A GUIDE

TO THE

ZOOLOGICAL COLLECTIONS

EXHIBITED IN THE

INVERTEBRATE GALLERY

OF THE

INDIAN MUSEUM.

CALCUTTA:
PRINTED BY ORDER OF THE TRUSTEES OF THE INDIAN MUSEUM.
1894.

Price Ten annas.

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PREFACE.

THIS Guide is issued with the main object of assisting those who may have occasion to study in detail the collections contained in the Invertebrate Gallery, but it is believed that it will be of equal service to the casual visitor.

The exhibited collections of Sponges and Corals, of Echinodermata, of Crustacea, and of Mollusca, may be regarded as at the least thoroughly representative of the Seas of India both in the shallows and in the depths, as far as the depths are known at present; but owing in the one case to want of space, and in the other case to the incompleteness of our present knowledge, the respective collections of the air-breathing Arthropoda of the Indian region (excepting only the Lepidoptera, and the Mantidæ among the Orthoptera) and of most of the groups of Worms of the Indian region, are intended only to illustrate important generic types.

A. ALCOCK, *Surgeon-Captain*,
Superintendent of the Indian Museum.

INDIAN MUSEUM, CALCUTTA;
21st May 1894.

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INTRODUCTORY.

THE matter of which the terrestrial system consists is either inorganic (mineral matter) or organic (living matter).

[We also include as organic matter all such dead substances as are or have been formed in Nature only by the agency of living plants and animals—such as starches, sugars, fats, albumens, alkaloids, and such as coal and other fossils].

Living organic matter differs broadly from the inorganic matter of the Mineral kingdom in being, on the one hand, liable to rapid dissolution and decay, but in being able, on the other hand, to spontaneously renew and increase itself out of the various inanimate substances with which it is brought into relation. The cycles of complicated physico-chemical changes that occur in the course of this constant decay and renewal constitute Life.

Living bodies are divided into (1) Animals which feel, and can move spontaneously; (2) Plants which do not. Although we have no difficulty in distinguishing a highly developed animal, *e.g.*, a vertebrate, from a highly developed plant, *e.g.*, a flowering tree, yet when we descend in

the animal kingdom we find many groups of animals, *e.g.*, the Sponges, which being devoid of organs of sensation and being devoid of the power of voluntary movement were for a long time classed as plants, and when we descend to the lowest foundations of the vegetable kingdom we find many microscopic plants, which being endowed with the power of spontaneous motion were at first classed as animals.

The broad distinction that holds good, in the main, throughout the two kingdoms is that Plants live upon and build themselves up out of inorganic substances, while Animals can only live upon and build themselves up out of already-made organic substances.

In other words, in the cycle of Nature, Plants are manufacturers of organic substances for the consumption of Animals.

All Animals and Plants are built up of cells.

[The word "cell," as used in biology, means a microscopic mass of semi-fluid living-substance or *protoplasm* usually containing a denser body known as the nucleus, and sometimes surrounded by a membrane or wall: the semi-fluid living jelly or protoplasm of which cells are made, is an extremely complex chemical compound of Carbon, Nitrogen, Oxygen, Hydrogen, Sulphur, etc.].

For purposes of classification Animals are divided into (1) *Protozoa*, or animals that consist of a single cell, and (2) *Metazoa*, or animals that consist of an aggregate of cells.

The *Metazoa* again are sub-divided into (1) *Cœlenterata*, or animals in which the cavity of the body is formed entirely by the intestine; and (2) *Cœlomata*, or animals in which there is a distinct body-cavity through which the intestinal tube runs,—like a lamp-chimney through a lamp-globe.

The *Cœlomata* are further sub-divided into several great phyla or family unions, namely, (1) the *Platyhelminthes* or Flat-worms, of which the common Liver Fluke may be taken as a type; (2) the *Nemathelminthes* or Non-

segmented Round-worms, of which the common Intestinal worm may be taken as a type; (3) the *Annelida* or Segmented worms, of which the common Earth-worm may be taken as a type; (4) the *Arthropoda* or Segmented animals with many-jointed legs, of which the common Prawn may be taken as a type; (5) the *Echinodermata*, of which the Star-fish may be taken as a type; (6) the *Mollusca*, of which the common Snail may be taken as a type; and (7) the *Vertebrata*, or animals which possess at some time of their life either a backbone or the element out of which a backbone is developed, of which the Fish, the Frog, the Crocodile, the Bird, and the Mammalian quadruped are types.

The old Lamarckian classification of animals is into (1) *Vertebrata* and (2) *Invertebrata*—the latter including the *Protozoa*, the *Cœlenterate Metazoa*, and all the *Cœlomate Metazoa*, with the exception of that portion of the Vertebrate phylum which consists of animals characterized by a well-developed backbone.

PROTOZOA.

[Occupying the Southern end of Case E on the Western side of the Gallery].

The *Protozoa* are microscopic animals which consist of a single cell, in other words of a single minute speck of protoplasm, usually with a nucleus, sometimes with several nuclei, but occasionally (*Monera*) without a nucleus, and the great majority of them therefore can only be represented in a Museum collection by enlarged models and drawings.

Many species, however, are able to secrete protective shells of chitin or of lime or of flint, or to manufacture tests by the agglutination of minute grains of sand, and some of these are large enough to be distinguished by the naked eye.

Most of the *Protozoa* are aquatic: the species of one group—the *Gregarinida*—live as parasites in the interior of the cockroach, the earth-worm, and other animals.

In the Museum collection the shell-secreting *Protozoa* are well represented—both actual shells and enlarged models.

There are two great groups of shell-secreting *Protozoa* —(1) the *Radiolaria*, the shells of which consist of flint, and (2) the *Foraminifera*, the shells of which consist either of agglutinated sand-grains or, more commonly, of chitin (a flexible horny substance like that which forms the wing-cases of beetles and the integument of Crustacea and many other invertebrate animals), impregnated and strengthened with either carbonate of lime or flint.

Only the Foraminiferal *Protozoa* will be here described, as they alone are represented in the collection by actual specimens visible to the naked eye.

The *Foraminifera* are aquatic (mostly marine) *Protozoa* in which the body is enclosed in a shell which is usually perforated all over with little holes like a sieve, whence the name *Foraminifera*, but in some cases is entire with at one end a single opening, or mouth, just like, for example, a snail-shell. From the little holes in the shell-wall, or from the mouth of the shell, the living animal puts forth and draws in again thread-like processes of its own body-substance, which are known as *pseudopodia*, and it is by the continuous motion of these threads of protoplasm, or pseudopodia, that the animals move from place to place and seize their minute prey.

The great majority of the *Foraminifera* live in the sea. At the surface of the great oceans they exist in countless numbers, and as they die their shells fall to the bottom, where they form deposits of vast extent known as "Foraminiferal ooze," or, form the name of the commonest and one of the largest of the oceanic species, "*Globigerina* ooze." When dry this ooze has all the appearance of common chalk, and the White Chalk of Geology is in fact

simply Foraminiferal ooze that has been laid down in the seas of past geological ages, and has since been upheaved into dry land.

Among the exhibits are to be seen :—

I.—Pelagic and Deep-sea *Foraminifera* :—

(1) A piece of rough dried *Globigerina* ooze from the Bay of Bengal.

(2) *Globigerina* ooze from the Laccadive Sea washed free from impurities, and dried : this specimen shows the constituent shells as a coarse powder.

(3) Specimens of *Globigerina bulloides*, one of the commoner "perforate" forms, mounted separately.

(4) Specimens of *Pulvinulina menardii*, another very common "perforate" form, mounted separately.

All these come from depths of one thousand to two thousand fathoms.

The imperforate forms are well illustrated by a large specimen of (5) *Hormosina bradyi* dredged in the Bay of Bengal at a depth of 561 fathoms. The shell of *Hormosina* consists not of lime, but of chitin strengthened on the outside by a smooth compact coat of minute grains of sand, and at one end of the shell is the opening—shown in the enlarged drawing that accompanies the specimen—from which the pseudopodia are emitted in a bunch.

II.—Littoral and shallow-water Foraminifera :—

(1) *Orbitolites.*

(2) *Nummulina.*

(3) *Alveolina.*

(4) *Planorbulina.*

III.—The other exhibits in the *Protozoa*-case are a series of models of recent and extinct *Foraminifera* much enlarged ; and

IV.—Enlarged drawings of the other types of *Protozoa*—*viz.*, *Monera*, *Amœba*, *Thalassicolla*

and *Sphærozoum*, *Chilomonas*, *Paramœcium*, and *Gregarina*, for an account of all of which the visitor is referred to works on systematic zoology.

The last exhibit is (V) a specimen of *Eozoon canadense* from Canada, presented by Lady Dufferin. *Eozoon* has been supposed to be the fossil remains of a gigantic Foraminifer, and its interest lies in the fact that, if fossil, it represents, geologically speaking, the most ancient form of life known to us. It is not generally conceded, however, that *Eozoon* represents an organic structure.

METAZOA.

We next come to the *Metazoa*, or animals that consist of a complex of cells.

Among the *Protozoa* the single simple cell performs, though imperfectly, all the various functions by which life is maintained: it receives simple impressions from without, *e.g.* of the proximity of food, it is locomotive, it takes hold of and digests prey, it respires, it circulates its assimilated nutriment, and it excretes its useless waste,—and in most of the *Protozoa* it does all this with any and every part of its simple unicellular body.

But when a multitude of cells is incorporated together to form a large many-celled animal, it is not economical for the incorporation that each of its cell-units should, so to speak, go its own way and continue to perform all its functions independently for itself. It is more economical, both for the incorporation as a whole, and for each of these cell-units, that each of the functions requisite for the common weal should be assigned to particular groups of cells—to some groups the receiving of impressions, to other groups the functions of digestion and assimilation, and so

on: much as happens in communities of men, where the various industries and activities of the community are not performed by all the citizens alike, but each citizen is devoted to one particular occupation. In this way, since "practice makes perfect," each function comes to be dexterously and economically performed.

This apportioning of functions is known as the "physiological division of labour," and we must now consider the changes to which it gives rise.

Let us imagine a colony of cells, all of which are alike in form, and, like a *Protozoon*, possess the same limited range of ill-developed functions, and let us now suppose that to one group of cells is allotted the function of protecting the colony from external injuries, and to another group of cells the function of digesting the food of the colony. Then as a natural result of special perfection in one set of protecting functions to the relative neglect of the digestive functions, and *vice versâ*, these two groups of cells will gradually come to differ in many points of structure and form.

In other words, among cells originally alike in form the specialization of function to which the division of physiological labour gives rise leads to many differences in form.

A second consequence of the physiological division of labour, and of the differences in occupation and structure to which it leads, is that all the various cells and groups of cells—like the citizens of a state—come to be mutually dependent on one another.

The earlier and simpler stages of the physiological division of labour are seen in the two large family-unions or phyla of *Metazoa* known as *Cœlenterata*, in which the constituent cells of the body fall into two distinct well-differentiated layers or membranes,—an external protective and sensory layer, and an internal digestive layer,—enclosing a central cavity or stomach.

METAZOA CŒLENTERATA.

[Cases 1—8 along the Western side, and 9—16 along the Eastern side of the Gallery].

The *Cœlenterata*, or Zoophytes, are multicellular animals, most of which are immovably fixed and have the power of increasing either by fission, or by budding like plants, to form tree-like colonies.

Many of them were formerly classed with plants, and their name of Zoophyte, or "Plant animal", indicates this superficial resemblance.

The group includes the Sponges, the Sea-firs and Sea-jellies, the Sea-pens, the Corals, and the Sea-anemones.

In the *Cœlenterata*-type the division of labour has progressed to the extent of segregating the cells of which the body is made up into two layers—an outer chiefly defensive layer known as the ectoderm, and an inner chiefly digestive layer known as the endoderm. Between these two layers a middle chiefly supporting layer, known as the mesoderm, is afterwards developed.

The *Cœlenterata* are divided into two great groups—(1) the *Porifera*, or Sponges, which have inhalant pores in the body-wall, but have no mouth, no tentacles, and no stinging cells; and (2) the *Cnidaria*, or Stinging Zoophytes, which have no inhalant pores in the body-wall, but have a mouth, tentacles, and stinging cells.

PHYLUM I OF THE CŒLENTERATA.

PORIFERA (SPONGES).

[Cases 1—3 along the Western side of the Gallery].

The typical form of the simple sponge-animal is that of a tube closed and fixed at one end and free and open at

the other. The tube-wall is built up of three layers of cells (1) a very thin outer layer of delicate cells known as the ectodermal epithelium, (2) an inner layer of large cells known as the endodermal epithelium, and (3) a middle layer of cells and intercellular substance secreted by the cells, known as the mesodermal connective tissue, or sponge parenchyma. In this mesodermal tissue a supporting skeleton of horn, or lime, or flint is usually developed, and it is this skeleton, washed and dried, that constitutes most of the Museum specimens of sponges.

The hollow of the tube is known as the "gastral cavity," and its open end as the "osculum".

The osculum does not correspond to the mouth of other Cœlenterates. The sponge in fact does not possess a mouth, but the body-wall is perforated by large pores which can be closed and opened again. Through these pores currents of water stream into the gastral cavity, carrying with them the microscopic organisms which form the food of the sponge, and passing away out through the osculum.

This simple type of sponge is seen in *Ascetta*, which, however, is not represented in the collection. Such simple forms are uncommon. In the *Syconidæ*, of which several specimens (*Sycandra*, *Grantessa*, *Leucandra*) are exhibited in the collection (Case 1), the mesodermal parenchyma gets much thicker, and becomes tunnelled by pouch-like offshoots of the gastral cavity, the ends of the pouches opening to the exterior by pores, and causing the conical bulgings to be seen on the outside wall of the sponge where they open. This not very complicated type is fairly well seen in the exhibited specimens of *Sycandra* and *Sycon*, both of which are shown in longitudinal section, in Case 1.

