidæ;* shell much like *Mytilus*, but valves obtusely keeled. They appear first in tertiary rocks, in some portions of which they are very numerous, so in the Congerien-sandstein of the Vienna tertiary basin.

Case 29, Shelf 1. The first shelf of the next case (29) contains large specimens of bivalves, and in the next shelf (2) we find the next

Case 29, Shelf 2. *Arcadæ.* family, that of the *Arcadæ*, in which the hinge of the valves shows numerous similar comb-like teeth. First is placed the type of the family, the genus *Arca*,[4] with generally an inflated shell, a straight hinge with numerous teeth, the umbones distant, and under each a triangular area. They begin doubtfully in lower silurian rocks, and are still numerous in present seas. Next to it is *Cucullæa*,[5] very much resembling *Arca*, but distinguished by a different arrangement of the teeth. Range, the same as of the former.

Next follow *Pectunculus*,[6] which commences in cretaceous, and is very numerous in miocene rocks, and lives also in present seas; *Nucula*,[7] a shell in which the umbones are reversed towards the posterior side and which ranges from silurian to the present days.

Case 29, Shelf 3. The *Arcadæ* continue into the next shelf, with the genus *Leda*,[8] which is like *Nucula*, but more elongated and produced posteriorly; from palæozoic rocks to the present days.

Case 29, Shelf 3. *Trigoniadæ.* The next family is that of the *Trigoniadæ* from the type genus *Trigonia*,[9] in which the shell is more or less trigonal

[1] *Modiolus* (Lat.)=a drinking vessel.

[2] Λιθὸς (Gr. lithos)=rock; δόμος (Gr. domos)=a house, home (a shell living in rock).

[3] Proper name Dreissen.

[4] *Arca* (Lat.)=a chest, an ark.

[5] *Cucullus* (Lat.)=a cowl.

[6] *Pectunculus* (Lat.)=diminutivum of *Pecten*.

[7] Diminutive of *nux* (Lat.)=a small nut.

[8] Mythological name (Greek.).

[9] Τρίγωνος (Gr. trigonos)=three-angled.

with two or three diverging hinge-teeth, which are prominent and transversely striated; they are mostly mesozoic, and some species live at present in Australian seas; the palæozoic representative of *Trigonia* is *Axinus*.[1]

The rest of shelf 3 is occupied by another family, the *Unionidæ*, with the genus *Unio*,[2] the common river mussels. The range of this genus is not known with certainty, as the species quoted formerly from palæozoic rocks were removed to other genera, but it appears to be represented in jurassic times, and is very numerous in the rivers, tanks, and lakes of the present day. The river pearl-mussel is also a *Unio*. Case 29, Shelf 3. *Unionidæ*.

Order: *Siphonida*.

With shelf 4 of case 29 the second order of the *Lamellibranchiata* begins, that of the *Siphonida*, *i.e.* shells with respiratory tubes (siphons) coming out from the posterior side, either only short ones, when there is a small sinus only or none, or longer ones, when the sinus of the pallial line becomes deeper. Case 29, Shelf 4. *Siphonida*.

(*a*) *Siphonate bivalves without pallial sinus.*

At first are placed the *Chamidæ*, called so from the genus *Chama*,[3] which has an unequivalved shell attached by one of the umbones, in which case the upper valve is the smallest; on the surface of the valves foliaceous expansions. It occurs already in cretaceous rocks, but is chiefly developed in tertiary rocks (eocene of the Paris basin) and lives in present seas. Next to it is *Diceras*,[4] so called from its beaks being very prominent and spiral, resembling horns of a ram; the valves are sub-equal; it is an oolitic genus; the third genus is *Requienia*,[5] which resembles *Diceras*, but with one of the valves (the right one) much smaller and not so spiral. It is a cretaceous fossil. Case 29, Shelf 4. *Chamidæ*.

Next to the *Chamaceæ* are representatives of that peculiar family, the *Hippuritidæ*, which are large, thick-shelled, unequivalved bivalves of a conical or cylindrical form, which are Case 22, Shelf 4. *Hippuritidæ*.

[1] Ἀξίνη (Gr. axine) = an axe, a hatchet, referring to the form of the shell.

[2] *Unio*=a pearl.

[3] Χημὴ (Gr. cheme)=a gaping.

[4] Δὶς (Gr. dis)=twice; κέρας (Gr. keras)=a horn, double-horned shell.

[5] From a proper name (Requien).

attached by the larger (right) umbo and show a peculiar structure of the valves and of the hinge apparatus, too complicated to be described here. They are, as far as known at present, restricted to the cretaceous rocks, and are represented in our collection by two genera. *Hippurites* [1] (from which the family takes its name) and *Radiolites*.[2]

Case 29, Shelf 4.

In this shelf is also the beginning of the *Cardiadæ*, at first represented by the genus *Cardium*,[3] which comprises the true cockles, which are extensively used for food. The shells are radiately ribbed; the genus ranges from carboniferous to the present day, where it is very numerous in the seas.

Case 30, Shelves 1, 2. *Cardiadæ*.

Shelf 1 of case 30 contains large bivalves, while the second shelf still contains specimens of *Cardium*; adjoining to it is *Protocardium*,[4] which is a cretaceous genus, and the shell of which is radiately ribbed in the posterior part, while the rest is concentrically striated. This is followed by the very peculiar genus *Conocardium*,[5] the shell of which is trigonal, conical, truncate behind, with long (siphonal) tube near the umbones. It is a palæozoic shell and ranges from silurian to carboniferous rocks.

Case 30, Shelves 2, 3. *Lucinidæ*.

In the same shelf also is the beginning of the next family, the *Lucinidæ*, called so from the well-known genus *Lucina*,[6] with generally an orbicular depressed shell, and the anterior muscular impression elongated. It ranges doubtfully from siluriau to the present days, being especially numerous in tertiary rocks; some more specimens of *Lucina* are found also in the third shelf; next follows *Corbis*,[7] with the surface of the shell concentrically sculptured, with denticulate edges; begins in jurassic rocks. Passing by two or three other forms of *Lucinidæ* of less importance, we find in this shelf also the genus *Cyrena*,[8] a fresh-water shell, r presenting the *Cycladidæ*, so called from the genus *Cyclas*, of which no specimens were available for exhibition; *Cycrena* appeared at the close of jurassic times.

Case 30, Shelf 3 *Cycladidæ*.

[1] Fossil horse-tail.

[2] *Radiolus* (Lat.)=a small ray, referring to the radiated structure of the upper valve.

[3] Καρδία (Gr. kardia)=a heart, referring to the shape.

[4] Πρῶτος (Gr. protos)=the first, and *Cardium*.

[5] *Conus* (Lat.)=cone, and *Cardium*.

[6] *Lucina* (Lat.)=goddess of light, a surname of Diana.

[7] *Corbis* (Lat.)=a basket, referring to the structure of the shell surface.

[8] Κυρήνη (Gr. Kyrene)=a nymph, the beloved of Apollo.

[9] Κύκλος (Gr. cyclos)=a circle.

At the end of the same shelf (3), we also find the beginning of the family *Cyprinidæ*, with the genera *Cyprina*,[1] which appears in the Muschelkalk and lives in present seas; *Astarte*,[2] which begins in lias, is very numerous in some jurassic rocks, and lives in present seas; it is especially characterised by having the so-called "lunula"[3] well-marked; *Crassatella*,[4] with thick solid shells and well-marked muscular impressions. It begins in cretaceous rocks and is especially numerous in tertiary rocks and lives at present. Then follow some other genera, of which it will be sufficient to quote the names only, with their etymological derivation: *Isocardia*[5] from trias to the present day; *Cypricardia*,[6] secondary, tertiary and recent; *Pachydomus*,[7] devonian and carboniferous; *Cardinia*,[8] from (doubtfully) silurian to jurassic rocks; *Myoconcha*,[9] from permian to tertiary (this is placed by Nicholson with *Mytilidæ*).

Case 30, Shelves 3, 4. *Cyprinidæ.*

While the first shelf of case 30 contains large specimens of bivalves, we find in the beginning of shelf 2 still two genera of the *Cyprinidæ*; *Cardita*,[10] has a cockle-shaped, somewhat obliquely oblong shell, with radiating ribs; it appears in triassic rocks and lives at present; and *Venericardia*,[11] which is a sub-genus of the former.

Case 31, Shelf 1.

Case 31, Shelf 2. *Cyprinidæ.*

(*b*) *Siphonate bivalves with pallial sinus.*

In this second shelf begins also that portion of Siphonate shells, the pallial line of which is sinuated; we find first the family *Veneridæ*, from the typical genus *Venus*,[12] the Venus shell, which appears in jurassic rocks and is numerous in present seas; closely related to it is *Cytherea*,[13] which also has a similar distribution; the sinus in both is moderate, angular; representatives of *Cytherea* are found also at the beginning of shelf 3; next to it is *Artemis*,[14] in which the pallial

Case 31, Shelf 2. *Veneridæ.*

Case 31, Shelf 3. *Veneridæ.*

[1] Κύπρις (Gr. kypris) = Cyprian, surname of Venus.
[2] Another name for Venus.
[3] An oval space in front of and below the beaks of the valves.
[4] *Crassus* (Lat.) = thick.
[5] Ἴσος (Gr. isos) = like; καρδία (Gr. kardia) = heart, heart-shaped shell.
[6] *Cypris* and Kardia.
[7] Παχὺς (Gr. pachys) = thick; δόμος (Gr. domos) = shell.
[8] *Cardo, cardinis* (Lat.) = a hinge.
[9] *Mya* (Lat.) = a mussel; *concha* (Lat.) = shell.
[10] Καρδία (Gr. kardia) heart.
[11] Venus-heart-shell.
[12] Mythological name (Venus).
[13] Κυθήρεια (Gr. Cythereia) = surname of Aphrodite (Venus).
[14] Ἄρτεμις (Gr. Artemis) = the Greek name for the Roman goddess Diana.

sinus is deep and angular; ranges from cretaceous (?) to the present days; of the others may be mentioned *Tapes*,[1] tertiary and living, and *Petricola*,[2] which ranges from cretaceous to the present days (it burrows in limestone and mud).

Case 31, Shelf 3.

With this we arrive at a next family, that of the *Mactridæ*, called so from the typical genus *Mactra*,[3] which appeared in liassic rocks and is very numerous in present seas. Another genus of the same family is *Lutraria*,[4] the "otter's shell," with a deep pallial sinus; it seems to appear first in cretaceous rocks and is still a living genus.