In most other cases the structure of the sponge is still more complicated by the further thickening of the mesoderma parenchyma and the repeated branching of the

pouches derived from the original gastral cavity to form systems of canals and of chambers—the "ciliated chambers"—in which all the digestive and respiratory work of the sponge is carried on. In these cases the water carrying food and dissolved air streams through the "pores" into "afferent canals" which lead into "ciliated chambers" that are really only special developments of the branches of the gastral cavity. From the ciliated chambers the now effete water passes through "efferent canals" into the much-restricted gastral cavity, whence it streams out at the osculum.

This complicated branching canal and chamber system can be seen in almost any sponge, but it is specially well seen in the exhibited vertical section (spirit-specimen) of the Hexactinellid sponge *Pheronema globosum*, in **Case 1.**

Further complications of the sponge-form result from the fact that many sponges increase by budding, so that the originally single sponge becomes a colony of sponges. This is well seen in the exhibited specimens of *Sycandra*, *Reniera* and *Chalina*.

It has already been stated that a firm supporting skeleton is usually developed in the mesoderm of the sponge, and this skeleton, from the superficial observer's point of view, is the principal part of the sponge, as it forms the bulk of the animal and its most enduring part.

With the exception of one small Family—the *Spongillidæ*—all the sponges are marine, living either attached to rocks and reefs in shallow water, or anchored in the mud of the ocean-depths.

Sponges are divided into two great Classes—(1) *Calcarea* and (2) *Non-Calcarea*.

I. PORIFERA CALCAREA.

[Case 1].

The *Calcarea* consist of one Order, namely,—

i.—CALCISPONGIÆ.

In the *Calcispongiæ* the sponge skeleton is made up of spicules of carbonate of lime interlaced to form a sort of rigid felt-work.

The *Calcispongiæ* are represented in the collection by specimens of *Ascetta*, *Sycon*, *Sycandra*, *Grantessa*, and *Leucandra*.

2. PORIFERA NON-CALCAREA.

[Cases 1—3].

In the *Non-Calcarea* the skeleton consists either of spicules of silica (flint), or of horny fibres. There are three Orders—*Hexactinellida*, *Chondrospongiæ*, and *Cornacuspongiæ*.

ii.—PORIFERA HEXACTINELLIDA.

[Case 1].

Hexactinellida (Glassy or Flinty Sponges), in which the skeleton consists of spicules of flint or opal. The *Hexactinellida*, which are well represented in the Museum collection, live almost entirely in the great depths of the ocean. They very rarely occur in less than 100 fathoms, but are to be found at all depths between 100 and 3,000 fathoms.

In the Indian Sea they have been found at the greatest depth at which the dredge has been used by H. M. I. M. S. "*Investigator*," and according to the observations of the naturalists of this vessel they occur in the greatest abundance in the neighbourhood of the Andaman Islands at depths of 180 to 300 fathoms.

The skeleton in the *Hexactinellida* is formed of spicules of flint or opal which are typically six-rayed, the tips of the rays of neighbouring spicules being very commonly cemented together by flint to form a lattice-work of remarkable regularity, symmetry, and rigidity. This is well seen in the beautiful Venus' Flower Basket (*Euplectella*),

and also in *Aphrocallistes* and *Farrea*, all of which are exhibited in the collection.

In some species the spicules at the base (or root) of the sponge are fused together to form stout threads, which either remain separate or in loosely-woven tufts as in the Bird's Nest Sponge (*Pheronema globosum*) and in *Semperella schultzei*, or are tightly woven together in strands to form a long rope, as in the Glass-rope Sponge (*Hyalonema*). By these tufts or ropes the sponge anchors itself in the mud at the bottom of the ocean.

The *Hexactinellida* are represented in the collection by specimens of the following genera :—*Euplectella*, *Aulochone*, *Hyalonema*, *Stylocalyx*, *Pheronema*, *Semperella*, *Aphrocallistes*, and *Farrea*. Some of the forms taken by the spicules of the flinty sponges are shown in the large plate of enlarged drawings in **Case 1**.

iii.—PORIFERA CHONDROSPONGIÆ.

[Case 2].

The *Chondrospongiæ*, or Horny-Flinty Sponges, form a very large Order of sponges, in which the skeleton is typically made up of a mass of siliceous, or flinty, spicules of various shapes, which are not usually cemented together either by spongin or by flint, but are matted together to form a stout felt-work.

The Order is fairly well represented in the collection by the following genera :—*Tethya*, *Aulospongus ; Raphyrus*, *Papillina ; Suberites*, *Poterion* (a series of magnificent specimens of *Poterion neptuni*), *Raspailia*, *Dictyocylindrus*, *Acanthella*, *Phakellia*, *Chondrilla*, *Spongilla*.

iv.—PORIFERA CORNACUSPONGIÆ.

[Case 3].

The *Cornacuspongiæ* also form a large Order, in which the skeleton is typically made up either of siliceous

spicules cemented together by a substance known as "spongin" chemically very similar to horn, or is formed entirely of spongin fibres without any spicules whatever. The common bath-sponge is a familiar example of this last group. In *Halme* the horny skeleton is strengthened with grains of sand. The *Cornacuspongiæ* are represented in the collection by the following genera:—*Esperella*, *Iotrocha*, *Clathria*, *Echinonema*, *Plumohalichondria*, *Clathrissa*, *Thalassodendron*, *Echinodictyum*, *Caulospongia*; *Reniera*, *Haplochalina*, *Chalinissa*, *Chalina*, *Tuba*; *Phyllospongia*, *Chalinopsilla*, *Hippospongia*, *Halme*, *Stelospongia*, *Hircinia*, *Cacospongia*, *Carterispongia*, and *Dendrilla*.

PHYLUM II OF THE CŒLENTERATA.

CNIDARIA (STINGING ZOOPHYTES).

[Cases 3—16].

The other great group of the *Cœlenterata* is that of the *Cnidaria*, or Stinging Zoophytes, distinguished from the *Porifera* or Sponges in possessing for the ingestion of food a mouth surrounded by tentacles, instead of pores, in being provided with special stinging-cells for defence and for disabling their prey, and in being possessed of a true stomach, as well as of the elements of a muscular and nervous system.

There are two great divisions of the *Cnidaria*, namely, (1) the division typified by *Hydra*, in which the mouth is a simple orifice in the body-wall, and leads directly into the stomach; and (2) the division typified by the Sea-anemone, in which the mouth is formed at an invagination of the body-wall, the invagination forming an ectodermal gullet. Of these two divisions the first consists of the one Class *Hydromedusæ*, and the second consists of three Classes the *Anthozoa*, the *Scyphomedusæ*, and the *Ctenophora*.

I. CNIDARIA HYDROMEDUSÆ.

[Cases 3—4].

In this great Class the type is an animal having the form of a simple tube closed and often attached at one end—the aboral pole; and provided at the other end (oral pole) with a mouth surrounded by tentacles. The tube of which the animal consists is mainly formed of two layers,—an outer layer or ectoderm, and an inner layer or endoderm—and between these two there occurs the elements of a third supporting layer, or mesoderm. The hollow of the tube is the gastric cavity, or stomach.

This simple type is seen in *Hydra*, an animal that can only be properly examined under the microscope, and which is therefore exhibited in the form of an enlarged drawing.

This simple type becomes complicated by the fact that the parent polyp usually buds and branches again and again—the resulting offspring remaining united together and to the parent to form a tree-like colony.

This is well seen in the exhibited specimens of *Tubularia*, *Eudendrium*, *Corydendrium*, *Plumularia*, and *Sertularia*.

In these colonial forms the units of the colony are known as "zooids," and the fleshy substance which binds them together is known as the "cœnosarc." In the ectodermal cœnosarc a protective and supporting investment is often secreted. In *Tubularia* and the allied forms this is a chitinous pellicle. In *Perigonimus* the chitinous pellicle is strengthened by grains of sand. In *Plumularia* and *Sertularia* the chitinous investment is very thick and stout, and is moreover continued over the zooids up to the level of their tentacles to form protective cups into which the zooids can completely retract themselves when alarmed. In *Millepora*, instead of a membranous or chitinous pellicle, a hard stony deposit, in structure exactly similar to a stony coral, is formed by the ectoderm,

and into cavities in this the zooids can withdraw themselves. All these gradations may be well studied in the specimens and models exhibited in the collection. (**Cases 3–4**).

Another complication found in these compound colonies is due to the fact that a physiological division of labour takes place among the zooids of which the individual colonies are composed, some of the zooids remaining devoted entirely to nutritive functions and retaining the hydroid form, while others become specialized for reproduction, and undergo much modification in form. The essence of this modification is that the reproductive zooids (or "gonozooids") lose their fixed attachment and become free-swimmers. The explanation of their becoming free-swimmers is that the eggs and young which they produce may be widely scattered, and so may be more likely to find food and to live and grow than they would be if they fell close to the already well-established parent colony.

The reproductive polyps are known as *Medusæ:* they may be regarded as *hydra*-form polyps, which have become greatly flattened out at the aboral pole into a disk, and then bent round into the form of a bell, from the centre of which the oral end of the polyp (the mouth) hangs down like a hollow clapper ("manubrium" or "gastric peduncle").

At the same time the mesoderm in the wall of the bell becomes much thickened, and the gastral cavity in the wall of the bell becomes obliterated, except at the circumference of the bell, where it remains as a canal ("circumferential canal"), and along certain definite lines (usually four in number) which lead from the cavity of the clapper or gastral peduncle to the circumferential canal. These canals are known as "radial canals", and they carry digested nutriment to all parts of the bell. They are well seen in the spirit-specimen of *Olindias mülleri*, in **Case 3.**

Further, the inside edge of the bell becomes thickened

to form a ring of muscle, by the contraction of which, under the control of a double ring of nerve-tissue, the *Medusa* swims through the water, and along the edge of the bell tentacles and sensory organs (auditory and visual) are developed at the point where the radial canals join the circumferential canal: these sense-organs are never covered over by folds of membrane. The development of the *Medusa* from the ordinary nutritive-zooid type into the free locomotive gonozooid type is well displayed in the enlarged glass-models of *Bougainvillea fruticosa*, *Syncoryne frutescens*, *Perigonimus vestitus*, etc., in Case 3.

From such a typical *Medusa*-form two other modifications arise, one being of the nature of an advancement, the other being probably a degradation.

The advanced type of *Medusa* is shown in the beautiful specimen of *Olindias mülleri*, a large *Medusa* which throughout its life is known only as a free animal, and never springs as a bud from a tree-like colony. The same thing is illustrated in the series of models of *Carmarina hastata*.

The degraded type of *Medusa* is seen in the exhibited specimens of *Sertularia*, and in the beautiful spirit-specimen of *Tubularia larynx*, where the reproductive units of the polyp-colony, instead of breaking away and becoming freely locomotive *Medusæ* with mouth and tentacles, merely grow into large buds or sacks, without mouth and tentacles, in which the reproductive elements are developed.

These arrested or incompletely developed *Medusæ* are usually known as "Medusoid gonophores."

An intermediate step, in which the reproductive zooid (gonozooid) becomes developed into a more or less perfect *Medusa*, which, however, never becomes detached from the parent colony, occurs, and is represented in the collection by the enlarged models of *Tubularia indivisa*, in Case 3.

In some *Hydrozoa* the physiological division of labour goes far beyond the simple separation of the units of the colony into two classes of zooids, the nutritive and the re-

productive. For example, in the *Millepora*, as is shown in the enlarged drawings after Moseley, the colony consists of a multitude of polyp-like zooids bound together by a hard stone-like cœnenchyma, as is seen in the exhibited specimen. The zooids are grouped together in little groups of six, in each of which the central zooid is short and stout with a mouth and few tentacles, while the five peripheral zooids are long and thin and flexible, and have no mouth but numerous tentacles. The central zooid, or gastrozooid, is specially modified to perform the work of digestion for the colony; while the long thin zooids (dactylozooids) are specially modified to catch prey, which they convey to the mouth of the gastrozooids. The food digested by the gastrozooids circulates in canals in the cœnenchyma, and is thus distributed all over the colony and to the dactylozooids, just as in other *Hydrozoa*.

In the *Siphonophora*, which are represented in the collection by the glass models of *Physophora*, *Apolemia*, *Agalmopsis*, *Halistemma*, and *Physalia*, the entire colony is freely locomotive, usually near the surface of the open sea, and the physiological labours of the colony are allotted to separate groups of units or "persons," each of which becomes specially modified for the sole performance of its own function. The exhibited specimen of *Physophora hydrostatica* may be taken as an illustration: here the labour of the colony is much subdivided, and of the polyps some are exclusively devoted to moving the colony about ("locomotive persons") and have a modified *Medusa* form, others are exclusively concerned with the digestive labours of the colony ("nutritive persons"), and have become transformed into simple tubes for taking in food, others are entirely occupied with the mechanical protection of their fellow-workers, and have become simple shield-like plates ("protective persons"), others are completely engaged in active defence or in offence, and have become changed into long grappling lines furnished with batteries of stinging-cells, while others are "reproductive persons," and are practically nothing but bunches of egg-capsules. All these

differently occupied and variously modified "persons" are indicated by letters on the life-sized models in Case 3.

Such colonies, made up of units of many different forms, are known as Polymorphic Colonial *Hydrozoa*.

Almost all the *Hydrozoa* are marine, *Hydra* being the best known of the very few freshwater forms.

The fixed *Hydrozoa* usually live attached to rocks or encrusting sea-weeds, dead shells, etc., between low water mark and 100 fathoms; a few are known from the deep sea; while some species attach themselves to freely locomotive animals, such as crabs, fishes, etc., by which arrangement they greatly profit. The free-swimming *Medusæ* are found at the surface of all the seas and oceans.

Not to include the usual glass models, the *Hydrozoa* are represented in the exhibited collection by spirit-specimens of the following genera: *Tubularia*, *Eudendrium*, *Corydendrium*, *Cordylophora*, *Olindias*, *Sertularia*, *Plumularia*, *Antennularia*, only the last three being from the Indian Seas.

2, 3, 4. CNIDARIA ANTHOZOA, SCYPHOMEDUSÆ, AND CTENOPHORA.

[Cases 4—16].

In the second division of the *Cnidaria* or Stinging Zoophytes the mouth is formed, as in all higher animals, by an invagination of the ectoderm. The mouth, therefore, does not open directly into the gastric cavity as it does in the *Hydrozoa*, but into an ectodermal invagination, or gullet, which leads to the gastric cavity or stomach.

There are three distinct and equivalent types or Classes of these more highly developed *Cnidaria*, (1) the *Anthozoa*-type, of which the Sea-anemones and Coral polyps are good examples, (2) the *Scyphomedusa*-type, of which the large Acraspedote *Medusæ* are the examples, and (3) the Ctenophor type.

In the typical Anthozoan the form of the body is still a three-layered tube usually closed and fixed at one end, free

and provided with a mouth surrounded by tentacles at the other—the hollow of the tube forming the gastric cavity or stomach.

The gastric cavity is divided into compartments along its whole length from pole to pole by radial partitions formed by outstanding ridges of endoderm and mesoderm—these being known as sarco-septa or mesenteric folds.

2. CNIDARIA ANTHOZOA.

[Cases 4—16, with the exception of a single compartment of Case 7 occupied by Scyphomedusæ and Ctenophora].

The *Anthozoa* comprise the Sea-anemones and various kinds of Corals, and form a very large and important group. They are all marine animals. The Corals especially are of much interest, because they give rise by budding and fission to great branching tree-like or turf-like colonies, the massing together of which in the shallower waters of tropical seas forms reefs of vast extent. These reefs often become at places raised to the sea level, and they then constitute the nuclei of groups of islands. Good examples of such coral islands near at hand are the Laccadive and Maldive Archipelagos.

The *Anthozoa* are divided into two sub-Classes—the *Actiniomorpha* and the *Alcyoniomorpha*.

a. ANTHOZOA ACTINIOMORPHA.

The *Actiniomorpha* are divided into three Orders *Actiniaria*, *Antipatharia*, *Madreporaria*.

i. ANTHOZOA ACTINIOMORPHA ACTINIARIA.

[Middle of Case 7].

The type of simple Actiniomorph Anthozoan is the Sea-anemone (*Actinia*), of which there are numerous examples exhibited, both glass models and actual spirit specimens, in Case 7. From an inspection of one of these it will be seen that the sea-anemone consists of a tube usually

attached at its aboral pole, which is known as the *pedal* disk or foot-plate, and provided with a mouth and crown of hollow tentacles at the oral pole, which is known as the oral disk or peristome. In *Polysiphonia*, a deep-sea form, shown in the Case, the tentacles are reduced to short broad stumps, each of which has an orifice at the end through which water with nutrient particles can enter the gastric cavity. The hollow of the tube forms the stomach, into which the pendent œsophagus opens, as may be seen in the several longitudinal bisections of *Sphenopus*. The wall of the stomach is raised to form sarco-septa or mesenteric folds, to the free edges of which are attached bunches of filaments (mesenteric filaments) and *acontia*. The latter are freely armed with stinging-cells, and can be protruded rapidly from the mouth, and sometimes through the body-wall, in defence, when the sea-anemone is irritated. From the free edges of the mesenteric folds the reproductive organs also arise. The sarco-septa, or mesenteric folds, with their bunches of mesenteric filaments and of generative products are very clearly displayed in the longitudinal bisections of *Sphenopus* and *Cerianthus*. The acontia are beautifully seen in the longitudinal bisection of *Cerianthus*, fringing the lower end of the septa.

The tentacles in the *Actiniaria* are multiples of six: they are usually retractile, as is seen in the sections of *Sphenopus*, and their function is to seize upon prey and convey it to the mouth.

Most of the sea-anemones have soft bodies, but some, as in the exhibited specimens of *Sphenopus arenaceus* and *Sphenopus marsupialis*, and of *Zoanthus* and *Epizoanthus*, have a leathery external coat, which is further strengthened by a layer of sand-grains agglutinated together. The interesting form *Cerianthus*, too, some large specimens of which are to be seen in the Case, is furnished with a thick jacket made of mucus and mud and sand, into which the animal can retract itself.

Most of the sea-anemones are simple, that is to say

they do not form colonies by budding and fission, but *Zoanthus* and *Epizoanthus* are exceptions to this rule, and form encrusting colonies on shells and very often on the anchoring strands of the Glass-rope Sponge.

The sea-anemones usually live attached to rocks between tide-marks or not far below low-water mark. Some, as *Sphenopus* and *Cerianthus*, which live in deeper water are not fixed, but bury their bodies in the mud of the sea-bottom, leaving the mouth and tentacles exposed. A few, as *Polysiphonia*, live on the soft mud of the ocean-bottom at the greatest depths.

Many sea-anemones attach themselves to the carapaces of hermit-crabs or other soft-bodied crustacea, by whom they are carried about from one feeding-ground to another, the anemone paying for this service by affording the necessary protection to the soft-bodied crab. This interchange of services between two animals, both of which live in other respects a completely independent life, is known as commensalism.

When an animal such as a simple sea-anemone gives off buds, or splits itself into two longitudinally to form new "persons," and when these newly-formed "persons" remain attached to the parent and themselves give rise to another generation which also remains attached, and when further the parent and all its attached generations of branching offspring secrete in their outer layer or ectoderm a hard protective coat of carbonate of lime, we then get the common forms of stony-coral. The stone coral, or Madreporarian, is in fact simply a sea-anemone or colony of sea-anemones with a calcified integument.

ii. ANTHOZOA ACTINIOMORPHA MADREPORARIA.

[Cases 8—16].

The stony corals (*Madreporaria*) do not all form colonies, but they all secrete in the outer layer of their

integument the stony protection and support known as "coral." The coral, or "corallum," when freed from the soft parts of the animal by maceration (as is done in most Museum specimens) consists of an outer cup or "calice," which usually contains a central upstanding column or "columella" and numerous series of vertical plates radiating from the columella to the calice wall—the "sklero-septa" and "pali"—by which the mouth and tentacles are supported. The vertical section through the corallum of *Caryophyllia communis* in Case 16 shows this well.

The living *Madreporaria* are divided into three sections —the (1) *Madreporaria Aporosa*, (2) *Madreporaria Fungida, and* (3) *Madreporaria Perforata.*

MADREPORARIA APOROSA,

[Cases 14-16].

In the *Madreporaria Aporosa* the corallum has a solid wall and solid septa. This section is divided into four families—the *Turbinolidæ*, the *Oculinidæ*, the *Pocilloporidæ*, and the *Astræidæ.*

1st Family Turbinolidæ—In which the corallum is almost always a single simple calice or cup, with the chambers between the sklero-septa ("interseptal loculi") open to the bottom of the cup. Branching colonies never occur and the *Turbinolidæ* therefore play no part in the formation of coral reefs.

Many of the *Turbinolidæ* live at the bottom of the deep sea, where sometimes, as in the case of *Caryophyllia communis*, they occur in large beds. This family is represented in Case 16 by the following genera, all of which occur in Indian waters:—*Flabellum*, *Rhizotrochus*, *Deltocyathus*, *Paracyathus*, *Heterocyathus*, *Caryophyllia*, *Stephanotrochus*, *Discotrochus*, and *Polycyathus*, the latter being one of the very few Turbinolians that form colonies.

2nd Family **Oculinidæ**—In this family the corallum is always compound, forming tall branching colonies, the calices or cups of the individual corallites being borne on the sides and tips of the branches. As growth goes on, the calices often fill up with stony deposit. So far as is known only two species of *Oculinidæ* occur in Indian waters, namely, *Lophohelia* and *Cyathohelia*. The *Oculinidæ* are represented in **Case 16** by the following genera :—*Lophohelia* from the depths, *Cyathohelia* from the Madras coast and from Japan, and *Amphihelia* from Japan.

3rd Family **Pocilloporidæ**.—In this family the coral consists of a branching tree-like colony bearing crowds of small calices with small or rudimentary septa—the calices often filling up with stony deposit.

The *Pocilloporidæ* consist of only two genera—*Pocillopora* and *Seriatopora*, both of which are common reef-forms, and are found in abundance in the shallow waters of the Indian Seas. Numerous species are represented in **Case 16**.

4th Family **Astræidæ**.—A very large family, some of which are simple, but the majority of which form the great massive boulder-like colonies of the coral-reefs. In structure the Astræoid much resembles the Turbinoloid coral, but the corallum in the *Astræidæ* differs in having the chambers between the septa (interseptal loculi) more or less crossed by strands of coral known as "dissepiments."

The *Astræidæ* are represented in **Cases 14-15** by the following genera—all from the coral-reefs of the Indian Seas :—*Montlivaltia*, one of the simple Astræans which does not form branching colonies ; *Cylicia*, one of the genera which forms creeping colonies ; *Cladocora*, *Trachyphyllia*, *Mussa*, *Euphyllia*, *Mæandrina*, *Cœloria*, *Symphyllia*, *Tridacophyllia*, *Hydnophora*, *Favia*, *Goniastræa*, *Phymastræa*, *Plesiastræa*, *Echinopora*, *Galaxea* *Leptastræa*, *Prionastræa*, *Merulina*—all these last being true reef-corals forming branching or massive turf like colonies.

MADREPORARIA FUNGIDA.

[Case 13].

The majority of the corals of this section are flat mushroom-like forms: the chambers between the sklerosepta ("interseptal loculi") are always more or less filled up by bars of coral ("dissepiments"), which pass across from septum to septum, and the calice-wall is usually fenestrated or perforated to a certain extent. The *Fungida* are divided into five families—two of which, however, are extinct, being known only as fossils. The three living families are the *Plesiofungidæ*, the *Fungidæ*, and the *Lophoseridæ*.

1st. The genera of the Plesiofungidæ are all extinct but one—*Siderastræa*—which lives in the Indian Seas, a specimen being exhibited in Case 13.

2nd Family Fungidæ.—The corals of this family are large flat mushroom-shaped disks, with perforated and fenestrated walls; some are simple and some compound. They are well represented in Case 13 by numerous beautiful specimens, from the Andaman and Mergui reefs, of the following genera:—*Fungia*, *Haliglossa*, *Halomitra* (*Podobacia*), *Cryptabacia*, *Herpolitha*, *Lithactinia*.

3rd Family Lophoseridæ.—In this family the calice-wall is not perforated or fenestrated, and the corals are either simple and small, flat and mushroom-like, or else they are compound, and form spreading encrusting fungus-like cakes. They are well represented in Case 13 by the following genera:—*Trochoseris*, *Cycloseris*, *Diaseris*, and the beautiful *Bathyactis* from the depths of the Bay of Bengal—all these being small simple forms: and *Lophoseris* (*Pavonia*), *Leptoseris*, *Agaricia*, *Coscinaræa*, and *Psammocora*—which are compound forms.

MADREPORARIA PERFORATA.

[Cases 8-12].

In this section, which includes both small simple corals and huge tree-like colonies, the great distinguishing char-

acter is that both the walls of the coral-cups and the branches are spongy and porous or lace-like. The Perforate *Madreporaria* are divided into three families—the *Eupsammidæ*, the *Madreporidæ*, and the *Poritidæ*.

1st Family **Eupsammidæ.**—The *Eupsammidæ* are mostly small simple corals, but some of them, *e.g.*, *Dendrophyllia*, form colonies. They are represented in **Case 12** by the following genera from the rocky parts of the coasts of India, Burma, and Ceylon: *Balanophyllia*, *Eupsammia*, *Heteropsammia*, *Dendrophyllia*, *Cænopsammia*, *Astropsammia*, and *Rhodopsammia*.

2nd Family **Madreporidæ.**—The Madrepores are the typical corals of the reefs of all parts of the world, where they occur as large tree-like colonies of singular beauty. A large number of species of the genera *Madrepora* and *Turbinaria* are shown in **Cases 9-12**, all of them being from the reefs and islands of the Indian Seas

3rd Family **Poritidæ.**—In this family not only the coral-walls, but the septa also, are porous and lace-like: the corals are always compound, and the individual coral-lites are very small. The colonies are usually in the form of tufts or boulders, and are very common constituents of coral-reefs. Numerous species, from the reefs of the Indian Islands, of the following genera, are exhibited in **Case 8**:—*Porites*, *Synaræa*, *Goniopora*, *Alveopora* (*Favositipora*), and *Montipora*.

In connexion with these exhibits of corals, it must be remembered that almost all Museum specimens are simply denuded and dried skeletons. The appearance of the living coral is well seen in the wax models of *Astroides* (**in Case 12**), and of *Caryophyllia smithii* (**in Case 16**), and can be fairly well understood by examination of the spirit specimens of *Bathyactis stephanus* (**in Case 13**), and of *Flabellum japonicum*, *Flabellum laciniatum*, and *Rhizotrochus crateriformis* (**in Case 16**), where the spirit-preserved specimens, with the soft parts intact though much

retracted, can be compared with the denuded and dried coralla alongside.

iii. ANTHOZOA ACTINIOMORPHA ANTIPATHARIA.

[Southern end of Case 7].

The *Antipatharia* constitute a small group of *Actiniomorpha* which, like the true corals, form branching tree-like colonies supported by a rigid skeleton. The skeleton of the *Antipatharia* differs from that of the *Madreporaria* in being formed of horn instead of stone, and in being developed only in the cœnenchyma and not round the polyps themselves, which are quite soft, like a sea-anemone. The Antipatharian corallum, in short, much resembles the corallum of the *Gorgonacea* next to be described, the resemblance being so complete as to have misled the older zoologists into classing the *Antipatharia* with the *Alcyonaria*. When, however, the living polyps are examined, the *Antipatharia* are found to agree with the *Actiniaria* in having tentacles in sixes or multiples of six, and in having usually numerous septa, instead of, like the *Alcyonaria*, eight tentacles and eight septa.