Case 31, Shelf 3. *Tellinidæ.*

Next to the *Mactridæ* we find another family, the *Tellinidæ*, represented by *Tellina*,[5] which is very numerous in present seas, especially in the tropics where the shells are highly coloured; the animal is eaten; as fossils the shells are known from oolitic rocks upwards; other genera of this family are—*Psammobia*,[6] the sunset-shell, or sand-shell, with a very deep siphonal sinus; it commences in eocene rocks and lives at present in seas; *Sanguinolaria*,[7] an oblong, compressed and thin shell, with a very deep siphonal sinus; it is also known from eocene rocks and lives in present seas, the shells exhibiting red colours; *Donax*,[8] the wedge-shell, with a trigonal wedge-like shell, has about the same range as the two last named; *Solen*,[9] the razor-fish, with a long, sub-cylindrical shell which makes its appearance in tertiary rocks and is numerous in present seas; it is the representative of another family of bivalves, the *Solenidæ*, in this shelf.

Case 3, Shelf 3, *Solenidæ.*

Case 31, Shelf 3. *Myacidæ.*

At end of the same shelf we also find the beginning of a next family, the *Myacidæ*, of which the genus *Mya*,[10] the Gaper, is the type, with an inequivalve shell, gaping at the ends; it appears in middle tertiary times and lives in the seas of the present day.

[1] *Tapes* (Lat.) = carpet, tapestry.

[2] *Petra* (Lat.) = a rock; *colo* (Lat.) = to inhabit.

[3] Μάκτρα (Gr. maktra) = kneading trough.

[4] *Lutra* (Lat.) = an otter.

[5] Τελλίνη (Gr. telline) = the Greek name of a mussel living in seas and rivers.

[6] Ψάμμος (Gr. psammos) = sand; βίοω (Gr. bioo) = to live, referring to its littoral habits.

[7] *Sanguinolarius* or *sanguinolentus* (Lat.) = bloody, with reference to the colour.

[8] Δόναξ (Gr. donax) = a reed, a pipe; the male of the Solen, razor-fish.

[9] Σώλην (Gr. solen) = a waterpipe, but also the Greek name for the knife-fish.

[10] Μύα (Gr. mya) = the Greek name of a shell, the mussel.

Further genera of the *Myaciłæ* are placed in the next shelf, 4; *Corbula*,[1] which has a very inequivalve, gibbose shell, the right valve being the larger one and with a prominent beak; ranges from jurassic to present times; *Panopæa*,[2] resembles *Mya*, but the shell is equivalve, commences in jurassic rocks and is also represented in present seas; *Saxicava*,[3] which lives in crevices of rocks or burrows in limestone and shells; as fossil it appears first in tertiary rocks. With *Anatina* a new family begins, that of the *Anatinidæ*,[4] which is especially numerously developed in secondary (mesozoic) times, although several types appear in the palæozoic epoch. *Anatina*, the lantern-shell, itself is doubtfully known from devonian rocks, occurs chiefly in the oolites and lives in present seas. Next to *Anatina* is the large and palæontologically interesting genus, *Pholadomya*,[5] which generally has a ventricose shell, gaping behind, generally truncate in front, and ornamented with radiating ribs on the sides. Their maximum development is in mesozoic rocks, where they appear for the first time; they are rare in tertiary rocks as well as in present seas.

Case 31, Shelf 4. *Myacidæ*.

Case 31, Shelf 4. *Anatinidæ*.

Large specimens of bivalves fill No. 1 shelf of the next case.

Case 32, Shelf 1.

In shelf No. 2, at the beginning, we find still specimens of *Phalodomya*. A sub-genus of *Phalodomya* is *Homomya*,[6] from jurassic rocks in Europe. Other forms are—*Myacites*,[7] which contains only extinct forms ranging from siluriau to the chalk; *Goniomya*,[8] which follows next, is a sub-genus of *Myacites*, distinguished by the ribs on the sides of the valves forming an angle; it is a mesozoic fossil, ranging from lias to cretaceous; *Ceromya*,[9] with a ventricose (anteriorly) shell, rather prominent, somewhat spiral umbones; surface of the valves often obliquely furrowed, chiefly jurassic. Some other forms are of less importance.

Case 32, Shelf 2. *Anatinidæ*.

[1] *Corbula* (Lat.) = a small basket.

[2] Πανόπη (Gr. Panope) = name of a Nereid.

[3] *Saxum* (Lat.) = a rock, stone; *cavo* (Lat.) = to excavate.

[4] *Anas* (Lat.) = the duck; *anatinus* (Lat.) = pertaining to a duck, the duck shell.

[5] A compound word from φωλὰς (Gr. pholas) = name of a shell, and μύα mussel.

[6] "Ομοιος *or* ὁμὸς (homos) = like, resembling, and Mya.

[7] Like a Mya.

[8] Γώνια (Gr. gonia) = an angle, and μύα = mussel.

[9] Κεραὸς (Gr. ceraos) = horned; and μύα = mussel, referring to the umbones.

Case 32, Shelf 2. *Gastrochænidæ*

Next in order we find the family of *Gastrochænidæ* represented by two genera, *Gastrochæne*,[1] with a wedge-shaped shell, which has a wide gape in front and is closed behind; they burrow in mud and stone, appear first in jurassic rocks and are still represented in present seas. *Clavagella*[2] is another genus of the *Gastrochænidæ*; commenced in cretaceous rocks and is still living.

Case 32, Shelf 2. *Pholadidæ*.

The last family in this shelf, with which also the bivalves terminate, is that of the *Pholadidæ*, the family of the "burrowing-shells," so called from the genus *Pholas*;[3] they burrow in clay, peat, or rock, and as fossils they are known to commence with certainty in eocene rocks; there are no specimens exhibited. The best known form of this family belong to the genus *Teredo*,[4] the "ship-worms" which burrow especially in wood and are thus very destructive to piers and ships.

Class: *Gasteropoda*.[5]

Cases 33–38. *Gasteropoda*.

With case 32 a new class of Mollusca begins, that of the *Gasteropoda*, which comprises, generally speaking, the univalved Mollusca, known as snails, whelks, limpets, &c. This class derives its name from the arrangement by which locomotion in the living forms is effected, *i. e.* by a broad horizontally flattened central disc—the "foot." In the fossil state we have to deal with the shell only.

In the greatest number of *Gasteropoda* the shell is univalved; in very few forms it is compound. The univalved shell is in the simplest form a low cone, as in the limpets; in other cases the cone becomes elongated and even tubiform; it retains either this shape (*Dentalium*) or in most cases is spirally coiled up. The turns of the spiral are termed "whorls." In a few cases they do not touch each other; generally, however, they are in contact, and then the lines or grooves formed by the contact of the whorls are called "sutures." The whorls either lie in the same plane, "discoidal," or in most cases they are "turriculated."

The axis round which the whorls are wound up is called "columella," and this is either solid ("imperforate shells"), or sometimes hollow "perforated shells;" at the apex of this columella there lies the smallest whorl, and from here they become wider downwards, terminating with

[1] Γαστὴρ (Gr. gaster) = the stomach, ventral side; χαίνω (Gr. chaino) = to gape.

[2] Diminutive of *clava* (Lat.) = a club, the "club-shell."

[3] Φωλὰς (Gr. pholas) = dwelling in caves, referring to the burrowing habits of these shells.

[4] Τερηδὼν (Gr. teredon) = a wood-boring shell.

[5] Γαστὴρ (Gr. gaster) = the stomach, belly; ποῦς = ποδός (gr. pus = podos) = foot, referring to the locomotive organ on the ventral side.

the "body whorl" which contains the "mouth" or "aperture" of the shell; this is enclosed by an "outer" and "inner lip," and is either "entire," or in other shells, notched in front (the apex placed posteriorly); in other cases, again, there may be also a posterior notch, and both of them, or one only, may be prolonged into canals, varying in length (this character indicates that the animal possessed "respiratory siphons," which came out through the canals).

According to the respiratory organs they are divided into two large sections, *Branchifera*,[1] respiration by gills (aquatic), and *Pulmonifera*[2] respiration by lungs (land-snails).

Section: *Branchifera.*

A.—Prosobranchiata.—The gills situated in advance (προσὸν = proson) of the heart. They begin in case 33. In the first shelf are large specimens.

In the next shelf we find at first the family of the *Strombidæ*, with expanded and notched lip, so called from the genus *Strombus*,[3] with a long aperture, expanded outer lip; has an anterior as well as posterior notch; cretaceous and tertiary, and very numerous in present seas. Case 33, Shelf 1. *Strombidæ.*

Pteroceras,[4]—the scorpion shell, has in the adult state the expanded lip furnished with several long processes; commences in the lias and has nice representatives in present seas.

Next to it is *Rostellaria*,[5] with an elongated shell and an expanded lip and long canals; very numerous in tertiary rocks, and surviving to the present day. *Seraphs*[6] or *Terebellum*[7] is another genus belonging to the *Strombidæ*; begins in eocene rocks, rare amongst the recent Molluscs.

In the same shelf begins also the family of the *Muricidæ*, very well known shells also amongst the recent *Mollusca*; the shell has a rounded aperture, entire behind, and the anterior canal long and straight. Several characteristic genera: *Murex*,[8] from which the family takes the name, is the type genus; has a shell ornamented with longitudinal ridges and a rounded aperture; begins in tertiary rocks and has many Case 33, Shelf 2. *Muricidæ.*

[1] Βράγχια (Gr. branchia) = the gill; φέρω (Gr. phero) = to carry, to have.

[2] *Pulmo* (Lat.) = a lung; *fero* (Lat.) = to have.

[3] Στρόμβος (Gr. strombos) = a top; also the name of a shell.

[4] Πτέρον (Gr. pteron) = a wing; κέρας (Gr. keras) = horn, referring to the expanded lip with several processes.

[5] *Rostellum* (Lat.) = a little beak.

[6] Derivation doubtful.

[7] Diminutivum of *Terebra*, a name of another shell (*terebra* means 'an auger').

[8] Name of the purpur-shell in Pliny.