The black skeleton or corallum of the *Antipatharia*, moreover, can be at once distinguished from that of the *Gorgonacea* in being densely covered with little thorns.

The *Antipatharia* are represented in Case 7 by the dried tree-like skeletons of *Antipathes* and *Cirrhipathes*, by the fine spirit-specimens of the same genera, in which the little polyps with their cœnenchyma can be seen investing all the twigs and branches of the corallum like a soft bark, and by the fine specimens of *Bathypathes*, a deep-sea genus.

Bathypathes is a remarkable type which is distinguished from all other *Actiniomorpha* by exhibiting the phenomenon, already described, of dimorphism: that is to say, in every colony some of the units are specially modified to perform only reproductive functions (reproductive zooids

or gonozooids), while the others are specially modified to perform only nutritive functions (nutritive zooids or gastrozooids).

The *Antipatharia* usually encrust rocky bottoms at moderate depths,—30–60 fathoms. The few deep-sea forms are also rock livers.

b. ANTHOZOA ALCYONIOMORPHA.

[Cases 4—6].

This sub-Class consists of marine reef-living animals very commonly in the form of branching tree-like colonies or of encrusting moss-like or fungus-like colonies, the constituent units or "persons" of which have the typical polyp shape and structure.

Each polyp usually has eight tentacles, instead of six or a multiple of six tentacles, as in the *Actiniomorpha*. The possession of eight tentacles and eight septa is in short the principal constant character of the *Alcyoniomorpha*. The tentacles, moreover, are *pinnate*.

The *Alcyoniomorpha*, like most of the *Actiniomorpha*, secrete a firm supporting skeleton or coral, which, however, differs from that of the *Actiniomorpha*, not merely in being less stony and rigid, but often in important points of development.

The skeleton or "coral" of the *Alcyoniomorpha* (1) is sometimes formed entirely by the mesoderm, in which calcareous spicules are deposited to finally fuse together into a hard solid wall: such a mesodermal coral is seen in the specimens of *Tubipora musica* (the organ-pipe coral) and of *Telesto arborea;* but (2) is most often formed by both ectoderm and mesoderm, the mesodermal element, however, greatly preponderating. In this case the polyp, at the point where it attaches itself to the ground, secretes between its ectoderm or outside layer and the ground a layer of *horny* matter, and as the polyp-stalk grows upwards this horny mass follows, until it forms a central horny core or axis which follows the polyp-stalk in all its

branchings: so that in this way the horny substance which was originally on the outside of the base of the polyp comes to occupy the central core of the polyp-colony. Round about this horny axis of ectodermal origin masses of calcareous spicules are deposited, and these often fuse together or interlace to form a thick rigid coral. Such a coral, formed of both ectoderm and mesoderm, is found in *Gorgonia*.

The *Alcyoniomorpha* are divided into three Orders, the *Alcyonacea*, the *Pennatulacea*, and the *Gorgonacea*.

i. ANTHOZOA ALCYONIOMORPHA ALCYONACEA.

[Case 4].

In the *Alcyonacea* there is no horny central axis of ectodermal origin, and the units of the polyp-colonies are united either by a thick fleshy cœnosarc in the mesoderm of which calcareous spicules are secreted, or by a hard calcareous cœnenchyma. The cœnosarc is tunnelled by canals which are continuations of the gastric cavities of the polyps, and by these canals ("nutritive canals") nutriment is distributed throughout the colony. The nutritive canals are well seen in the vertical section of *Alcyonium glaucum*, and in the transverse section of *Spongodes*, in Case 4.

The *Alcyonacea* are represented in Case 4 by the fine spirit specimen of *Telesto arborea*, by the series of dried coralla (mesodermic) of *Tubipora musica*, by the spirit specimens of *Alcyonium*, *Lobularia*, and the fine series of species of *Spongodes*, and by the dry specimens and drawings of *Heliopora*. In *Spongodes* the colony has the form of a bush, in which the cœnosarc forms a root and stem and branches, and the polyps occupy the sides and tips of the branches like leaves or flowers.

In *Heliopora* the cœnenchyma has become calcified and forms a crystalline stony mass, like the coral of a Madreporarian.

In *Tubipora* the cœnenchyma consists of a mass of tubes shaped like organ-pipes.

The *Alcyonacea* mostly inhabit the reefs and rocks of shallow waters, encrusting rocks, dead coral, etc., with their fungus-like and shrub-like colonies.

ii. ANTHOZOA ALCYONIOMORPHA PENNATULACEA.

[Case 4].

In the *Pennatulacea*, which comprise the Sea-pens, Sea-feathers and Sea-rods, the polyp-colony consists of a more or less fleshy stem (cœnosarc), one end of which is buried in the mud, while at the other end are borne the polyps, either on regular bilateral overlapping leaf-like plates (as in *Pteroeides*, *Godeffroyia*, *Pennatula*, *Halisceptrum*, *Virgularia*, and *Scytalium*), or sessile on the stem in a long row or rows (*Leptoptilum*), or in a bunch at the end of the stalk (*Umbellula*), or in a head, like the radiating florets of a dahlia (*Veretillum*, *Cavernularia*). In most cases the fleshy stem is strengthened by a deposit of calcareous salts in the mesoderm, and in *Virgularia* the central axis of the stem forms a rigid rod.

Examples of all the above genera (specimens preserved in alcohol) are to be found in Case 4.

The *Pennatulacea* are mostly adapted for life on the muddy bottom of shallow seas, but *Umbellula* and *Leptoptilum* are peculiarly deep-sea forms.

iii. ANTHOZOA ALCYONIOMORPHA GORGONACEA.

[Cases 5-6].

The *Gorgonacea* include the Sea-mats and Sea-fans, and form a large group. The polyp colonies in this group consist of a hard, often horny and flexible axis, which is covered by cœnenchyma from which the little polyps protrude. Calcareous spicules are usually deposited in the cœnenchyma, so that the "coral" of the *Gorgonacea* consists of two elements—a hard or horny central

axis or core, and a spicular skin or rind. The *Gorgonacea*, like the *Alcyonacea*, are usually found encrusting coral-reefs, and rocky banks in shallow water, but they also occur in considerable abundance in the great depths of the sea up to 1,200 fathoms, and a few species have been found in the abysses of the ocean.

In Cases 5-6 the *Gorgonacea* are exhibited. Of shallow-water forms (surf-line to 40 fathoms) the following Indian genera are represented:—*Solenocaulon*, *Sclerogorgia* (*Rhipidigorgia* and *Pterogorgia*), *Melithæa*, *Mopsea*, *Isis*, *Acanthogorgia*, *Muricea*, *Paramuricea*, *Leptogorgia*, *Eunicella*, *Gorgonia*, *Juncella*, *Ctenocella*, *Gorgonella*, *Verucella*, *Scirpearella*. While of deep-sea forms fine alcoholic specimens of the following beautiful species occur:—*Strophogorgia verrilli*, *Ceratoisis grandiflora*, *Acanella fruticosa*, *Calypterinus allmani*, *Stenella*, *Thouarella*, *Callistephanus koreni*.

To these beautiful specimens, which were dredged by the "Investigator," most of them in the Laccadive Sea at about 700 fathoms, attention is particularly directed.

3. CNIDARIA SCYPHOMEDUSÆ.

[Northern end of Case 7].

The *Scyphomedusæ*, or Acraspedote *Medusæ*, are animals of the Anthozoan type modified for a free-swimming life at the surface of the ocean. They may be looked upon as Anthozoan polyps that have become converted into swimming-bells by a flattening out and cupping of the body, just as the Craspedote *Hydromedusæ* may be derived from the Hydrozoan polyp type.

In the case of the *Scyphomedusæ*, however, this metamorphosis has no special relation to reproduction, and the *Scyphomedusæ* are usually throughout the whole cycle of their existence free-swimming *Medusæ*, giving rise by reproduction not to polyp stocks, but to *Medusæ* like the parent.

The *Scyphomedusæ*, or Acraspedote *Medusæ*, besides being very much larger, differ from the *Hydromedusæ*, or Craspedote *Medusæ*, in the following essential points :—

(1) The muscle at the circumference of the medusa-bell never projects into the cavity of the bell to form a 'velum.'

(2) Instead of a velum we find the edge of the swimming-bell produced into variously complicated lobes and filaments (marginal lobes) *into which prolongations of the gastric cavity extend.*

(3) The manubrium, or gastric peduncle or oral tube, of the medusa-bell is provided with an ectodermal œsophagus or gullet, and the edge of the mouth is generally prolonged into long oral arms.

In some *Scyphomedusæ* (the *Rhizostomæ*) these oral arms become deeply grooved, and the edges at last curl over and meet to convert the groove into a tube which, however, remains unclosed at certain spots known as 'suctorial mouths." The tubes of the oral tentacles lead into the gullet, while the true mouth becomes closed.

(4) Where the ectodermal œsophagus joins the true endodermal gastric cavity special gastral filaments, or gastric tentacles, usually in tufts, are developed.

(5) Another important difference, which, however, does not hold good throughout, is that the Craspedote *Medusæ* (*Hydromedusæ*) very seldom (only in one family) give rise to secondary medusæ asexually by budding, whereas reproduction by asexual budding is not uncommon among the *Scyphomedusæ*. This is well seen in the glass model of *Lucernaria*.

(6) The sense-organs at the edge of the umbrella are always covered.

(7) The generative products arise in diverticula of the stomach, and not, as in the *Hydromedusæ* (as is so well shown in *Olindias mülleri*), from the ectoderm.

The *Scyphomedusæ* are usually free-swimmers throughout the whole of their existence, but in the family *Lucernaridæ* they are attached by their aboral pole in the adult stage.

The *Scyphomedusæ* being exceedingly delicate animals, are not easy to preserve for Museum purposes, and in this collection they are represented only by the usual glass models, and by spirit specimens of the deep-sea form *Atolla*.

4. CNIDARIA CTENOPHORA.

[Northern end of Case 7].

In the *Ctenophora* the simple polyp type is much modified, and, as in the *Scyphomedusæ*, the modification is such as to fit the animal for a freely locomotive life at the surface of the ocean. Locomotion, however, is effected not so much by the contraction of muscles as by the rowing action of special processes of the ectodermal cells known as "cilia." The cilia are collected together in rows which much resemble combs (hence the name *Ctenophora* or "comb-bearers"), and the combs of cilia are usually disposed in eight bands or meridians which pass from pole to pole of the usually spherical or ovate or helmet-shaped body. These rows of combs of cilia are very well displayed in the spirit specimens of *Beröe ovata* and *Cydippe plumosa*. The internal structure of the typical Ctenophor is not essentially different from that of the *Medusa*: the mouth leads by a much-compressed gullet into a long stomach placed crosswise to the gullet, and from this stomach a number of canals radiate throughout the body.

The sensory organ of the Ctenophors is single and is situated at the aboral pole of the body. The *Ctenophora* are very delicate animals, and are very difficult to preserve,

and are therefore seldom met with in Museum collections.

In this collection they are represented at present only by the alcoholic specimens already named, and by glass models of *Mertensia* and *Cestum veneris*.

Cestum veneris, however, is an unusual form, for the reason that its body is much compressed and elongated.

Cydippe and *Beröe* are the typical forms.

METAZOA CŒLOMATA.

We next come to the *Cœlomata*, or animals that possess a true body-cavity, or cœlom, through which the alimentary canal runs somewhat like a lamp-chimney through a lamp-globe. The cœlom is a closed cavity and lodges, besides the alimentary canal and the glands accessory to digestion, at least the organs of circulation, excretion and reproduction.

In the *Cœlomata* the differentiation of the cells of which the body is built up has become so complicated that it is only in the very earliest stages of development that the simple division into three germinal layers—ectoderm, endoderm and mesoderm—is to be verified.

In a majority of the Cœlomate phyla we are able to distinguish an anterior end or head, just behind which the mouth opens; a posterior end at which the vent opens; a ventral surface turned towards the ground upon which the animal moves, and opposite to it a dorsal surface; and in most a plane carried vertically through the body, along its whole length, from dorsum to venter divides the body into two practically symmetrical halves.

The first phylum, or family union, of the *Cœlomata* is formed by the *Platyhelminthes* or Flat-worms in which the body-cavity is imperfect and parenchymatous, and the intestine, except in the case of the one Class of Nemertines, either ends blindly or is entirely absent.

PHYLUM I OF THE CŒLOMATA.

PLATYHELMINTHES.

[Western Wall-case 46].

The *Platyhelminthes* include four natural groups, namely, (1) the *Turbellaria*, (2) the *Trematoda*, (3) the *Cestoda*, and (4) the *Nemertina*. Of these the *Cestoda* and *Trematoda* are entirely parasitic, and are therefore much degraded in form, the alimentary canal being either absent or incomplete. The only characters that are common to all four groups are that the body is flat and more or less elongated and solid, and that the nervous system is concentrated in a mass or "ganglion" at the head end. Reproduction is usually sexual, but may sometimes, especially in the larval stages, take place asexually.

1. PLATYHELMINTHES TURBELLARIA.

[Western Wall-case 46].

The *Turbellaria* are small *Platyhelminthes* with a leaf-shaped body: some live in the sea, some in freshwater, and some in damp places on land.

The main features of their organization are illustrated by enlarged drawings of *Planaria polychroa* and *Planaria lactea* and of *Cycloporus papillosus* (Case 46), in which the body-cavity is seen to be filled with parenchyma and the intestine to end blindly.

2. PLATYHELMINTHES TREMATODA.

[Western Wall-case 46].

The *Trematoda*, or Flukes, also are small *Platyhelminthes* usually with a leaf-shaped body. They are parasitic, commonly in the alimentary canal of warm-blooded vertebrates, whence they sometimes pass into the portal vein and its affluents: other forms are found in the gill-chambers of fishes, in the bladder of the frog, etc. In order

to secure their hold upon the walls of these cavities the *Trematoda* are furnished with large suckers for adhesion. The intestine ends blindly. The *Trematoda* are represented in Case 46, by specimens of *Distoma hepaticum* (the common liver fluke), and of *D. sinense*, *D. crassum*, and *D. conjunctum*. In the last of these, as well as in *D. sinense*, most of the details of the internal organization can be made out through the thin transparent body-wall.

The Flukes pass through a complicated series of larval changes, or metamorphoses, in the course of their development, the larval stages, like the adult, being parasitic.

3. PLATYHELMINTHES CESTODA.

[Western Wall-case 46].

The *Cestoda*, or Tape-worms, are *Platyhelminthes* that also are parasitic in the alimentary canal of vertebrate animals. Mouth and intestine are alike absent, the parasite being nourished by simple absorption through its soft body-wall.

A tape-worm such as *Tænia solium*, several good specimens of which are exhibited in Case 46, consists of a small head not much larger than a pin-head, followed by a long chain of joints or segments, the anterior of which, nearest the head, are very short, while the posterior increase in length as they recede from the head.

The head is the real essential part of the animal: the joints, or "proglottides" as the yare called, are to be regarded as packets of egg-cells which are constantly dropping off at the far end as the eggs ripen, and as constantly being renewed by budding immediately behind the head. This explains the fact that the segments nearest the head, being the latest formed and youngest, are the smallest while those farthest from the head, being the oldest and most mature, are the largest.

The structure of the head is not easily seen without a magnifying lens: it consists of a globular mass the apex of

which is slightly drawn out—the protuberance or "*rostellum*" being armed with a ring of hooklets—and the equatorial circumference of which is furnished with four large suckers. By careful examination all these details, except only the individual hooklets, can be recognized in the exhibited specimens. It is by the hooklets and suckers that the parasite adheres to the wall of the alimentary canal of its host. The structure of the segments or "proglottides" cannot be made apparent to the naked eye, and all that can be seen on simple inspection of a large mature proglottis is that it is a flat solid oblong mass with a prominent pore at the middle of one edge : this pore is the genital orifice.

The proglottis, in fact, is honey-combed with reproductive organs—both elements, male and female, being present in the same segment—and when it is fully mature it is little more than a packet of impregnated ova. It will be noticed that the pores are not all placed in one series along the same side of the chain of segments, but in two alternating series, on opposite sides.

A tape-worm goes through a complicated series of metamorphoses in the course of its development from the egg. The egg, after liberation from the proglottis, if it finds its way into the stomach of a (vertebrate) "host" does not forthwith develope into a tape-worm, but the resulting embryo, which is furnished with hooklets and somewhat resembles in appearance the "head" of the adult tape-worm, bores its way by means of its hooklets through the stomach of its host (first or intermediate host) until it falls into one of the blood or lymph vessels, by the stream of which it is carried often to some distant part of the body. Somewhere or other in the tissues of its first or intermediate host it lodges and, becoming encysted, is known as a *Cysticercus*, or bladder-worm. The bladder-worm may increase in size and may give rise by budding to other generations of bladder-worms, but no further development occurs within the first host. If, however, the first host be

eaten by another vertebrate animal, then the bladder-worm, when it reaches the intestine of the second host, develops into a sexually mature tape-worm such as those exhibited.

A specimen of a *Cysticercus*, or bladder-worm, is shown in Case 46.

The *Cestoda* are further represented by three fine specimens of *Tænia mediocanellata*, which differs from *T. solium* in being without the coronet of chitinous hooks.

4. PLATYHELMINTHES NEMERTINA.

[Western Wall-case 46].

The *Nemertina* are flat worms, usually of small size, although some reach gigantic dimensions, and are for the most part marine: a few, however, live on land. Unfortunately there are no specimens in the Museum collection, and we are compelled for the present to represent the Order by enlarged drawings of *Tetrastemma agricola*, a Land Nemertine from Bermuda, and of *Pelagonemertes rollestoni*, an Oceanic Nemertine, to both of which explanations are attached. The *Nemertina* are the most highly organized of the *Platyhelminthes*.

PHYLUM II OF THE CŒLOMATA.

NEMATHELMINTHES.

[Western Wall-case 46].

The *Nemathelminthes* or phylum of Non-segmented Round-worms includes three natural groups: (1) the *Nematoda* or Thread-worms, (2) the *Chætognatha*, and (3) the *Acanthocephala*. The most noticeable external character that they have in common is the elongated cylindrical body, which is devoid of appendages of any sort and tapers more or less at both ends. The great majority of the *Nemathelminthes* are parasites: they are, however, on a higher level than the *Platyhelminthes*, the body-cavity being distinct. Reproduction is sexual.

1. NEMATHELMINTHES NEMATODA.

[Western Wall-case 46].

The *Nematoda* or Thread-worms are mostly parasitic either in the intestine or in the blood-vessels of vertebrate animals. The *Nematoda* usually have a complicated development, and pass through larval stages in the tissues of one or more intermediate hosts before they reach their final sexually-mature growth in a permanent host.

In the collection specimens of the following are exhibited:—*Ascaris lumbricoides*, the common intestinal round-worm, *Ascaris* from the intestine of the dugong, *Tricocephalus dispar* and *Ankylostoma duodenale* from the intestine of man, and *Filaria medinensis* (the common guinea-worm). The exhibited dissection of a large female of *Ascaris lumbricoides* shows the nature of their internal organization.

2. NEMATHELMINTHES CHÆTOGNATHA.

[Western Wall-case 46].

The *Chætognatha* include only the two genera *Sagitta* and *Spadella*, small delicate worms found swimming free at the surface of almost all seas. An enlarged drawing of *Sagitta* is exhibited.

3. NEMATHELMINTHES ACANTHOCEPHALA.

[Western Wall-case 46].

The *Acanthocephala* include only the one genus *Echinorhynchus*, a parasitic round-worm, the head end of which is armed with a thorny proboscis by means of which the parasite maintains a firm hold on the wall of the gut of its host. Like all parasites its organization is much degraded, even a mouth and intestine being absent, the parasite as it lies in the alimentary canal of its host being nourished by simple absorption through the body-wall.

A slightly enlarged drawing of *Echinorhynchus gigas* is shown in Case 46.

PHYLUM III OF THE CŒLOMATA.

ANNELIDA.

[Western Wall-cases 43-44].

The next phylum is formed by the *Annelida,* including the Sea-worms, the Earth-worms, the Leeches, and the Wheel-animalcules, or *Rotifera.* The members of this phylum usually possess blood and blood-vessels. In most of the *Annelida* we distinguish very plainly the following external characters:—(i) a body made up of a succession of equal rings or segments, (ii) an anterior or head segment behind which is the mouth, (iii) a posterior or anal segment in which is the anus, (iv) ventral and dorsal surfaces, and (v) bilateral symmetry.

The segments behind the head are not only alike externally, but internally their contents correspond or nearly correspond,—each containing an equivalent portion at least of digestive tube, of blood-vessel, of excretory organ, and of nerve-cord.

In many *Annelida* each segment carries a pair of locomotor appendages, one on each side, which are known as "parapodia" (or foot-like organs), and each parapodium commonly consists of two elements—a dorsal element or "notopodium" and a ventral element or "neuropodium," both carrying a tuft of bristles and a finger-like process or "cirrus." This is especially well seen in the sections of the large Sea-worm—*Eunice.*

The alimentary canal usually passes straight along the body-cavity from one end to the other, and is held in place by two longitudinal folds of the membrane that lines the body-cavity—one above (the dorsal mesentery) the other below (the ventral mesentery), and by transverse partitions or "septa" which correspond to the segments. By these septa the cavities of the segments are shut off from one another.

The body-cavity contains blood, but there are also closed blood-vessels, the two principal trunks of which traverse the whole length of the body—one above (the dorsal blood-vessel) and the other below (the ventral blood-vessel). When "branchiæ," or gills, exist, as they do in most of the Sea-worms, many small blood-vessels run into them, the branchiæ in short being organs specially developed for the æration of the blood. There are special excretory organs—a pair in each segment.

The nervous system consists of a cerebral ganglion placed above the gullet, and connected, by means of a nerve-ring which embraces the gullet, with a pair of usually very closely approximated nerve-cords that run along the ventral wall of the body. This can be seen in one of the dissections of the Earth-worm in Case 44.

The internal morphological characters sketched above can be seen by reference to the dissections of the large Sea-worm *Eunice* from the Andamans, and by the several dissections of the common Earth-worm in Case 44. Reproduction is usually sexual, but many *Annelida* are reproduced asexually by budding and fission from the parent.

The *Annelida* consist of three groups or natural Classes—the *Chætopoda* or Worms, the *Rotifera* or Wheel-animalcules, and the *Hirudinea* or Leeches. Along with them we may briefly consider, as an appendix, the *Gephyrea* or unsegmented Sea-worms, the *Bryozoa* or *Polyzoa*, and the *Brachiopoda*, which along with the *Annelida*, the *Platyhelminthes* and the *Nemathelminthes* used to constitute the phylum *Vermes* of older systematists.

I. ANNELIDA CHÆTOPODA.

[Western Wall-cases 43-44].

The *Chætopoda* possess, on each segment, either paired parapodia bearing cirri and setæ and surmounted by breathing organs (branchiæ), or at least paired tufts of setæ.

A head, often surrounded with tentacles, is generally present.

The *Chætopoda* are divided into two great natural Orders, (1) the *Polychæta* or segmented Sea-worms and (2) the *Oligochæta* or segmented Earth-worms.

i. CHÆTOPODA POLYCHÆTA.

Good typical examples of Polychætous *Annelida* are the large Sea-worm, *Eunice*, from the Andaman Reefs, and the species of *Nereis* from Norway, in Case 43. In *Nereis* we find a distinct head (formed of two segments,—"prostomium" and "peristomium"), provided with tentacles, palps or feelers, and eyes. On the under (ventral) surface of the head is the mouth, from which, in one of the specimens of *Nereis pelagica*, the muscular pharynx with its chitinous hooks and its pair of large sickle-shaped chitinous jaws is seen protruded.

Behind the head comes an indefinite number of equal sized rings or segments, each of which bears, on each side, a parapodium with dorsal and ventral cirri and bundles of setæ, while above the dorsal half-section of each parapodium (notopodium) is a broad flat membranous plate—the gill-plate or branchia, by means of which the blood is ærated. On the ventral surface of each segment are seen the depressions where the excretory organs ("segmental organs"), of which there is a pair in each segment, open.

The last segment is smaller than any of the others, and in the middle of it is seen the anus with a pair of long anal cirri.

The main facts of the internal organization of the typical *Polychæta* can be made out from the lettered dissections and sections of *Eunice* from the Andamans, exhibited in Case 43.

The bundles of setæ, both ventral and dorsal, and the gill-tufts which surmount the latter, are remarkably well shown in the specimens of *Chloeia*.

The Seaworms are sub-divided into two groups according to their mode of life, namely the *Errantia* or free-

swimming *Polychæta*, and the *Tubicola* or sedentary *Polychæta*.

POLYCHÆTA ERRANTIA.

The *Errantia*, or free-swimmers, live usually in sand and mud and shallow water near the coast: some, however, inhabit the abyssal depths, and some live habitually at the surface of the ocean. In accordance with their manner of life they have a distinct head with powerful biting jaws (well seen in *Eunice*), and have well-developed parapodia and setæ for locomotion, and usually large and numerous branchiæ or breathing organs. Although freely locomotive they sometimes inhabit thin tubes, as may be seen in *Hyalinœcia*.

POLYCHÆTA TUBICOLA.

The *Tubicola* or sedentary Sea-worms live in protective tubes or shells, which they either manufacture, or actually secrete for themselves. The tubes may consist of grains of sand and stones and broken shells glued together by a sticky secretion, or of chitin strengthened with sand, etc., or of carbonate of lime. Examples of these different tubes are exhibited in Case 43.

Being sedentary, the *Tubicola* have no need of parapodia and setæ for locomotion, and these structures therefore along with branchiæ are quite rudimentary. The head is indistinctly demarcated from the rest of the body, and there are no jaws. On the other hand the anterior end of the body, which can be protruded from the tube, is provided with bundles of long thread-like tentacles which are not only used for sweeping food into the mouth, but are also organs of respiration.

These tentacles are beautifully shown in the exhibited specimens of *Cirratulus filigerus* and *Spirographis spallanzani* from the Gulf of Naples.

In the exhibited collection the *Polychæta* are represented by specimens of the following genera from Indian seas :—

Errantia—*Chlocia*, *Eurythoe*, *Aphrodita*, *Eupompe*,

Eunice, *Hyalinœcia*, the last named from the depths of the Arabian Sea.

Tubicola—*Branchiomma*, *Chætopterus*, and *Serpula*, the last named also being from the deep-sea. Besides the Indian representatives of the Order there is exhibited a fine collection of beautifully-prepared spirit specimens from the Naples Aquarium, and in **Case 47** are some glass models.

ii. CHÆTOPODA OLIGOCHÆTA.

The other order of the *Annelida Chætopoda* is formed by the *Oligochæta*, and includes the Earth-worms and River-worms.

These much resemble the *Polychæta* in that they have a cylindrical body made up of rings or segments, but they differ from the *Polychæta* in several important characters. In the first place they have no definitely demarcated head with palps and tentacles, and in the second place the segments of which the body consists never bear parapodia and branchiæ and have but few setæ and these small.

The details of the internal organization of a typical Oligochæte—the common Earth-worm—are displayed in a series of dissections in spirit in **Case 44** to which explanatory drawings are attached.

2. ANNELIDA ROTIFERA.

The *Rotifera* or Wheel-animalcules are aquatic animals of such microscopic size as to be beyond the limits of an exhibition gallery, except in the form of greatly magnified drawings.

Though externally but little resembling adult worms they have many essential characters in common with the *larval* annelid type.