Case 33, Shelf 3. *Muricidæ.*

representatives in present days; other genera are *Pisania*,[1] begins in eocene, and is very numerous in present seas; *Ranella*[2] (the frog-shell) and *Triton*,[3] both begin in eocene and are well represented amongst the recent Molluscs; *Turbinella*,[4] miocene and living; *Cancellaria*,[5] the cross-barred shell, eocene and in present seas; *Pyrula*,[6] with pear-shaped shell and a long (open) canal, commences in cretaceous rocks, and is well represented amongst the recent shells; *Fusus*[7] (the spindle-shell) is, next to *Murex*, the most numerous and best known shell, both fossil and recent, of the *Muricidæ;* it has a fusiform shell with a long canal; it commences in cretaceous and is very numerous also in present seas.

Case 33, Shelf 4. *Muricidæ.*

In the beginning of the next shelf (4) there are some more specimens of *Fusus*, with which the family *Muricidæ* is concluded.

Case 33, Shelf 4. *Buccinidæ.*

Next follows the family *Buccinidæ;* the best known of this is the genus *Buccinum*,[8] the whelk, which commences in cretaceous and is very numerous in present seas; it is an article of food. All the other genera, which fill the rest of this shelf, also belong to the *Buccinidæ: Terebra*,[9] the auger-shell; *Eburna*,[10] the ivory-shell; *Nassa*,[11] the dog-whelk; *Purpura*,[12] the purple-shell, &c. These commence in tertiary rocks and are numerous in present days.

Case 34, Shelf 1.

Passing to the next case (34) we find in the first shelf large specimens of *Gasteropoda.*

Case 34, Shelf 2. *Buccinidæ.*

In the next shelf there are some more representatives of the *Buccinidæ*, of which may be mentioned *Cassis*,[13] the helmet-shell; *Cassidaria*,[14] related with the former; *Oliva*,[15] the olive-shell, and *Ancillaria*,[16] all of which commence in eocene

[1] *Pisa* (city) in Tuscany.
[2] *Rana* (Lat.) = the frog.
[3] Τρίτων (Gr. Triton) = a sea deity.
[4] Diminutivum of *turbo* (Lat.) = a top.
[5] *Cancellatus* (Lat.) = cross-barred.
[6] Diminutive of *pyrus* (Lat.) = a pear.
[7] *Fusus* (Lat.) = a spindle.
[8] *Buccina* (Lat.) = a trumpet; also the triton shell.
[9] *Terebra* (Lat) = an auger.
[10] *Ebur* (Lat.) = ivory (*eburneus* = made of ivory).
[11] *Nassa* (Lat.) = the net or basket for catching fish.
[12] *Purpura* (Lat.) = the purple shell-fish.
[13] *Cassis* (Lat.) = the helmet.
[14] The same derivation.
[15] *Oliva* (Lat.) = the olive.
[16] *Ancilla* (Lat.) = a maiden.

tertiaries and are well represented amongst the living shells. In *Oliva* the whorls are shorter, the aperture long and narrow, notched in front; *Ancillaria* has longer whorls, more conical, and the aperture is shorter.

In this shelf we also find the beginning of the *Conidæ*, commencing with the typical genus *Conus*, the cone shell, with very low whorls and a conical shell; this genus is very numerous amongst the living Molluscs and among fossils; it appears first in cretaceous rocks. Case 34, Shelf 2. *Conidæ.*

The only other genus of importance in this family is *Pleurotoma*,[1] the shell of which resembles somewhat *Fusus*, but the outer lip has a deep slit near the suture; it is very numerous in present seas, but is hardly less numerous in the fossil state; commences in cretaceous and is most numerous in tertiaries.

In the beginning of the next shelf there are some more specimens of *Pleurotoma;* adjoining it are representatives of the family *Volutidæ*, of which *Voluta*, volute, is the type; it has a ventricose shell, with a mammillated apex and a deep notch in front of the aperture; it commences in cretaceous rocks, but is especially numerous in tertiary deposits and recent; *Mitra*,[2] the mitre-shell, which begins in cretaceous, and *Marginella*,[3] which begins in eocene rocks, are two other genera of *Volutidæ;* both very numerous in present seas. Case 34, Shelf 3. *Conidæ.* *Volutidæ.*

The end of this shelf is occupied by the family *Cypræidæ*, the cowries, with the typical genus *Cypræa*,[4] which has numerous representatives in present seas, especially in the Indian Ocean, amongst which may be noticed the coin-shell (*Cypræa moneta*)[5], in India known as *the* cowry, and used here as well as in Africa in place of coins; amongst the fossils, it appears first in cretaceous rocks. Case 34, Shelf 3 *Cypræidæ.*

The lowest shelf is occupied by the family *Naticidæ*, with the type-genus *Natica*, with a more or less globular smooth shell, the inner lip callous, and the shell umblicated; ranges from devonian to the present days; in almost all seas. Case 34, Shelf 4, *Naticidæ.*

Large specimens of Gasteropoda occupy the first shelf of case 35. In the second shelf we still find some forms of *Natica;* next to it is *Sigaretus*,[6] another genus of the *Naticidæ*, Case 35, Shelf 1. Large specimens. Case 35, Shelf 2. *Naticidæ.*

[1] Πλευρὸν (Gr. pleuron) = the side (here 'lip'); τομὴ (Gr. tome) = incision.

[2] *Mitra* (Lat.) = the bishop's hat, referring to the shape of the shell.

[3] *Marginella*, diminutive of *margo* (Lat.) = a rim, referring to the thickened margin of the outer lip.

[4] Κύπρις (Gr. Kypris) = Cyprian, an epitheton of Venus.

[5] A coin.

[6] *Sigaret* is the African name of this shell, introduced by Adamson.

which is car-shaped, and has a very wide aperture; it commences in eocene rocks and lives in present seas.

Case 35, Shelf 2. *Pyramidellidæ.*

The family *Pyramidellidæ* fills the rest of this shelf. The more known genera are *Chemnitzia,*[1] which commences in permian rocks and is still amongst the living forms; and *Macrocheilus,*[2] which is a fossil genus, occurring in devonian and carboniferous rocks only (a genus numerous in the carboniferous of the Salt-range in India).

Case 35, Shelf 3. *Cerithiadæ.*

Next follows the large family *Cerithiadæ,* of which the typical genus *Cerithium*[3] occupies the entire third shelf. The shell is turreted, with a round aperture and a distinct anterior canal, somewhat inflexed. They live in present seas, close to the shore or in brackish water; as fossils they commence in the trias.

Case 35, Shelf 4. *Cerithiadæ.*

Other genera of *Cerithiadæ* are *Potamides,*[4] which (with its synonyms) comprises the Cerithium-like shells, living in brackish and fresh water; *Nerinea,*[5] with a very elongated shell, having ridges on the columella and inside of the whorls, is a fossil genus; jurassic and cretaceous. *Aporrhais,*[6] the spout shell, is also placed here, although some of them show great relation to *Rostelleria.* It commences in jurassic times, and is represented in present seas.

Case 35, Shelf 4. *Melaniadæ.*

The rest of the shelf is occupied by the family *Melaniadæ* with the genus *Melania,*[7] which inhabits fresh water. Some more specimens of *Melania* are found in the second shelf of case 36. Here also the family of *Turritellidæ* begins. The typical genus is *Turritella,*[8] the tower shell, commencing in cretaceous rocks.

Case 36, Shelf 1. Case 36, Shelf 2. *Melaniadæ. Turritellidæ.*

Other genera of *Turritellidæ* are found in the next (third) shelf, of which may be mentioned *Omphalia,*[9] which is especially numerous in the cretaceous rocks of the Gosau, in

[1] Chemnitz, a German conchologist.

[2] Μακρὸς (Gr. makros) = large; χεῖλος (Gr. cheilus) = aperture, referring to its large, anteriorly rounded aperture.

[3] Κεράτιον (Gr. keration) = a small horn, referring to the shape of the shell.

[4] Ποταμὸς (Gr. potamos) = the river; εἶδος (Gr. eidos) = species.

[5] Nerine, a sea nymph.

[6] Ἀπορέω (Gr. aporrheo) = to flow away, to flow out (spout).

[7] Μελανία (Gr. melania) = blackness, referring to the dark (blackish) epidermis of the living forms.

[8] Diminutive of *turris* (Lat.) = tower.

[9] Ὀμφαλὸς (Gr. Omphalos) = the navel, umbilicus, referring to the umbilicus in the columella.

Austria; *Vermetus,*[1] the worm-shell, with a tubular irregularly spiral shell; resembles sometimes very much the tubes of *Serpula*; commences in cretaceous rocks. *Siliquaria*[2] resembles *Vermetus,* but the tube has a continuous longitudinal slit; commences in eocene rocks; *Scalaria,*[3] the wentle trap, the shell of which is generally ornamented by longitudinal ribs like those of a ladder. Very numerous in present seas, and also as fossil, commencing in jurassic rocks. Case 36, Shelf 3. *Turritellidæ.*

The family *Littorinidæ* of which *Littorina,*[4] the periwinkle, is the type genus, fill the rest of the shelf, and are represented by *Solarium,*[5] the staircase shell, commencing in cretaceous rocks; *Phorus,*[6] the carrier shell, so called because most of the species of this genus attach foreign substances to the margin of their shell in growing; commencing in cretaceous rocks; doubtfully palæozoic; *Rissoa,*[7] minute shells which commence in permian rocks. Case 36, Shelf 3. *Littorinidæ.*

With the *Littorinidæ* are now also placed some other genera, which formerly were classed elsewhere. The most important is *Euomphalus,*[8] Sow., with a flat or discoidal shell and a wide umbilicus; it is a fossil genus, ranging from silurian to trias, but being most numerous in carboniferous limestone. It was classed before with the *Turbinidæ.* Case 36, Shelf 4. *Littorinidæ (Solariidæ).*

Passing by the large specimens of *Gasteropoda* in the first shelf of case 37, we find in the beginning of the second shelf the family *Paludinidæ,* which contains fresh-water shells. *Paludina,*[9] the river (or marsh) snail, is the chief genus, commences in wealden and is numerous at present. Case 37, Shelf 1. Case 37, Shelf 2. *Paludinidæ.*

Next comes the family *Neritidæ* with the type genus *Nerita,*[10] the "nerite," which has a semi-globose thick shell, smooth or striated; although commencing in lias it is most numerous in present seas. Case 37, Shelf 2. *Neritidæ.*

In the same shelf the family *Turbinidæ* begins, with the type genus *Turbo,*[11] the "pegtop shell," species of which are Case 37, Shelf 2. *Turbinidæ.*

[1] *Vermis* (Lat.) = the worm.
[2] *Siliqua* (Lat.) = a pod.
[3] *Scalaris* (Lat.) = like a ladder.
[4] *Littus* (Lat.) = shore.
[5] *Solarium* (Lat.) = dial.
[6] Φορεῦς (Gr. foreus) = the porter.
[7] Risso, name of a French zoologist.
[8] Εὖ (Gr. eu) = nice, pretty, wide; ὀμφαλὸς (Gr. omphalos) = umbilicus.
[9] *Palus* (Lat.) = a marsh.
[10] Νηρίτης (Gr. nerites) = a sea snail.
[11] *Turbo* (Lat.) = a top, whirligig.

very numerous in present seas, but occur more so in the fossil state, commencing in silurian rocks. Its shell is turbinated, with a round base.