The sexes are separate, and only the females attain their full organization, the males being small, being devoid

of an alimentary canal, and leading therefore only a transient life.

An enlarged diagrammatic drawing of a female Rotifer, in side view, is exhibited in **Case 44**.

3. ANNELIDA HIRUDINEA.

[Western Wall-case 44].

The third class of the *Annelida* includes the *Hirudinea* or Leeches.

The Leeches, like the Earth-worms, have a ringed and segmented body; the rings however are only external markings and must not be confounded with the "segments", for each segment consist of five rings. The segments of the Leeches differ from those of the other Annelids in being destitute of appendages (parapodia and setæ) of any kind. Locomotion is effected entirely by suckers, of which there are usually two, one at the fore end and one at the after end of the body. In the anterior sucker lies the mouth, which in some leeches is provided with three jaws disposed in Y-fashion and each armed with a saw-like series of chitinous teeth.

The nature of the internal organization of the Leeches is shown in the spirit dissections of the large Horse-leech, in **Case 44**, alongside of which is an explanatory drawing. Of the Leeches a few are marine, but the greater number live either in freshwater or in damp places on land. The marine Leeches are represented in the collection by fine specimens of *Pontobdella* from the European seas. The terrestrial leeches are represented by the following genera from India :—*Hirudo*, *Hæmodipsa*, and *Limnatis*.

The habits of the leech are proverbial.

APPENDIX TO THE PHYLUM ANNELIDA.

As an appendix to the *Annelida* we may here consider the *Gephyrea*, the *Brachiopoda*, and the *Polyzoa*, three

groups which have been classed together by Professor Ray Lankester as a distinct phylum under the name of *Podaxonia*.

The reasons why these three groups have been placed together near to the Annelida group cannot be discussed here, where it is enough to say that they follow from the fact that the larval forms of all four groups have many characters in common.

1. GEPHYREA.

[Western Wall-case 44].

The *Gephyrea*, or Spoon-worms, are entirely marine. They differ from the *Chætopoda* in not having the body segmented and in not having parapodia and setæ. *Sipunculus*, of which several specimens are exhibited in Case 44, illustrates this class.

In *Sipunculus* we see a papillated proboscis, at the end of which is the mouth-opening. The rest of the body is marked by deep longitudinal and transverse furrows, the latter dividing the body into a series of rings which, however, are only superficial and must not be confounded with the segments of Annelids.

In the Indian Seas *Sipunculus* has been found on the Andaman reefs and in the depths of the Andaman and the Laccadive Seas.

The details of the internal anatomy of *Sipunculus* can be seen in the dissected specimen, which has been laid open along the ventral surface, a little to the right of the middle line of the body. The dissection is accompanied by an explanatory drawing.

2. BRACHIOPODA.

[Western Wall-cases 44-45].

The body of the *Brachiopoda* is enclosed in a bivalve shell, something like the shell of a Mussel or of a Cockle in external appearance, and so far as mere outward resemblance goes the adult *Brachiopoda* have little likeness to

worms, near which, however, they are classed on embryological grounds.

The Brachiopod shell consists of an upper or dorsal and a lower or ventral valve, and, as may be observed in the specimens of *Lingula anatina*, is furnished at its hinder end with a long fleshy stalk, or "peduncle", by which the animal is fixed to the sea-bottom. In *Lingula* the "peduncle" simply passes out between the valves: in *Waldheimia* it passes through an aperture in the beak of the ventral shell. In a few forms the "peduncle" is wanting.

A general idea of the internal organisation of the *Brachiopoda* may be gained by a study of the lettered dissections of *Lingula anatina*. In *Lingula* the inner surface of each valve is seen to be lined by a thickened fold of the integument—the "mantle", the edge of the mantle lobes being closely fringed with "setæ". A large part of the space between the "mantle" folds is occupied by the coils of two long fringed "arms"—one situated on each side of the mouth—which function both for procuring food and as organs of respiration. At the broad fore-end of the shell is the mouth lying between the coiled up arms, and behind it the coiled intestine, embedded in a dark brown granular mass,—the liver. The rest of the cavity is filled by the great muscles which open and close the shell.

The *Brachiopoda* are all marine: they are but sparely represented at the present day, the majority of known species being fossils, many of them of great geological antiquity.

The *Brachiopoda* are divided into two groups—the *Ecardines*, represented by *Lingula*, in which the shell is not hinged and not furnished with an internal calcareous hoop for the support of the long coiled "arms", and the *Testicardines*, represented by *Waldheimia*, in which the shell is hinged and furnished with an internal calcareous hoop for the support of the "arms".

In the collection the only representatives from the Indian seas are *Lingula* and *Crania* from comparatively

shallow water, and *Terebratula* from the depths of the Laccadive Sea ; but Australian, Mediterranean, and Atlantic forms are well represented.

3. POLYZOA.

[Western Wall-cases 44-45].

The *Polyzoa* are small animals which bud asexually, like many of the *Hydrozoa* and *Actinozoa*, to form branching or encrusting shrub-like or moss-like colonies. Some live in freshwater, but the majority are marine. The colonies are supported and protected by a horny (chitinous) or calcareous exoskeleton formed by the hardening of the outer layer of the ectoderm of their units or zooids. It is these horny and seaweed-like, or calcareous and coral-like, exoskeletons, denuded of their occupants, which form the majority of museum specimens of *Polyzoa*.

A good example of a Polyzoon colony is the specimen of *Retepora* in Case 45. This is seen to be an encrusting branching lichen-like mass, the thin leaves of which are formed of carbonate of lime and have the texture of a very fine lace with very regular meshes. The meshes of the lace-work are the openings of chambers which, during life, were occupied by the *Polyzoa* zooids. The colony, in short, consists of myriads of these little chambers, all shut off from one another, in each of which dwelt a small animal, or zooid, of the shape and structure shown in the enlarged diagrammatic drawing alongside of the specimen ; and each little chamber was formed simply by the calcification of the cuticle of its occupant. During life the zooids ordinarily extrude their head and tentacles from the openings of the chambers, as shown in fig. 1, but they are able, when alarmed, to completely withdraw within the chambers, and sometimes to close the orifice, as shown in fig. 2.

In many of the Polyzoa colonies a division of physiological labour occurs, with the result that some of the zooids lose all resemblance to the typical form. Certain of them become transformed into structures resembling a bird's head, and these, which are known as *avicularia* and are

shown (enlarged) in fig. 3, by a continual snapping action seize and hold the animalcules that form the prey of the colony. Others become transformed into long lashlike filaments, known as *vibracula* (fig. 4), which also serve the colony by sweeping prey into the mouths of the ordinary zooids.

The *Polyzoa* of the Indian Seas have not as yet been systematically investigated. Many of them appear to be identical with well-known European forms, a fact that is easily explained when it is remembered that *Polyzoa* habitually encrust the bottoms of ships, and are thus likely to be widely distributed along frequented lines of navigation.

In the exhibited collection of Indian *Polyzoa* specimens of the following genera are included:—*Cellularia*, *Retepora*, and *Cellepora*.

As already stated, the majority of the *Polyzoa* are marine. They incrust rocks, dead coral, etc., and thus contribute considerably to the growth of reefs. They also incrust all sorts of floating drift. The larvæ are free-swimming.

PHYLUM IV OF THE CŒLOMATA.

ARTHROPODA.

[Cases 37—42 along Northern wall, 48—63 along Western wall, 64—69 along Southern wall, and Desk-cases 70—125].

The great phylum of the *Arthropoda* includes the remarkable form *Peripatus*, the *Myriapoda* (Centipedes), the *Hexapoda* (Insects), the *Crustacea*, and the *Arachnida* (Spiders and Scorpions). It contains an immense number of species, far more in short than all the species of all the other phyla put together.

In their general plan of structure the *Arthropoda* resemble the *Annelida* proper, and the main groups of the

latter phylum, namely the *Rotifera* and *Chætopoda*, have been classed with the *Arthropoda* by Professor Ray Lankester as a single phylum under the name *Appendiculata*; the two phyla resemble each other in the prime fact that they are alike made up of a repetition of rings or segments (somites), but whereas in the *Annelida* the segments, with the exception of the two which form the head and the one which forms the posterior limit, are all very nearly alike and equivalent in function and structure, in most of the *Arthropoda* the segments differ in function, and consequently in structure, in the different regions of the body. Instead of a body constructed of a succession of nearly similar rings or segments, we now find in the adult Arthropod, a body in which the segments usually fall into three dissimilar groups or regions—a head region, a thorax region, and an abdominal region—and even within the limits of any one region, but especially in the regions of the head and thorax, the constituent segments may differ from each other. Another important morphological difference between the *Annelida* and the *Arthropoda* is that in the *Annelida* the segmental (locomotor) appendages, when they exist, are unjointed, whereas in the *Arthropoda* these appendages, or limbs, are built up of a succession of different pieces all movably jointed together—from which fact the name *Arthropoda* is derived, *viz.*, "joint-footed" animals, or animals with jointed legs. A third less important and less constant difference, which relates to the manner of life, is that the *Annelida* usually have soft bodies, while the body and limbs of the adult Arthropod are generally encased in an armour of chitin.

The head region of the Arthropod consists of several segments which are often fused together, their appendages being modified to form sensory organs (or antennæ), and biting and chewing organs (or mandibles and maxillæ).

The thorax region, which lies behind the head and is often fused with it to form a cephalothorax, also consists of several intimately fused segments, the appendages of

which usually preserve their purely locomotor function and structure, but are sometimes modified for prehension, and even for the mastication of food.

The abdominal region forms the posterior part of the body and consists of numerous segments, which are but little modified in form, and are in some groups (*e.g.*, the Insects and Spiders and some *Crustacea*), quite devoid of appendages.

The alimentary canal has very much the same general form that it has in the *Annelida*, as has also the nervous system ; and this can be verified by inspection of the lettered dissectio ns in Case 54, which is occupied entirely by preparations illustrating the internal morphology of the *Arthropoda*. The nervous system of the Arthropod is, however, much more highly developed, and sense-organs (feelers or antennæ, eyes, olfactory and auditory organs) are usually present. The breathing organs differ greatly in the different groups : in *Peripatus*, in the Centipedes, and in the Insects, air is taken in through numerous small tubes, known as tracheæ, which open to the exterior at various places on the surface and ramify throughout the tissues of the body : in the Spiders air usually passes in and out of pocket-like depressions known as pulmonary sacks : in the *Crustacea* breathing is effected by means of gills. The different forms of breathing organs—tracheæ, pulmonary sacks and gills—are specially shown in several preparations in Cases 54, 60, 62 and 63.

The blood, which is colourless, commonly circulates in a distinct system of blood-vessels, and is often propelled by a contractile heart which is placed in the dorsal half of the body, as is shown in the dissection of the common Crab, and common freshwater Shrimp in Case 54.

Reproduction is usually sexual, but many forms of asexual reproduction occur among the *Arthropoda*, especially in the Class of Insects.

I. ARTHROPODA CRUSTACEA.

[Cases 37—42 Northern end 48—55 Western wall, and 64—69 Southern end].

The *Crustacea* are Arthropods that breathe by means of gills.

A majority of them live in the sea, but many species inhabit fresh-water, and some live on land.

The ringed or segmented nature of the body is generally very apparent, and most of the rings or segments carry a pair of jointed appendages which are variously modified in different regions of the body for feeling, for biting and chewing, for prehension, for crawling, and for swimming.

A good general idea of the external structure of a typical Crustacean can be gained by examining the large Prawn in Case 49, in which all the segments of which the body is made up are, as far as is possible, disjointed from one another, and laid out in succession with their appendages. The *Crustacea* are usually encased in a stout "shell", or exoskeleton, formed by the hardening of the superficial layer of the integument: this shell is periodically cast off or moulted *en masse*, to be again soon renewed.

In many, or in most, *Crustacea* the main developmental changes, instead of being completed within the egg, are continued long after the young one has left the egg and has started an independent life, the final form being reached only after a succession of moults or "metamorphoses": so that the young when first hatched is quite unlike the adult.

The *Crustacea* fall into two divisions—the *Entomostraca* which are for the most part small lowly-organised aquatic species, with a body made up of an inconstant number of segments or somites; and the *Malacostraca* which are for the most part large, highly-organised species, both aquatic and terrestrial, with a body made up of a constant definite number of somites, each one usually with

its pair of appendages. The curious form *Nebalia* is a link between these two divisions.

a. CRUSTACEA ENTOMOSTRACA.

[Western Wall-case 48].

As the *Entomostraca* are for the most part minute, and can be properly examined only under the microscope, they occupy but an unimportant place in the Museum Gallery and cannot, therefore, be treated of at any length here.

There are four orders of the *Entomostraca*—namely, the *Phyllopoda*, the *Ostracoda*, the *Copepoda*, and the *Cirripedia*.

The species which constitute the three first-named of these orders are almost all too minute for exhibition.

i. CRUSTACEA ENTOMOSTRACA PHYLLOPODA.

The *Phyllopoda* are represented in Case 48, by two species of *Apus* from Europe.

In *Apus* the body is made up of a large number of ring-like segments, the first twenty or more of which are covered over dorsally by a large shield-shaped carapace, and bear each a pair of bilobed leaf-like feet; while the last five or six are uncovered and are devoid of appendages, and project behind in the form of a short ringed cylindrical tail which ends in a long fork. At the front of the carapace are seen the large eyes.

ii. CRUSTACEA ENTOMOSTRACA OSTRACODA.

The *Ostracoda* are marine forms usually of a size far too small for exhibition. To illustrate their size some specimens of *Cypridina* are shown in Case 48.

iii. CRUSTACEA ENTOMOSTRACA COPEPODA.