Case 37, Shelf 3. *Turbinidæ.*

Next in importance is *Trochus*,[1] with a pyramidal shell and a nearly flat base; very numerous amongst fossils, commencing in devonian rocks; also numerous in present seas. As other genera may be mentioned *Phasianella*,[2] the "pheasant shell," commencing in jurassic rocks, and now living in seas; *Monodonta*,[3] commencing in tertiary rocks and living in present seas; *Delphinula*,[4] the "dolphin shell," which commences in triassic rocks, but is also not uncommon in present seas.

Case 37, Shelf 4. *Haliotidæ.*

The family *Haliotidæ*, which takes its name from the living genus *Haliotis*,[5] the "ear-shell," entirely fills the fourth shelf; *Scissurella*,[6] which commences in miocene rocks and is now living, is represented by a few specimens. The chief fossil genus is *Pleurotomaria*;[7] it is numerous in palæozoic rocks, commencing with silurian, and also in mesozoic, rare in tertiary rocks, and very rare amongst the living Gasteropods; it has a trochiform shell, with a subquadrate aperture and a slit in the outer lip, which becomes in the progress of growth filled in and forms a slit-band.

Case 38. Shelf 1. Large specimens. Case 38, Shelf 2. *Haliotidæ.*

Another important fossil genus of the *Haliotidæ* is *Murchisonia*,[8] which is especially palæozoic; it resembles somewhat *Turritella*, but the outer lip has a deep slit, which gets filled in and forms a slit-band; ranges from silurian to permian; it is in shelf 2 of case 38.

Case 38, Shelf 3. *Fissurelidæ. Calyptræidæ. Patellidæ.*

The other portion of this shelf is occupied by three families, which contain the shells generally known as limpets; the *Fissurelidæ* are represented by three closely related genera; *Fissurela*,[9] key-hole limpet, with a perforation in the apex of the oval, conical shell; numerous in present seas, fossil in

[1] Τροχὸς (Gr. trochos)=a top, &c.

[2] *Phasianus* (Lat.)=the pheasant, referring to the rich colouring of the shell.

[3] Μόνος (Gr. monos)=single; ὀδοὺς (Gr. odous)=tooth, referring to the one tooth of the columella.

[4] *Delphinus* (Lat.)=the dolphin (diminutive of).

[5] Ἅλιος (Gr. halios)=marine; οὖς-ὠτος (Gr. us-otos)=the ear.

[6] Diminutive of *scissus* (Lat.)=the slit, referring to the slit in the outer lip.

[7] Πλεῦρα (Gr. pleura)=side; τομὴ (Gr. tome)=incision.

[8] Named after Sir Roderik I. Murchison.

[9] Diminutive of *fissura* (Lat.)=a fissure, aperture.

secondary and tertiary rocks (doubtfully palæozoic); *Rimula*,[1] the fissure-limpet, with a perforation near the anterior margin; ranges from trias to the present day (in seas); *Emarginula*,[2] the notched limpet, has a slit in the anterior margin; commences in triassic rocks and is represented in present seas.

The *Calyptræidæ*, "the bonnet limpets," take their name from the genus *Calyptræo*,[3] which occurs as fossil in cretaceous and tertiary rocks and is numerous in present seas.

The *Patellidæ* comprise especially the genus *Patella*,[4] the common "rock limpet," which is extensively used as bait, and in some places as human food also; it is very numerous in present seas, and also amongst fossils, commencing in silurian rocks.

In shelf 3 the *Branchifera prosobranchiata* end with the family *Dentalidæ*, which is represented by the genus *Dentalium*,[5] the 'tooth-shell,' which has its shell tubular, open at both ends; it lives in present seas and amongst fossils it is known with certainty to commence in secondary rocks. Case 38, Shelf 3. *Dentalidæ.*

After the *Dentalidæ* the peculiar family *Chitonidæ* (Chiton=a coat of mail) has its place, the shell of which is multivalve, consisting of eight transverse plates; but no specimens were available for exhibition; commence in silurian rocks and live in present seas.

B.—*Opisthobranchiata.*—This group comprises a few forms, where the gills are placed towards the hinder part (ὄπισθεν= opisthen) of the body. We have two families of this group, the *Tornatellidæ*, so named from the genus *Tornatella*,[6] the fossil representatives of which commence in triassic rocks, while several species live in present seas; the *Bullidæ*, so called from the genus *Bulla*,[7] the "bubble-shell," which makes its appearance in jurassic rocks and is fairly numerous in present seas. Case 38, Shelf 3. *Branchifera, opisthobranchiata. Tornatellidæ. Bullidæ.*

C.—*Heteropoda.*[8]—The animals of this order differ from the others in the organisation, especially of the foot, which is here transformed into a fin, by which they are enabled to swim in the open ocean. Case 38, Shelf 3. *Atlantidæ.*

[1] Diminutive of *rima* (Lat.) = a fissure.
[2] Emarginate.
[3] Καλύπτρα (Gr. kalyptra) = a female head-dress.
[4] *Patella* (Lat.) = a bowl, a dish.
[5] *Dens-dentis* (Lat.) = the tooth.
[6] *Tornatus* (Lat.) = turned.
[7] *Bulla* (Lat.) = a bubble, referring to the thin globular shell.
[8] Ἕτερος (Gr. heteros) = differing, diverse; πούς-ποδός (Gr. pus-podos) = foot.

For the palæontologist the family *Atlantidæ*[1] is especially of interest, of which the genus *Bellerophon*[2] is best known and most important for the palæozoic formations, especially carboniferous; they have a globose, few whorled convoluted shell, the aperture emarginated or slit on the dorsal side.

Section—*Pulmonifera*.[3]

This order includes the air-breathing Gasteropods, such as land-snails, slugs, &c. Most of them have a perfect shell; in some, however, it is rudimentary or wanting.

Case 38, Shelf 4. *Helicidæ*.

The family *Helicidæ*, "land-snails," is represented by the following genera: *Helix*,[4] the common land-snail, tertiary and recent; *Achatina*,[5] the "agate shell" commencing in eocene tertiary; *Bulimus*,[6] the same range; *Pupa*,[7] the chrysalis-shell, known from the coal measures, but especially tertiary and recent.

Case 38, Shelf 4. *Limnæidæ*.

The family *Limnæidæ*, the "pond-shells," is represented by the genera *Lymnæus*,[8] the "pond-snail," commences in the wealden (cretaceous), numerous in tertiary rocks and recent; *Physa*,[9] in which the whorls of the shell are turned from left to right, commences in wealden, but its largest representatives are in tertiary eocene rocks.

Case 38, Shelf 4. *Auriculidæ*.

The family *Auriculidæ*, which is a very small family and of no great importance for palæontology, is represented by the genus *Auricula*,[10] which has the outer lip expanded and thickened, resembling the outer margin of an ear; commences in eocene tertiary.

Case 38, Shelf 4. *Cyclostomidæ*.

With the family *Cyclostomidæ* the *Gasteropoda* are concluded. A genus of some importance for palæontology is *Cyclostoma*,[11] which is very numerous amongst the living Gasteropods, but also occurs in tertiary rocks commencing in the eocene.

[1] Ἄτλας (Gr. Atlas) = one of the Titans.
[2] Mythological name.
[3] *Pulmones* (Lat.) = the lungs; *fero* (Lat.) = to bear, to have.
[4] *Helix* (Lat.) = a coil.
[5] *Achātes* (Lat.) = agate.
[6] Βούλιμος (Gr. bulimos) = immense hunger, referring to its voracity.
[7] *Pupa* (Lat.) = chrysallis, referring to its cylindrical shape.
[8] Λιμναῖος (Gr. limnæus) = frequenting marshes.
[9] Φῦσα (Gr. physa) = bellows.
[10] *Auricula* (Lat.) = a small ear.
[11] Κῦκλος (Gr. cyclos) = a circle; στῶμα (Gr. stoma) = the mouth, referring to the round aperture.

Class: *Pteropoda*.[1]

Case 39, Shelf 2.

This is a small class of pelagic Molluscs, which are either naked or are enclosed into a glassy shell, and in which locomotion is effected by two fin-like appendages developed from the sides of the head.

Certain fossil shells were also placed with the *Pteropoda*, although some authors would like to assign them to another systematical place. The case, however, being not nearly yet settled, we shall leave them still with the *Pteropoda*. The most important, and here represented, are: *Hyolithes*,[2] ranging from silurian to permian; *Tentaculites*,[3] having a straight conical tubular shell with a round aperture; principally silurian, ranging into devonian; *Conularia*,[4] the largest of the Pteropods, having a straight four-sided shell, tapering at one end, generally ornamented with a transverse striation; commences in silurian, where it is chiefly developed, passing through the whole palæozoic period, and also known from secondary rocks.

Class: *Cephalopoda*.[5]

This very large class has its most numerous representatives in the earth's strata, and where they occur they are very important fossils. The living representatives are all marine.

The Cephalopoda are animals furnished with arms (feet) round their mouth which serve for locomotion, and for prehension of food; the breathing is performed by gills. Most of the living forms (cuttle-fishes, &c.) are naked, having only an interior skeleton, which is called the cuttle-bone.[6] A few others have an external shell (the "Paper Nautilus" and the "Pearly Nautilus.")

To judge from the variety and great number of the fossil forms they were mostly furnished with an outer shell.

The Cephalopoda are divided into two great orders, the *Dibranchiata*,[7] breathing performed by two gills; and

[1] Πτερὸν (Gr. pteron) = wing; πους-ποδὸς (Gr. pus) = a foot, leg, referring to the organs for sailing or swimming.