The *Copepoda* inhabit both salt-water and fresh-water, and they also are for the most part toos mall for exhibi-

tion. Some of them live as parasites on fishes, and one of these parasitic forms is exhibited, with the front end of its body embedded in the tissues of its host,—a fish of the genus *Macrurus*. It must be remembered, however, that this species, being a parasite, has undergone great degeneration and has retrograded greatly from the typical Copepod form. A more typical form is *Cyclops* shown in Case 48.

iv. CRUSTACEA ENTOMOSTRACA CIRRIPEDIA.

The *Cirripedia* are well known to sea-farers as Acorn-shells and Barnacles, and in external appearance are quite unlike Crustaceans, being commonly enclosed in a multivalve calcareous shell, somewhat resembling that of a Mussel, which is fixed to foreign objects, often by means of a long fleshy stalk. It is by following out their developmental changes that their Crustacean affinities are clearly proved, for the young, or larval, Cirriped, far from being fixed, is freely locomotive, and in all important particulars resembles the early larval form of the Prawn: it has eyes, antennæ, and swimming-feet, but with increasing growth it fixes itself by means of its antennæ and by a substance secreted by certain glands, known as cement-glands, which open at the base of the antennæ: after attachment it loses its eyes, antennal filaments, and swimming-feet, and developes forked cirriform feet and an external shell. The adult Cirriped is thus immovably fixed, head and mouth downwards, with its forked cirriform feet protruding between the valves of the shell behind, the feet being used to sweep currents of water containing food and oxygen towards the mouth.

The internal structure of a typical Cirriped can be seen from the dissections of *Scalpellum* in Case 48.

A few of the *Cirripedia* are parasitic. One of these parasitic forms is shown in the specimen of *Sacculina* parasitic on the abdomen of a crab. *Sacculina*, as a result of its parasitic habits, has retrograded to such an

extent as to have lost all resemblance, not only to its Crustacean relatives, but to an animal of any sort,—all its organs, except its genital glands, have degenerated and atrophied, and in its final stage it is, as the exhibited specimen shows, a mere shapeless bag of eggs.

The sexes in the *Cirripedia* are commonly united in the same individual, but in some genera, of which *Scalpellum* is one, there are also what are called "complemental males" which attach themselves like parasites to the hermaphrodites. One of these small parasitic complemental males is seen in one of the exhibited dissections of *Scalpellum*.

The *Cirripedia* are represented in Case 48 by *Scalpellum* and *Verruca* from the depths of the Andaman Sea and by *Lepas* and *Conchoderma* from the German Ocean.

b. CRUSTACEA MALACOSTRACA.

[Cases 37—42, 49—55, 57, 59, 64—69].

There are six orders of Malacostracous Crustaceans—*Amphipoda*, *Isopoda*, *Cumacea*, *Stomapoda*, *Schizopoda*, and *Decapoda*—all of which are represented in the exhibited collection.

In the *Malacostraca* the body consists typically of 21 segments, all of which, except the last, bear a pair of jointed limbs. From these 21 segments, however, some zoologists exclude the segment that bears the eyes, and others exclude the terminal limbless segment or telson—thus reducing the number to 20, or to 19.

Of these 21 segments six are always immovably fused together to form a head, the limbs or appendages of which are known in order from before backwards as eye-stalks, antennules, antennæ, mandibles, first maxillæ, and second maxillæ. Of the remaining 15 segments eight form the thorax and are often more or less fused together and to the head to form a cephalothorax, and their limbs or appendages are modified to form foot-jaws and prehensile (often pincer-like), or walking, or rarely swimming, legs :

there are usually three pairs of foot-jaws or maxillipeds, and five pairs of legs. The last seven segments (abdominal segments) are almost always separate and distinct, and all but the terminal one usually carry a pair of swimming or jumping feet: the terminal limbless segment is known as the "telson."

Gills are borne on either the thoracic or the abdominal limbs.

The nature and typical arrangement of the segments, and of their appendages, should be studied in the disarticulated specimens of *Nephrops*, *Penæus*, *Scylla*, *Cenobita*, and *Squilla*, in Case 49.

i. CRUSTACEA MALACOSTRACA AMPHIPODA.

[Western Wall-case 50].

The *Amphipoda* are usually very small Crustaceans, and are not therefore adapted for exhibition in the Gallery. Some of the deep-sea species, however, are comparatively gigantic, and a specimen of one of these—*Andania*, dredged in the Bay of Bengal at a depth of 1,997 fathoms—is exhibited in Case 50.

Some of the *Amphipoda* live in freshwater, but the great majority are marine. In the *Amphipoda* the eyes are never stalked. Of the thoracic segments seven are almost always separate and distinct from one another and from the head.

The nature of the Amphipod body should be studied in *Andania*.

The following genera from Indian waters are exhibited:—*Andania*, *Rhabdosoma*, *Caprella*, besides a few species from Europe and New Zealand.

ii. CRUSTACEA MALACOSTRACA ISOPODA.

[Western Wall-case 50].

The *Isopoda* include the familiar Woodlice, and are small Crustaceans, some of which inhabit dry land and some

fresh-water, but the majority of which are marine. A good many of the marine species are parasites and are more or less degraded in form.

The *Isopoda* are usually small, but one of the deep-sea species—*Bathynomus giganteus*, two specimens of which are exhibited in Case 50, is of relatively gigantic proportions, one of the exhibited specimens being over eight inches long.

Particular attention should be paid to these magnificent specimens of *Bathynomus*, as they exhibit on such a unique scale the typical form of the body and appendages of the *Isopoda*, showing (1) a head made up of six (five) segments fused together to form a single ring and bearing a pair of sessile eyes, a pair of short antennules, a pair of longer antennæ, a pair of mandibles, and two pairs of maxillæ; (2) a thorax of eight segments, the first of which, bearing a pair of foot-jaws, is fused with the head, while the remaining seven are separate and distinct rings, each of which carries a pair of many-jointed crawling legs; and (3) an abdomen made up of seven segments, the first five of which are separate and carry each a pair of broad membranous bilobed paddles, while the last two are fused together to form a broad telson with a single pair of two-bladed swimming paddles: upon each lobe of each of the first five pairs of abdominal appendages can be seen a branching feathery gill.

Besides *Bathynomus* the following Indian genera are represented in the exhibited collection:—*Cymothoa*, *Ceratothoa*, *Nerocila*, *Anilocra*, *Idotæa*, *Cleantis*, *Ligia*, *Bopyrus*, and *Armadillo*, the last being a terrestrial species.

Bopyrus is parasitic in the gill-chamber of prawns, and the males are of minute size and further attach themselves as parasites to the abdomen of the female. This is well seen in the two exhibited specimens, in one of which the tiny male is shown alongside the female, while in the other the male is seen attached in its natural position.

In addition to the above there is exhibited a handsome specimen of *Arcturus cornutus*, Beddard, from the depths of the Andaman Sea.

iii. CRUSTACEA MALACOSTRACA CUMACEA.

[Western Wall-case 54].

The *Cumacea* is a small order of small Crustacea which have a resemblance to some of the larval forms of the *Decapoda*.

This very limited order is represented in the Gallery by a small specimen of *Diastylis* from Norway.

Alongside of this specimen are shown for comparison some larvæ of a prawn (*Penæus*) in the *Mysis* stage.

iv. CRUSTACEA MALACOSTRACA STOMAPODA.

[Western Wall-cases 49 and 52].

In the *Stomapoda* the abdominal region is greatly developed, forming a powerful swimming "tail", its appendages having the form of broad two-bladed swimming plates.

The segmental structure of this Order is so well displayed in the large dissected specimen of *Squilla raphidea*, in Case 49, that no further explanation is here required. Observe that the first five pairs of thoracic limbs form powerful chelate foot-jaws, those of the second pair being of predominant size and being used for seizing and holding prey.

In the spirit specimens observe the feathery gill-tufts on the abdominal swimming plates.

The *Stomapoda* are all marine, and are specially abundant in the seas of the tropics: they are excessively predaceous, seizing their prey with the second pair of thoracic limbs, which on account of their great size and terrible armature are known as the raptorial claws.

In their growth they pass through several metamorphoses, and even the later larval stages differ so much from the adult that they were originally taken to belong to a different genus, one of which was described as *Erichthus*. Several specimens of *Squilla* in the *Erichthus* stage are exhibited.

The *Stomapoda* are represented by specimens of the following genera :—*Squilla*, *Lysiosquilla*, *Chloridella*, *Pseudosquilla*, *Protosquilla*, *Gonodactylus*.

v. CRUSTACEA MALACOSTRACA SCHIZOPODA.

[Western Wall-case 54].

The *Schizopoda* have a complete outward resemblance to prawns, but they differ from the prawns and their relatives in the form of the thoracic limbs, all of which are forked from near the base—hence the name of *Schizopoda* or cloven-footed Crustaceans.

The *Schizopoda* are mostly small, but some of the deep-sea forms are as large as a small prawn. In the exhibited collection they are represented by fine specimens of *Gnathophausia* and *Eucopia* from the depths of the Bay of Bengal.

In *Gnathophausia* the external structure of the Schizopod body can be very well seen.

vi. CRUSTACEA MALACOSTRACA DECAPODA.

[Cases 37—42, 49, 51, 53, 55, 64—69].

The Decapod Crustaceans include the two great groups of the Lobsters and Crabs, along with a third intermediate group typified by the Hermit-crabs.

All three groups are essentially alike in structure, and the chief distinction between them is to be found in the relative size and functional importance of the abdomen. In the Lobsters the abdomen is as well developed as any other region of the body, and forms a powerful symmet-

rical swimming "tail": in the Crabs the abdomen is rudimentary, is carried tucked up out of sight beneath the thorax, and lodges only the hinder end of the intestine: while in the Hermit-crabs the abdomen is in an intermediate condition, being useless as an organ of locomotion, asymmetrical, soft, and liable to injury, but being of considerable size, and lodging several important organs.

In all the Decapod *Crustacea* the body is made up of twenty-one segments, if we include the region that carries the eye-stalks and the telson as such, and the first fourteen are almost always immovably fused together to form a cephalothorax, the back of which is known as the carapace, and the sides of which are expanded outwards and downwards to form a gill-chamber. Of the paired appendages of these fourteen segments, the first are eyes borne on long stalks, the second are antennules fringed with hairs which are probably organs of smell (also in the base of the antennules the organ of hearing is lodged), the third are long antennæ or feelers, the fourth are mandibles or biting-jaws, the next five pairs are closely crowded together on each side of the mouth and are modified to form chewing-jaws, or maxillæ and maxillipeds, while the last five are many-jointed crawling feet, some or all of which may end in powerful nippers, or chelæ. The first pair of thoracic legs usually end in nippers of great size and are known as "chelipeds". In a few forms the one or two last pairs of crawling legs are rudimentary or absent.

The abdomen consists of seven segments, the structure of which will be subsequently considered.

In connexion with the appendages the breathing-organs, or gills, must be noticed: they are sometimes feather-like, but much more commonly brush-like structures attached to or near to the bases of a certain number of the thoracic appendages on each side, and enclosed in a gill-chamber formed by the lateral extensions of the carapace already mentioned. The water with its dissolved oxygen usually passes into the gill-chamber from behind, and after bath-

ing the gills and giving up its oxygen, passes out at the fore end of the chamber, a continuous current from behind forwards being kept up not merely by the movements of the legs but by a special "baling-out scoop" or *scaphognathite*, attached to the second pair of maxillæ. Similar baling and sweeping organs are often attached to the maxillipeds, as is well seen in the disarticulated specimen of the crab *Scylla serrata*. The nature and arrangement of the gills as well as of the digestive system, of the circulatory system (heart, etc.), and of the nervous system, should be observed in the dissected spirit specimens of *Scylla*, *Palaemon*, *Palinurus*, *Penæus* and *Nephropsis*, in Case 54, in which is also shown the stomach of a large crab laid open to display the gastric teeth and gastric hairs.

α. DECAPODA MACRURA.

[Cases 37—41, 49, 53, 55].

This sub-Order includes the Shrimps, Prawns, Lobsters, Crayfish, etc.

For a general idea of the structure of a typical macrurous or long-tailed Decapod Crustacean, the disarticulated specimen of one of the common Indian prawns (*Penæus indicus*) in Case 49 should be studied.

Comparing this with the specimen of the common Indian edible crab (*Scylla serrata*) alongside, we find that the Prawn differs from the Crab in having a long and large abdomen or "tail", every segment of which, except the last, carries a pair of swimming-legs, and that the legs of the last segment but one are expanded to form with the last and legless segment a powerful fin or "swimmeret."

Other differences easy to notice are that the third pair of foot-jaws or maxillipeds in the Prawn are slender and claw-like, and that the carapace is prolonged anteriorly into a long pointed "rostrum."

The Macrurous Decapods form a large sub-Order, most of the members of which are marine, though a considerable number inhabit rivers and other fresh-waters.

The marine forms are found in every kind of region, from the Arctic shores to those of the Equator, from tide-mark to the deepest abysses, from creeks and backwaters to the open expanses of the ocean; and they are found in all situations, burrowing in the sand and mud, hiding in crevices in rocks and under stones, sheltering amid branching colonies of the Sea-firs, Sea-mats, etc., flitting near the surface of the ocean, or swarming near the bottom.

Of the numerous tribes and families into which the Decapod *Macrura* are subdivided, the following are represented in the Gallery:—

1st Tribe, Thalassinidea, Case 41.—Two families are represented, the *Thalassinidæ* and the *Callianassidæ*.

The **Thalassinidæ** include the single genus *Thalassina*, one of the few species of which, *Thalassina scorpionoides*, is common in Indian estuaries, where it lives in deep burrows tunnelled in the mud. Observe the long narrow tail already beginning to show signs of degeneration, and the small degenerated eyes.

The **Callianassidæ** are small burrowing Crustaceans found in the sand usually between tide-marks, but often at great depths. Specimens of *Callianassa*, *Callianidea*, *Gebia*, and *Gebiopsis* are shown in the Gallery, all of them having been taken in Indian waters. In both of these families the carapace is short and the "tail" long, and the pincers of the thoracic legs are imperfectly developed, forming "subchelæ."