[2] Ὑς-ύὸς (Gr. hys-hyos) = a pig; λιθὸς (lithos) = stone. Pigstone, pig's-tooth, referring to the form and size.

[3] *Tentacula* (Lat.) = appendages, so called by Schlotheim because he thought them to be tentacula of Cephalopoda.

[4] *Conulus* (Lat.) = a little cone.

[5] Κεφαλὴ (Gr. kephale) = head; πους-ποδὸς (Gr. pus-podos) = foot, referring to the arrangement of the feet round the mouth.

[6] "Ossa sepiæ" of the druggists.

[7] Δὶς (Gr. dis) = twofold; βράγχια (Gr. branchia) = gills.

Tetrabranchiata,[1] breathing by two pairs of gills. The latter order being by far the more numerous and important, its representatives are placed first in our collections.

Order: *Tetrabranchiata.*

Cases 39–45, Shelf 1. *Tetrabranchiata.*

The animal has four gills, and is protected by an external shell; this is divided by septa into many chambers, the outermost of which is the largest and is occupied by the animal; all the chambers are traversed by a tube called the siphuncle.

This order is very numerous in geological strata, and its representatives exhibit great variety in the character of the septa and in the position of the siphuncle.

The *Tetrabranchiata* are sub-divided into two large families.

Family: *Nautilidæ.*

Case 39, Shelves 3, 4. Case 40, Shelves 2, 3. *Nautilidæ.*

In this family the shell is coiled or straight, the septa simple, as are also the edges ("sutures"), where they appear on the surface, the siphuncle central, or near the concavity of the curved shell.

In case 39, shelves 3, 4, are contained the *Nautilidæ* with convoluted shell.

Nautilus[2] (in shelf 3 and beginning of shelf 4), with a central siphuncle, is the type-genus of the family; commences in upper silurian and passes through all formations up to the present day. Of other genera there are represented: *Lituites*[3] (shelf 4), which is especially a silurian genus; *Trochoceras*[4] (shelf 4) includes silurian forms only; *Clymenia*[5] (shelf 4) resembles *Nautilus* very much, but is flat, whorls very deeply embracing, siphuncle on the concave side of the whorls; it is especially a devonian genus.

The straight *Nautilidæ* are in the next case (40); (shelf No. 1 of this case contains large specimens of Cephalopods). In shelf 2 we find representatives of the genus *Orthoceras*,[6] which can well be described as a straight *Nautilus*. *Orthocerata* are very numerous, especially in palæozoic times (beginning in silurian), and find their close in upper trias.

[1] Τέτρα (Gr. tetra)=four; βράγχια (Gr. branchia)=gills.

[2] Ναύτιλος (Gr. nautilos)=the sailor.

[3] *Lituus* (Lat.)=a trumpet.

[4] Τροχός (Gr. trochos)=a wheel; κέρας (Gr. keras)=a horn.

[5] Κλυμένη (Gr. Klymene)=mythological name, a sea-nymph, wife of Prometheus and mother of Helen.

[6] Ὀρθὸς (Gr. orthos)=straight; κέρας=horn.

Representatives of this genus are found still in the beginning of shelf 3, and then follow some other genera of the *Orthoceras* family, of which it will be sufficient to name some only: *Endoceras*,[1] in which the septa are funnel-shaped; it is lower silurian; *Gomphoceras*,[2] which ranges from silurian to carboniferous; and *Cyrtoceras*,[3] the shell of which is curved, otherwise very much resembling *Orthoceras*, with which it also has about the same range, commencing in silurian and dying out in the trias.

Family: *Ammonitidæ*.[4]

Case 40, Shelves 3, 4. Cases 41—44 Family *Ammonitidæ*.

This family is the largest of the *Cephalopoda*, and entirely extinct. The shell of the *Ammonitidæ* is either discoidal, spiral, curved, or straight, siphuncle dorsal; the chief difference from the *Nautilidæ* is in the lobes and the sutures, these latter being always angulated, lobed, or foliaceous.

The flexures of the sutures, which are directed away from the mouth of the shell, are termed "lobes," the elevations between the lobes are called "saddles."

Case 40, Shelf 3. *Bactrites*. *Goniatites*.

The genus *Bactrites*[5] is straight like *Nautilus*, but has simply lobed or angulated sutures; is silurian and devonian. *Goniatites*[6] has the same character as *Bactrites*, but the shell is discoidal; ranges from silurian to trias.

Case 40, Shelf 4. *Goniatites*. *Clydonites*. *Ceratites*.

In shelf 4 are found, at the beginning, some more representatives of *Goniatites*; in the same shelf is also the interesting genus *Ceratites*,[7] which resembles *Goniatites*, but has the "lobes" denticulated or crenulated and the "saddles" simply rounded. This nice and characteristic genus has recently been sub-divided into numerous sub-genera by the Cephalopodic specialists of the Continent; but it would be hardly of any interest to give an account of this here. The genus *Ceratites* (including the Indian *Xenodiscus* from the Salt-range) appears at the close of palæozoic times; has its greatest development in trias; is not known in jurassic strata, but some species are described from cretaceous rocks (by D'Orbigny).

[1] Ἔνδον (Gr. endon) = within.

[2] Γόμφος (Gr. gomphos) = club; κέρας = horn.

[3] Κυρτὸς (Gr. kyrtos) = curved; κέρας = horn.

[4] From *Ammonites*, the typical genus.

Βάκτρον (Gr. baktron) = a walking-stick, referring to the shape of the shell.

[6] Γωνία (Gr. gonia) = the angle, referring to the angled lobes.

[7] Κέρας (Gr. keras) = a horn.

Cases 41–43.
Case 44,
Shelves 1, 2, 3.
Ammonites.

The very large genus *Ammonites*[1] has an involute (discoidal) shell, with lobed and foliated (sometimes very complicated) sutures.

The various species are arranged here according to the more generally known, though older method, based chiefly upon the characters of the back (the convex side) of the shell, its shapes, its ornamentation, &c. The more recent division into sub-genera (the founders confer on them the rank of "genera") is based on the characters of the body, the shape of the aperture of the shell, and some other characters, which has in so far its difficulties, as only complete specimens can be assigned with some certainty to the one or the other sub-genus.

If we include the Indian sub-genus *Cyclolobus* (*Phylloceras*, Waagen, olim; *Arcestes* Mojs.) from the Salt-range, then we have a range for this genus from the close of the palæozoic epoch till the end of the cretaceous.

Representatives of the genus *Ammonites* occupy the cases 41, 42, 43, and shelves 1, 2, and the beginning of shelf 3 of case 44. This is the original collection of Ammonites, (arranged as in the "Catalogue of Cephalopoda" in the Museum of the Geological Survey of India, 1866,) in which the species of the various genera are arranged stratigraphically.

To arrange the genera according to the more recent nomenclature would have required much more time and labour than at present could be spent on this subject; it may be done at a subsequent opportunity.

Case 44,
Shelves 3, 4.
Scaphitese,
Ancyloceras,
Hamites, &c.

Next to *Ammonites* are other genera of the *Ammonitidæ*, of which may be mentioned *Scaphites*[2] (a series of volutions coiled into a flat spiral, but in contact, the last volution detached, somewhat prolonged and bent back upon itself), cretaceous; *Ancyloceras*[3] (like *Scaphites*, but the volutions separate, the prolongation much longer), jurassic and cretaceous; *Hamites*[4] (hook-shaped or bent upon itself more than once), cretaceous; *Ptychoceras*[5] (bent once upon itself the straight portions in contact), cretaceous; *Turrilites*[6] (shell spiral, after the manner of a Turritella and sinistral), cretaceous; *Baculites*[7] (shell

[1] Jupiter Ammon of the Libyan desert.
[2] Σκάφη (Gr. skaphe) =a boat.
[3] Ἀγκύλος (Gr. ankylos) = curved; κέρας =horn.
[4] *Hamus* (Lat.) = a hook.
Πτύχη (Gr. ptyche) =a fold; κέρας =horn.
[6] *Turris* (Lat.) = the tower.
[7] *Baculus* (Lat.) = a stick.

straight, is amongst the *Ammonitidæ* what *Orthoceras* is amongst the *Nautilidæ*), cretaceous.

In the beginning of shelf 2, case 45, are placed several specimens of that peculiar fossil called *Aptychus*,[1] consisting of a calcareous or horny plate in one or two pieces, somewhat heart-shaped, smooth, or variously sculptured. The nature of these organs is still obscure, although it is generally believed that they belong to the genus *Ammonites*, representing probably the "operculum" in Gasteropods. They occur chiefly in jurassic rocks, rare in cretaceous.

Case 45, Shelf 2. *Aptychus.* *Rhyncholithus.*

Next to this are, in the same shelf, other fossils, which are commonly called *Rhyncholithus*,[2] and which are supposed to be mandibles of *Cephalopoda*, resembling somewhat the beak of a bird. They range from trias to cretaceous.

Order: *Dibranchiata*.[3]

The *Dibranchiata* possess only two branchiæ (gills); they are, with one exception, naked, having an internal skeleton only, and possessing an ink-bag for defensive purposes. The *Argonaut* (the only genus with an external shell) and the cuttle-fishes are the chief representatives of this order.

Cases 45—46. *Dibranchiata.*

It is generally the internal skeleton which we meet with in a fossil state, but sometimes also the ink-bag and the mandibles.

The internal skeleton has various shapes according to the various animals to which it belongs.

In our collection are exhibited representatives of the *Teuthidæ*, *Sepiadæ* and *Belemnitidæ*.

In the *Teuthidæ*,[4] the internal shell consists of a horny plate, composed of a central shaft and two lateral wings. The following genera may be mentioned: *Geoteuthis*[5] from lias and upper jurassic; *Acanthoteuthis*,[6] which is jurassic.

Case 45, Shelves 2, 3. *Teuthidæ.*

In the *Sepiadæ*[7] the internal skeleton is a broad calcareous plate with a hollow imperfectly chambered area behind.

Case 45, Shelf 3. *Sepiadæ.*

[1] Ἀ (Gr. A) = a negation; πτυχή (Gr. ptyche), a fold, referring to the circumstance that some of these consist of two halves like bivalves, but do not shut or fold.

[2] Ῥύγχος (Gr. rhynchos) = a beak; λίθος (Gr. lithos) = stone.

[3] Δὶς (Gr. dis) = twofold; βράγχια (Gr. branchia) = gills.

[4] Τευθὶς (Gr. teuthis) = the cuttle-fish.

[5] Γῆ (Gr. ge) = the earth; τευθὶς (teuthis), meaning 'fossil cuttle-fish.'

[6] Ἄκανθα (Gr. akantha) = a spine; τευθὶς = a cuttle-fish.

[7] Σηπία (Gr. sepia) = the ink cuttle-fish.

The only genus represented in our collection is *Belopteva*,[1] which is known from tertiary (eocene) rocks only.

Case 45, Shelf 4. Case 46. *Belemnitidæ.*

The next shelf (4) is occupied by the representatives of the family *Belemnitidæ*, which are also found in case 46.

In this family the shell is internal, composed of a cylindrical fibrous "guard," in which is lodged a conical chambered portion, called "phragmocone," which is produced into a horny plate called the "proostracum."

The best known genus is *Belemnites*,[2] of which numerous specimens are exhibited (case 45, shelf 4; case 46, shelves 2 and 3); the genus ranges from upper trias to upper cretaceous.

Some other forms, very similar to *Belemnites*, are distinguished as *Belemnitella*. The distinctive characters are the presence of a straight fissure in the guard at its upper end, and of distinct vascular impressions on the surface, characters, however, which can only be seen in complete specimens. This genus is cretaceous.

Sub-kingdom: Vertebrata.[3]

Cases 47-50 (50*a*) *Vertebrata.*

The four remaining cases and the smaller case, 50*a*, standing against the western wall of the gallery, next to case 50, contain the remains of the last, and anatomically the highest sub-kingdom, the human genus being the most highly organised member of this sub-kingdom. It comprises the classes of fishes *(pisces)*, amphibians *(amphibia,)* reptiles *(reptilia)*, birds *(aves)*, and mammals *(mammalia.)* The four first classes only are here represented. The mammals are in the western gallery on the lower floor and have already been described by Mr. R. Lydekker in a guide to that portion of the collections.[4]

Class: *Pisces.*

Cases 47, 48. *Pisces.*

Fishes are animals well known to everybody; they are inhabitants of water, and therefore breathe by gills all their life. Besides the inner skeleton (vertebral column, ribs, &c.), they generally have, as it were, an outer skeleton consisting of a coating of variously formed scales. There are

[1] Βελὸς (Gr. belos) = a dart; πτέρον (Gr. pteron) = a wing.

[2] Βέλεμνον (Gr. belemnon) = a dart, bolt (thunder-bolts).

[3] So called from that portion of the internal skeleton which encloses the neural cord (spinal cord) and is termed "vertebral column," consisting of a certain number of segments, which are called "vertebræ."

[4] Popular Guide to the Geological Collections of the Indian Museum, No. I, Tertiary Vertebrate Animals, 1879.

especially three kinds of scales: *Cycloid*,[1] *Ctenoid*,[2] and *Ganoid*.[3] The locomotion is generally effected by fins, which are distinguished as pectoral and ventral fins, these being paired; besides which there are unpaired fins which can be anal, dorsal, and caudal, this latter being generally present.

The fishes are, as far as known at present, the oldest of the *Vertebrata*, being known already in the silurian period, and ranging from there through all formations to the present day.

The few representatives we have in our collection occupy case 47 and the shelves 1, 2, 3, 4, (first half) of case 48. The remains consist of the inner skeleton, the outer skeleton, and in some cases of single teeth only.

At first we find a few representatives of the order *Teleostei*,[4] which have the inner skeleton completely ossified; their scales are *Cycloid* and *Ctenoid*, and their tail is homocercal, *i. e.*, symmetrical, composed of two equal lobes. Case 47, Shelf 2. *Teleostei.*

To this order most of the living fishes belong; amongst fossils they begin in the cretaceous period. The eocene fishes from Monte Bolca in Upper Italy are especially well preserved.

Next follow the representatives of the order *Ganoidei*, which have the inner skeleton only partially ossified; they are covered with *ganoid* scales and the caudal fin is mostly *heterocercal*, *i. e.* unsymmetrical,[5] but in several cases this fin is homocercal. Case 47, Shelves 3, 4. Case 48, Shelves 1, *Ganoidei.*

Most of the palæozoic ganoids are heterocercal, and the mesozoic homocercal, although there are a few forms amongst the living *Ganoids* which also have heterocercal caudal fins. Some of the most important genera are here represented.

Palæoniscus,[6] a heterocercal fish, very common in permian rocks, but also occurring in carboniferous, and also, but rarely, in trias. Another genus is *Amblypterus*[7] also heterocercal, of similar range as the former one. *Pygopterus*,[8] belonging to

[1] Κύκλος (Gr. kyklos) = a circle = horny scales, circular or elliptical in shape, with more or less smooth margins.

[2] Κτεῖς (Gr. kteis) = a comb, horny scales, jagged at the posterior margin, resembling the teeth of a comb.

[3] Γάνος (Gr. ganos) = splendour, angular scales, consisting of a bony plate, covered with a thick plate of enamel.

[4] Τέλειος (Gr. teleios) = complete; ὀστέον (Gr. osteon) = bone.

[5] Here the lower lobe is, actually, the larger one, and the spinal column is prolonged into the upper lobe which appears longer.

[6] Παλαιὸς (Gr. palaios) = old; and ὀνίσκος (Gr. oniscos) = a sea-fish.

[7] Ἀμβλὺς (Gr. amblys) = blunt; πτερὸν (Gr. pteron) = the fin.

[8] Πύγη (pyge) = the rump, posterior part of the body, and πτέρυγ.

the same group as the two former ones, is also a palæozoic heterocercal fish.

In the next shelf are specimens of mesozoic ganoid fishes of which may be mentioned *Tetragonolepis*[1] which is jurassic, *Dapedius*,[2] especially liassic, and *Leptolepis*,[3] mesozoic.

Case 48. Shelves 1, 2.

In the next case, on shelf 2, we find some further representatives of the Ganoids, at first the mesozoic and tertiary family of the *Pyknodonts*,[4] the "thick-toothed" fishes, to which the genera *Pycnodus*,[4] *Sphærodus*,[5] and *Gyrodus*,[6] belong.

Next to these is *Platysomus*,[7] a carboniferous and permian heterocercal fish, with a very compressed, broad body, and long dorsal and anal fins.

Peculiar genera of the *Ganoids* are *Pterichthys*,[8] and *Cephalaspis*[9] (a model of the latter is found on the first shelf of this case); the former is a devonian fish, the latter also is chiefly devonian, but also occurs in upper silurian rocks.

Case 49, Shelf 3. *Elasmobranchii* (the Shark family.)

On shelf 3 there are placed spines and numerous teeth of the *Elasmobranchii*,[10] which include the sharks, rays, and chimæræ; they belong to all formations beginning with upper silurian, and are also numerous in present seas. There are amongst others also several fine teeth of *Ptychodus* (with folds on the teeth) from cretaceous rocks. A few additional specimens of the same order on shelf 4 bring the class of the fishes to a conclusion.

The order *Dipnoi*,[11] to which belongs the remarkable genus *Ceratodus*,[12] with its living representative in Victoria, is not represented here, but many teeth will be found in the Indian portion of the collection.

[1] Τετράγωνος (Gr. tetragonos) = square; λέπις (Gr. lepis) = a scale of a fish.

[2] Δάπεδον (Gr. dapedon) = a pavement, referring to the scales.

[3] Λεπτὸς (Gr. leptos) = thin; λέπις = a scale.

[4] Πυκνὸς (Gr. pyknos) = thick; ὀδοὺς (Gr. odus) = the tooth.

[5] Σφαῖρα (Gr. sphæra) = a sphere, a ball; ὀδοὺς.

[6] Γύρος (Gr. gyros) = curved; ὀδοὺς.

[7] Πλατὺς (Gr. platys) = broad; σῶμα (Gr. soma) = body.

[8] Πτερὸν (Gr. pteron) = a wing; ἰχθὺς (Gr. ichthys) = fish, the winged fish.

[9] Κεφαλὴ (Gr. kephale) = a head; ἀσπὶς (Gr. aspis) = shield.

[10] Ἐλασμὸς (Gr. elasmos) = a plate; βράγχια (Gr. branchia) = gills.

[11] Δὶς (Gr. dis) twofold; πνοὴ (Gr. pnoe) = breath, referring to the two-fold arrangement for breathing.

[12] Κέρας (Gr. keras) = horn; ὀδοὺς (Gr. odus) tooth.

In Europe it is a triassic and jurassic genus.

Class: *Amphibia.*[1]

This includes the frogs, toads, salamanders, &c.; they possess a double system of breathing, having gills in the young state, and lungs when adult, gills disappearing or remaining. Amongst fossils the family *Labyrinthodontia*[2] belongs to this class. This family is represented by the genus *Archegosaurus*[3] at the end of shelf 4, case 48; this is a carboniferous and permian genus, and one of the best known and most common forms of the class.

Case 48, Shelf 4. *Amphibia.*

Class: *Reptilia.*[4]

The two last cases, 49 and 50, contain remains of the class of *Reptilia*, which includes the tortoises, snakes, lizards, crocodiles, and many extinct forms. Our collection does not contain many types and these mostly in models, so that it will be sufficient to mention them briefly.

Cases 49, 50. *Reptilia.*

The reptiles never possess gills like the *Amphibia*, but show, on the other hand, various points of affinity with the birds, so that they have been included together with them into one division, called *Sauropsida.*[5]

Of the several orders there are in our collections representatives of the following:—

On shelf 1 and in the beginning of the second shelf (case 49) we find a few representatives (mostly casts) of the *Chelonia*[6] or tortoises. Unmistakeable traces of these commence in jurassic rocks, and they are numerous in present days. Mention may be made here of the *Lacertilia*, only on account of the remarkable genus *Hyperodapedon*,[7] occurring in trias in England and not uncommon in India in certain beds (Kota-Maleri) together with *Ceratodus.*

Case 49, Shelves 1, 2*a* *Chelonia.*

The rest of the second shelf (case 49) is occupied by models of some extinct types.

[1] Ἀμφὶ (Gr. amphi) = both; βίος (Gr. bios) = life.

[2] Λαβύρινθος (Gr. labyrinthos) = a labyrinth; ὀδούς (Gr. odus) = tooth, referring to the complicate microscopical structure of the teeth.

[3] Ἀρχηγὸς (Gr. archegos) = ancestor; σαῦρος (Gr. sauros) = lizard.

[4] *Repto* (Lat.) = to crawl.

[5] Σαῦρος (Gr. sauros) = a lizard; ὄψις (Gr. opsis) = appearance.

[6] Χελώνη (Gr. chelone) = a tortoise.

[7] Ὕπερον (Gr. hyperon) = a pestle, and δάπεδον (dapedon) = pavement, referring to the arrangement of the teeth in the upper jaw.

Case 49, Shelves 3,4. *Crocodilia.*

In the third and fourth shelves we find representatives of the *Crocodilia*, to which in present days the *Crocodiles, Alligators* and *Gavials* belong. As fossils the earliest forms are known from triassic rocks. The genera *Crocodilus, Belodon,*[1] and *Teleosaurus*[2] are sufficient to mention here. The first genus belongs to the group of *Procœlian*[3] crocodiles, and begins in eocene rocks; the other two are *Amphicœlian*[4] crocodiles; *Belodon* is triassic, and *Teleosaurus* jurassic.

Case 50. Extinct reptiles.

The last case contains specimens of reptiles which are now entirely extinct. Only some of the most common may be mentioned: *Ichthyosaurus*[5] (on the second shelf) fish-like reptiles with finlike extremities; they are exclusively mesozoic, especially in liassic rocks; *Plesiosaurus,*[6] (on the third shelf) includes gigantic reptiles, with fin-like extremities, like in *Ichthyosaurus*, but with a very long, snake-like neck and a small head, the opposite of these characters being present in *Ichthyosaurus*. The genus ranges from lias to cretaceous. The last is *Pterodactylus*[7] (on the fourth shelf), flying reptiles with large heads, the jaws provided with teeth, the fourth (outer) finger of the hand immensely long and between this, the body and the short hind limb there was a membrane expanded, used for flying after the manner of the bats of the present day. The genus is jurassic.

Here also the peculiar *Dicynodontia*[8] may be placed, which have representatives in India (in the Panchet rocks) and in the South African Karoo beds.

Class: *Aves.*

Case 50*a* Birds.

Of birds, which follow in natural order after the reptiles, there are not many specimens in our collection. They are placed in a smaller upright wall-case, numbered 50*a*, and

[1] Βέλος (Gr. belos) = a missile; ὀδούς (Gr. odus) = the tooth.

[2] Τέλεος (Gr. teleos) = complete; σαῦρος (Gr. sauros) = a lizard.

[3] Πρὸ (Gr. pro.) = before; κοῖλος (Gr. koilos) = hollow, concave, referring to the vertebræ being concave in front.

[4] Ἀμφὶ (Gr. amphi) = both; κοῖλος (Gr. koilos) = vertebræ concave at both ends.

[5] Ἰχθὺς (Gr. ichthys) = fish; σαῦρος (Gr. sauros) = lizard, referring to the fish-like appearance.

[6] Πλησίον (Gr. plesion) = near to; σαῦρος = (its head is related to that of a lizard).

[7] Πτερὸν (Gr. pteron) = a wing; δάκτυλος (Gr. daktylos) = the finger.

[8] Δὶς (Gr. dis) = twice; κύων (Gr. kyon) = dog; ὀδούς, referring to the large teeth in the upper jaw.

standing against the western wall of the gallery, next to the last (No. 50) of the large wall-cases.

The specimens exhibited are mostly bones of gigantic birds of the order *Cursores*,[1] to which appertain in present days the *Ostrich, Cassowary,* and some others. The best known genera amongst them are *Dinornis*[2] and *Palapteryx*[3] from the post-tertiary deposits of New Zealand.

With this case the general biological series terminates, and we now come to the second series of fossils in the gallery, *i.e.*, the Indian collection.

B.—COLLECTION OF INDIAN FOSSILS.

This collection is placed in the series of flat cases, occupying the floor of the gallery in three rows. It consists of the specimens from the various formations of India, a great majority of them collected by the officers of the Survey; and, as this work is always in progress, it will be easily understood that changes of position in the cases must sometimes occur owing to additions. The general order of arrangement, in stratigraphical sequence of formations, will, however, be maintained as at present; but the importance of keeping the fossils of certain geographical regions by themselves makes it impossible to observe as great uniformity of arrangement in this branch of the collections as in the foregoing, where the biological order could be maintained throughout. For details regarding the classification of Indian rocks and their distribution, reference may be made to the Manual of Geology of India;[4] only a cursory mention of the facts can be made here. Cases 51—144.

Fossils of the Gondwana System.

Series of Cases 51—86.

The Gondwána system presents the oldest and the most extensive fossiliferous formation of Peninsular India, also the most important as containing the Indian coal measures. Its Cases 51—86. *Gondwána System.*

[1] *Curro* (Lat.) = to run.

[2] Δεινὸς (Gr. deinos) = huge, big; ὄρνις (Gr. ornis) = bird.

[3] Παλαιὸς (Gr. palaios) = ancient, old; ἀπτέρυξ (Gr. apteryx) = wingless; (also the name of a living wingless bird in New Zealand.)

[4] Calcutta, 1879, 2 vols; plates and map.

fossils occupy the whole row of table-cases on the south side of the gallery, beginning with case 51, at the west end.

During the process of survey this formation has been sub-divided into various groups, several of them forming an upper division of the whole, distinguished as *Upper Gondwánas;*[1] others, especially coal-bearing, forming the *Lower Gondwānas.* The fossils of all these groups are mostly plants; in some of them, however, animal fossils also occur.

Cases 51—64. Upper Gondwāna groups. Kach group. Jabalpur group. Kota-Maleri beds. Sripermatur. Vemáveram.

In cases 51 to 64 there are placed the fossil remains from the groups forming the upper portion of the Gondwána system; they are the Kach group (Umia group) developed in Kach (case 51); Jabalpur group in the Sátpura basin and in South Rewah[2] (cases 52—54); Kota-Maleri beds in the Central Provinces (case 55), containing especially land animals and fishes; then follow plants with marine animals from three districts on the south-eastern coast—from the Sripermatur area west and north-west of Madras and from the Vemáveram area, South Kistna district (cases 56—58), and from Ragavapuram, on the lower Godávari river (case 59); next follow the plants of

Rájmahé group.

the Rájmahál group in the Rájmahál hills (cases 60-63) and from Golapili, near Ellore, on the lower Godávari river (case 64).

The fossils in each of these groups are arranged in systematical order, and, as many of the genera and species occur in several of the groups, it will be sufficient to make general remarks on them only.[3]

The most numerous fossils are plants. Remains of *Equisetaceæ* (horse-tail family) are very rare; we only know one species of *Equisetum* from the Rájmahál group, Rájmahál hills (case 60). *Filices* (ferns) are much more numerous in all groups; there is *Alethopteris*[4] (Asplenium) *whitbyensis*[5] from the Kach and Jabalpur groups (cases 51—52) as well as from the Sripermatur and Vemáveram shales (case 56). *Dicksonia*[6] is an interesting plant from the Rájmahál group

[1] From the old province Gondwána.

[2] The fossils are at present placed together, but will in time be separated according to the localities.

[3] The fossils of the upper Gondwánas are described in the Palæontologia Indica, the plants forming Vols. I and II of the Flora of the Gondwána system; Vol. I contains the plants from the Rájmahál group in the Rájmahál hills and near Golapil (South Godávari), as also the Flora of the Sripermatur-Vemáveram and Ragavapuram rocks (outliers on the Madras coast); Vol. II contains the Floras of the Jabalpur and Kach groups.

[4] Derivation, see *ante*, p. 6.

[5] Whitby, in Yorkshire, from where the plant has been first described.

(case 60), where it is not rare. The genus *Thinnfeldia*[1] is not wanting, and the *Th. indica* from the Rájmahál group in the Rájmahál hills, much resembles liassic and rhætic forms in Europe. Extremely numerous are the *Tæniopterideæ*, (ribbon-ferns), especially the broad-leaved, mesozoic forms distinguished as *Macrotæniopteris*;[2] this is especially frequent in the Rájmahál group of the Rájmahál hills (case 60) (other forms will be mentioned hereafter from the lower Gondwána system). *Oleandridium*[3] is known from the Kach group (case 51); *Angiopteridium*[4] from the Ragavapuram (case 59), Vemáveram and Sripermatur shales (case 56), and from the Rájmahál group (60 and 64). *Cycadeaceæ* (Cycad family) are also very numerous; two species of *Ptilophyllum*,[5] Morr., a genus peculiar to this Gondwána system, passes through all the groups. *Pterophyllum* is very numerous in the Rájmahál group (cases 62 and 64), less in the Vemáveram and Sripermatur shales. Besides these there are *Podozamites* (Kach group), *Cycadites* (Rájmahál group, Rájmahál hills), *Otozamites* (all groups). Special mention must be made of one peculiar plant, *i.e.* *Dictyozamites*,[6] Oldh., from the Rájmahál group, Rájmahál hills (case 63), and Golapili (case 64); but much more numerous in the Sripermatur and Vemáveram groups (case 56). *Coniferæ* (cone-bearing plants) are also not rare in all the groups, and one species of *Palissya*, Endl., passes through all of them. The *Taxites planus*, Fstm., from the Vemáveram and Sripermatur group (case 58), and from the Rágavapuram shales (case 59) is also noteworthy. The *Glossopteris*, a fern formerly thought to be confined to the lower portion of the Gondwána system, has been found in one of the highest groups of the Upper Gondwánas, in the Jabalpur groups (see case 52). More recent observations seem, however, to show that it also occurs in the (lower) Mahádevas of the Auranga coal-field, together with other lower Damuda fossils.[7]

I may now mention the animal fossils of the Upper Gondwána groups. The Kota-Maleri beds of the Central

[1] Proper name.

[2] Μακρὸς (Gr. makros)=large, broad.

[3] *Diminutive* of *Oleandra*, living genus of ferns.

[4] *Angiopteris*, a living genus.

[5] This and the following have been explained before (pp. 10-11).

[6] Δίκτυον (Gr. diktyon)=a net; and *zamites*.

[7] V. Ball, Auranga Coalfield, Mem., G. S. I., Vol. XV, Pl. 1, p. 89. I have collected some more fossils at this locality, and they really appear to come from the Mahádevas.

Provinces (case 55) contain ganoid fishes, then numerous teeth *Ceratodus* (of the order *Dipnoi*), and jaws of *Hyperodapedon* of (Lacertiliau reptile).

In the Ragavapuram, Vemáveram, and Sripermatur shales (cases 56—59) marine animals are associated with the plants, and there are several instances in the cases where a shell and a plant are together on the same specimen.

Cases 65—86 Lower Gondwána group. Panchet. Raniganj (Kámthi)— Iron shales, Barákars. Karharbári— Talchir shales.

We pass now to the cases containing the lower Gondwána[2] fossils. At first are the fossils of the Panchet group which was first described from the Raniganj coal-field, from whence came the fossils exhibited in cases 65 and 66; *Schizoneura*, two or three forms of *Glossopteris*, and a *Pecopteroid* plant are the most noteworthy.

Somewhat more numerous are the animal remains, which represent bones of *Labyrinthodontia* and *Dicynodontia* (case 66). In this same case I have also placed specimens of the shale at Mángli, 50 miles south of Nágpur, with two species of *Estheria;* there is also a cast of the head of the reptile *Brachyops laticeps* (short-faced and broad-headed).

The next cases, 67-80, contain the fossils of the Damuda rocks; this series, besides being highly fossiliferous, is also important on account of the rich coal-beds it contains.

The groups into which it is stratigraphically divided all contain fossils, which are, on the whole, of the same character. The fossils from the various groups are arranged first geographically, according to the basins and districts they were derived from, and within these the arrangement is systematical.

The fossils of the Kámthi horizon of the Raniganj group in the Central Provinces and on the lower Godávari river are placed first. These are *Vertebraria*,[3] *Glossopteris*,[4] very numerous, *Macrotæniopteris*, a small *Gangamopteris*;[5] *Nöggerathiopsis*, a large-leaved Cycadeaceæ (Zamieæ); *Rhipidopsis*[6], a large-leaved conifer of the Gingko family and others.

[1] Recently also discovered in South Rewah by Mr. Hughes.

[2] Of the plants of this portion were described—
The Talchir-Karharbári Plants, Gondwána Flora, Vol. III, Pt. 1, and Supplement, 1879, 1881.
Damuda-Panchet plants. *Equisetaceæ*, Vol. III, Pt. 2, 1880: ("Pal. Indica").

[3] *Vertebra*, backbone.

[4] Derivation, see *ante*, p. 7.

[5] Γαγγάμη=a small net.

[6] Ῥίπις (Gr. rhipis)=a fan; ὄψις (Gr. opsis)=appearance.

Next is the Raniganj group of Bengal, in which *Schizoneura* is a prominent feature; *Vertebraria* is very numerous; another equisetaceous plant is *Trizygia*;[1] *Glossopteris* is extremely numerous; there is of other ferns a *Macrotæniopteris*, *Sphenopteris*, *Alethopteris*, *Sagenopteris* and others; of Cycadeacæ must be named, *Pterophyllum* and *Nöggerathiopsis*. There are no Coniferæ here, but in the same horizon in South Rewah there occurs a coniferous plant, which I cannot distinguish from *Voltzia*.

In the Sátpura basin the Raniganj group is represented by the Bijori horizon, containing similar fossils.

In case 78 we find the fossils of the iron shales from the Raniganj coal-field;[2] there is especially a fine leaf of a large species of *Glossopteris*.

Next come in the Barákar fossils from the coal-beds in the Rájmahál hills, the Raniganj and the Talchir coal-fields, which contain about the same fossils as the preceding. As especially interesting I would point to the genus *Macrotæniopteris*, which is represented by the same species as in the Raniganj group; and this year I have collected in the Barákars of the Auranga coal-field another *Macrotæniopteris* (with very narrow veins like a species in the Kámthis), a *Pterophyllum* (Anomozamites) and other interesting fossils.

The lowest beds of the Gondwána system are the Karharbári and Talchir groups,[3] (cases 81-86). The former contains very good coal in the Karharbári and Mohpáni coal-fields. Both groups have the most frequent fossils in common. The most characteristic fossil of both is *Gangamopteris*, in both in almost all varieties; *Glossopteris*, however, occurs also, and so does *Nöggerathiopsis* (in both very numerous). Besides these the Karharbári beds have yielded especially a large single-pinnate *Neuropteris (Neuropteridium)* and a coniferous plant, which I refer to *Voltzia*. Talchir fossils were at first made known from the Deoghur coal-field south of Muddapur.[4] Later Mr. Hughes brought some specimens from near Cháno, north-east portion of the Káranpúra coal-field; recently I have myself collected at the same place, and also

[1] Τρεῖς (treis) = three; ζῦγον (zygon) = a pair, referring to the three-pair arrangement of the leaves in the joint.

[2] I have recently collected pretty numerous fossils from the iron shales in the South Káranpúra coal-field, but they could not yet be exhibited.

[3] The flora of these beds has been already described.

[4] On the Chord Line, East Indian Railway.

at a new locality, *i. e.* on the northern face of the Latiahar hill, Auranga coalfield, in Lohardugga district.

With this the Gondwána system terminates.

Collection of Indian Animal Fossils.

Northern series of cases (87—124.)

The series of table-cases on the north side of the gallery, beginning with case 87, at the eastern end, contains animal fossils of the Indian sedimentary rocks, in descending order from the newest (post-pliocene or pleistocene deposits) down to the cretaceous fossils, the series being continued in the middle row of cases.

Cases 87-88. Post-pliocene.

Cases 87 and 88 contain partly well preserved remains, chiefly Mollusca, from the latest geological deposits, from Ceylon, the Madras Coast, Kathiawar, &c.

Cases 89-91. Kach.

The next three cases (89—91) contain tertiary fossils from Kach; there are amongst them very nice specimens, especially some of the crabs (in case 91), but they are still incompletely arranged.

Cases 92, 93, 94. Sind corals.

In cases 92—93 there are the type specimens of Sind corals (miocene, oligocene and eocene), which were recently described by Professor Duncan in the "Palæontologia Indica." In case 94, in the lower shelf, there are corals, also from Sind, but from the lowest beds, below trap, of cretaceous age. The rest of this case, as well as 95 and 96, are to contain the types of *Echinodermata* from Sind, now (1881) under examination for description by the same author.

Cases 95-96. Empty.

Cases 97-100. Sind.

In cases 97—100 there are at present some other collections of tertiary (and cretaceous) fossils from Sind in systematical order (beginning with the Foraminifera and ending with Cephalopoda, or, as the case may be, with remains of fishes or reptilia,) which, however, will in time be amalgamated with the systematically worked-out Sind collection.

Cases 101-102. Salt-range.

Next to these Sind fossils join tertiary fossils from the Salt-range, many species of which are identical with those from Sind and Kach. The next two cases (103-104) contain small collections of tertiary fossils from Kathiawar, Cherra Punji (Khasia hills), and Burma.

Cases 103-104. Tertiary collections.

Case 105. Empty.

Case 105 is reserved at present for an expected extension of the preceding collections.

Case 106.

Then follow in case 106 fresh-water fossils from the inter-

trappean beds of the Deccan, which are mostly chalcedonised. Similar fossils were found in Kach. Several specimens of these are also laid out. The most prominent are one or two species of *Unio* and one species of a Gasteropod, *Physa Prinsepi*, Hisl. Intertrappean. fresh-water.

The next case (107) contains estuarine animal fossils from between and below the traps, from the Lower Godávari. Case 107. Estuarine.

Then follow in case 108 bones (especially *vertebræ*) of a huge reptile, called by Mr. Lydekker *Titanosaurus*, from the so-called Lameta beds in Central Provinces, which are of cretaceous age. Case 108. Lameta beds.

The subsequent cases, from 109 to 123, contain the splendid collection of cretaceous fossils from Southern India (Trichinopoly and neighbourhood), the descriptions and illustrations of which, contained in four volumes of the "Palæontologia Indica," form a worthy monument of the distinguished author, the late Dr. Stoliczka, whose bust has been recently placed in the centre of the gallery. They are arranged in systematical order according to Dr. Stoliczka's descriptions, beginning with the corals, and ending with remains of fishes. Cases 109-123. Cretaceous, South India.

The last case of this series (124) contains specimens of cretaceous fossils, from some other places as from Bágh (Narbada valley), from Sind, from Assam, and from the Namcho lake, near Lhassa, in Thibet. Case 124. Cretaceous, various places.

Middle series of cases (125—144).

From this last case, 124, the arrangement of Indian fossil animals is continued in the middle series of flat cases, beginning at the west end with those of the jurassic in Kach, which are followed by the fossils of the Spiti shales in the Himálaya, and then the lias of Spiti, the trias of Spiti and Kashmir, the carboniferous of the Salt-range, carboniferous of Spiti and Kashmir, and lastly the silurian fossils from Niti. These cases, although the fossils contained in them are in general order, cannot be considered as permanently arranged, as they will, most likely in a short time, require an extension with the increase of the collections. *Jura—Silurian.*

Other subjects in the Gallery.

To the east of the table-cases in the centre of the gallery is placed the late Dr. Stoliczka's bust.

Then follow five extinct huge animals; the first is a cast) skeleton of *Megatherium Cuvieri* (Cuvier's gigantic *Megatherium.*

animal), a sloth-like mammal from post-pliocene deposits in South America.

Cervus megaceros. Next to this is a real skeleton of the great "Irish elk" (*Cervus megaceros*, large-horned stag) from post-pliocene deposits in Ireland.

Palapteryx. After this we find a (cast) skeleton of an extinct New Zealand bird (Palapteryx) from post-pliocene deposits of New Zealand; this genus was already mentioned when the birds' bones in case 50*a* were noticed.

Glyptodon. Colossochelys. Of the two adjoining large casts that on the north represents the carapace and a portion of the skeleton of *Glyptodon*, an Armadillo-like animal, from post-pliocene deposits in South America; the other one is the carapace of the gigantic tortoise, called *Colossochelys*, from the pliocene deposits in the Sivalik hills of India.

Fossilised wood. In the corner, to the right of this animal, there stands a group of fossilised wood from various, mostly tertiary, deposits in India.

Specimens and Pictures on the walls.

Above the high wall-cases on both longitudinal walls are placed such large specimens (partly casts, partly real) of vertebrates (reptiles and fishes) which could not be placed in the cases.

There are also a number of pictures hung up; some of them (on the western half of the northern wall) represent ideal restorations of some fossil vertebrate animals; the others are geological views from various parts of India and elsewhere.

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