2nd Tribe, Scyllaridea or Loricata, Cases 41 and 53.

This tribe includes two families, the *Scyllaridæ* and the *Palinuridæ*, both of which are represented in the Gallery.

The **Scyllaridæ** have a broad flattened crab-like carapace, and the antennæ (second pair) form flat warty plates. None of the thoracic legs are in the form of pincers or

chelæ, but all end in simple claws. Three genera are met with in Indian Seas—*Scyllarus*, *Thenus*, and *Ibacus*, specimens of all of which are to be seen in Cases 41 and 53.

The Palinuridæ much resemble Lobsters at first sight, but they differ from the Lobster in not having chelæ,—all the thoracic legs ending in simple claws. One genus, or subgenus, *Panulirus* is very common in Indian Seas, off rocky coasts, and in the neighbourhood of coral islands. Notice the specimen of *Palinurus* (*Panulirus*) *ornatus* with one side of the carapace removed to display the gills, (Case 54).

3rd Tribe, Astacidea, Case 40.—This tribe includes the Lobsters, and contains four families, all of which are represented in the Gallery, though only two, the *Eryontidæ* and *Nephropsidæ*, are to be met with in Indian Seas.

The recent Eryontidæ are entirely confined to the great depths of the sea: the carapace is depressed, and in correlation with the fact that they live at great depths to which sunlight cannot penetrate, the eyes are rudimentary or absent: except in the males of one genus all the thoracic legs end in chelæ. In the Indian Seas the *Eryontidæ* appear to be fairly common at depths of from 500 to 1,500 fathoms. Specimens of three genera *Polycheles*, *Pentacheles*, and *Willemœsia*, are exhibited, all of which were dredged by the officers of the Indian Marine Survey.

The Nephropsidæ or Lobsters proper, are, as far as the Indian fauna is concerned, to be found only in deep water (175 to 250 fathoms), although in other regions they occur in shallow water. The Indian genera are *Nephrops* and *Nephropsis*, fine specimens of which are exhibited along with Lobsters from the European and Japan Seas. In *Nephrops* the eyes are of enormous size, while in *Nephropsis* they are the merest rudiments. This contrast illustrates the fact that when animals live at moderate depths to which a certain amount of sunlight can penetrate, their eyes often become increased in size to profit by all the

light that exists; but when they live at great depths to which no sunlight penetrates, their eyes, being then of little or no use, often become atrophied.

The fresh-water Lobsters, or Crayfish do not occur in India, and all the exhibited specimens of these two families come from Europe and Australia.

4th Tribe, Penæidea, Case 39.—This tribe includes the Prawns and contains, two families, the *Sergestidæ* and the *Penæidæ*.

In the Sergestidæ the fourth and fifth pairs of thoracic legs are rudimentary or absent. *Sergestes* is the only genus of the family represented in the Gallery, the specimens having been taken at great depths in the open part of the Bay of Bengal.

The Penæidæ form a very large family, the members of which have the abdomen very long and well adapted for swimming: very commonly the first three pairs of thoracic legs end in pincers. The female does not carry her eggs about with her when laid. Many *Penæidæ* are gregarious, living in swarms at the bottom of the sea: such is the case with *Penæus*, *Solenocera*, and *Aristæus*. The *Penæidæ* are very well represented by numerous specimens of the following genera, all from the Indian Seas—*Stenopus*, *Penæus*, *Crotalocaris*, *Aristæus*, *Aristæopsis*, *Gennadas*, *Hemipenæus*, *Hymenopenæus*, *Metapenæus*, *Haliporus*, and *Solenocera*. Some species of the deep-sea genus *Aristæus* are brilliantly luminous.

5th Tribe, Caridea, Cases 37 and 38.—This great tribe includes the Shrimps and "fresh-water Prawns," and contains a very great variety of forms, which have been arranged in a great number of families.

In the *Caridea* there are never more than two pairs of pincer-like thoracic legs, and the eggs when laid are usually carried about by the female, attached to her abdominal swimming-legs, until they are hatched.

The following families are illustrated in the Gallery:—

1st Family, Crangonidæ, Shrimps: the single genus *Crangon* is found in Indian Seas on sandy bottoms and in deep water. Two species of Indian Shrimps are exhibited.

2nd Family, Glyphocrangonidæ: the genus *Glyphocrangon* is commonly dredged in the Bay of Bengal and Andaman Sea at depths of about 200 fathoms. In the beautiful specimens exhibited notice the huge eyes which seem to be specially developed to catch the very small amount of sunlight that penetrates to the depth at which these animals live, just like the large eyes of owls and other twilight-loving animals.

3rd Family, Alpheidæ: two genera *Alpheus* and *Athanas* occur in Indian waters. *Alpheus* is exceedingly common in the reefs of the Andaman and Laccadive Islands, living usually in pairs, male and female, in crannies in the rocks, in the cavities of sponges, corals, etc.

4th Family, Psalidopodidæ: one genus *Psalidopus* has been dredged in the Andaman Sea at depths of 400 to 500 fathoms. To this great depth no sunlight can penetrate, and it is not surprising therefore to find that *Psalidopus* has the eyes reduced to mere rudiments. The first pair of thoracic legs is peculiar in ending, not in pincers, but in two blades, which cut across each other like scissors.

5th Family, Hippolytidæ. To illustrate this family specimens of the genus *Hippolyte* are shown, being the only form that occurs in the Seas of India.

6th Family, Pandalidæ. Fine specimens of the genera *Pandalus, Dorodotes*, and *Heterocarpus*, all from the depths of the Indian Seas, are exhibited. *Heterocarpus* is highly luminous.

7th Family, Pontoniidæ. This family is represented by specimens of a *Pontonia* which lives in pairs, male and female, within the shell of the large bivalve Mollusk *Tridacna*.

8th Family, Acanthephyridæ. The curious *Hoplophorus* which has the antennal scale sharply pointed and serrated along the edge, *Ephyrina*, and *Acanthephyra*, belong to this family. All come from great depths.

9th Family, Palæmonidæ. Fresh-water Shrimps. Observe the gigantic male specimen of *Palæmoncarcinus* from Trivandrum, the second pair of legs of which (in the male only) are more than twice the length of the body.

10th Family, Nematocarcinidæ. *Nematocarcinus* with its long legs ending in brush-like tufts is found in the great depths of the Bay of Bengal.

11th Family, Pasiphaidæ. *Pasiphäe*, *Parapasiphäe* and *Psathyrocaris* all come from the depths of the Sea.

Several other families of *Caridea* exist but are not, as far as is known, represented in the seas or rivers of India.

β. DECAPODA BRACHYURA.

[Cases 49, 51, 64—69].

This sub-Order includes the Crabs.

The *Brachyura* differ from the other *Decapoda* in the great development and concentration of the cephalothorax, and in the rudimentary character of the abdomen.

The abdomen, the segments of which are small and are usually more or less fused together, is bent up beneath the thorax: in the male it usually carries but two pairs of very rudimentary feet, and although in the female there are four pairs of hairy biramous feet, these are of no use in locomotion and are only used in the breeding season to carry the developing eggs. The eyes are lodged in distinct

orbits, and there are cavities into which the short antennules can be folded. The maxillipeds have lost their foot-like appearance, and the last (third) pair have the basal joints expanded to form complete doors in front of the mouth.

The disarticulated specimen of the common Indian edible crab (*Scylla serrata*) in Case 49 should be carefully compared with the neighbouring disarticulated specimens of *Penæus* and *Nephrops*.

The majority of the Crabs are marine, but there are numerous fresh-water species, and a good many species live entirely on land quite remote from either sea or river.

The great majority of the marine species are found within the hundred-fathom line, and although about sixty species have been dredged at greater depths, only two or three have been taken in water over a thousand fathoms deep.

The *Brachyura* are subdivided into five tribes—*Cyclometopa*, *Catometopa*, *Oxyrhyncha*, *Oxystomata*, and *Anomala*, the last presenting a considerable resemblance to some of the *Anomura*, *e.g.*, to the *Hippidæ*.

1st Tribe, Cyclometopa. Cases 65-67.—This tribe includes the common edible crabs, the swimming crabs, and the common Indian fresh-water crabs. The carapace is generally very much broader than long, and often forms a wide nearly semicircular arch in front: the chelæ are usually very large and powerful. Many of the members of this tribe reach a large size, and most of them are very bold and active. They are arranged in numerous families, five of which are well represented in the Gallery.

1st Family, Cancridæ.—Chiefly reef-loving crabs.—Specimens of the following Indian genera are exhibited: *Carpilius*, *Atergatis*, *Lophactæa*, *Lophozozymus*, *Actæa*, *Xantho*, *Chlorodius*, *Euxanthus*, *Epixanthus*, *Panopeus*, *Chlorodopsis*, *Zozymus*, *Etisus*, *Leptodius*, *Pseudozius*, *Heterozius*, *Pilumnus*, *Actumnus* *Menippe*, *Eudora*.

2nd Family, **Trapeziidæ**—with the exception of *Eriphia*, the *Trapeziidæ*, are small crabs found usually esconced in coral-stocks. The Indian genera exhibited are *Eriphia*, *Trapezia*, *Quadrella*, and *Cymo*.

3rd Family, **Portunidæ**—large, fierce, marine crabs with the last pair of thoracic legs forming broad paddles for swimming. They swim sideways with great rapidity with one of the big chelæ fully extended in front. The following common Indian marine genera are shown:—*Achelous*, *Scylla*, *Neptunus*, *Thalamita*, and *Goniosoma*.

4th Family, **Podophthalmidæ**. *Podophthalmus vigil*, Fabr. (Case 65) with eye-stalks of enormous length, is the only Indian representative of this family.

5th Family, **Telphusidæ**.—This is a very large family as regards species, all of which however fall into two genera—*Telphusa* and *Paratelphusa*,—both of which are largely exhibited. The *Telphusidæ* live in fresh-water, and are very common in rivers and ponds in India. It should be mentioned that by several authorities the *Telphusidæ* are placed in the next tribe, of *Catometopa*, and by all are regarded as in many respects intermediate in structure between the two tribes.

2nd Tribe, Catometopa, Case 69.—The members of this tribe are characterised by having the front part of the carapace bent downwards: some live entirely on dry land, some frequent the muddy flats of estuaries, and some are marine.

The Catometopes form four families, all of which occur in India.

1st Family, **Gecarcinidæ**:—Land-crabs.—Specimens of three genera, *Gecarcinus*, *Cardisoma*, and *Hylæocarcinus*—are shown in Case 69—the last

two are very common in the jungles of the Andaman Islands.

2nd Family, Ocypodidæ—Largely shore and estuarine crabs burrowing in the sand and mud; a few species inhabit deep water. The Indian genera shown are *Ocypoda*, *Gelasimus* and *Macrophthalmus*.

The *Ocypoda* live together in "warrens" on the seashore of tropical countries, and derive their name from their wonderful swiftness of foot. Some species possess stridulating organs. *Gelasimus* also lives in "warrens" among the mud flats of tidal creeks and estuaries. The males of *Gelasimus* have one of their chelæ not only enormously magnified, for the purpose of fighting in the periodic contests that occur for the possession of the females, but also beautifully coloured, apparently for the purpose of attractive display before the females. Observe the dried specimens of *Gelasimus annulipes*, Edw., in Case 51 in which this wonderful, difference between the male and the female is contrasted.

3rd Family, Grapsidæ—largely rock and reef-haunting crabs. The genera *Grapsus*, *Goniograpsus*, *Cyclograpsus*, *Varuna*, *Sesarma*, *Metasesarma*, *Plagusia*, all from the Indian Seas, represent this family in the Gallery. Most of the *Grapsidæ* are extremely bold, active and alert.

4th Family, Pinnotheridæ—Small and often soft-shelled crabs, many of which are commensal with Mollusks and Echinoderms. The genera *Xanthasia* and *Hymenicus*, both found in the Indian Seas, illustrate this family.

3rd Tribe, Oxyrhyncha, Case 64.—This tribe, as its name of Oxyrhynch or "Sharp-nose" implies, is characterised by having the carapace prolonged in front into a sharp spine somewhat like the "rostrum" of a prawn. Very many of the Oxyrhynchs have a globular and relatively small carapace, together with long slender legs, and hence

are popularly known as Spider-crabs. The Oxyrhynchs are, for the most part, timid and inoffensive crabs trusting to their spiny integument for protection from their enemies, or else bedecking their carapace with fragments of sponge and coralline etc., for concealment.

Three families of the *Oxyrhyncha* are represented in the Gallery:

1st Family, Inachidæ.—Typical Spider-crabs, several species of which live at considerable depths. To this family belongs the gigantic *Macrocheira kæmpferi* from Japan, a specimen of which is exhibited beside Case 64. The genera from the Indian shallow seas are *Huenia*, *Doclea*, *Egeria*, and from the depths the huge *Platymaia*, *Echinoplax*, *Encephaloides*, *Anamathia*, *Pugettia*, *Oxypleurodon*.

2nd Family, Maiidæ.—The genera *Chorinus*, *Mithrax*, and *Micippa*, of which specimens are exhibited in Case 64, are found on the reefs of the Indian Seas.

3rd Family, Parthenopidæ.—The genera *Lambrus* and *Parthenope* are common in the Bay of Bengal at depths of 20 to 60 fathoms. Observe the great length of their chelipeds and the wonderful sculpturing of their carapace.

4th Tribe, Oxystoma, Case 68.—In this tribe the mouth-frame, instead of being square as it is in other crabs, is triangular, and is often produced in front to a point, whence the name Oxystome or "Sharp-mouth": the incurrent opening into the branchial cavity instead of being placed at the base of the great cheliped, as it is in other crabs, is very commonly a channel placed alongside the mouth-frame: the carapace is often globular.

The Oxystomes are, for the most part, feeble and inoffensive crabs, living half-buried in soft mud and sand at the bottom of the sea: some, however, are bold and active

swimmers. All of the four families into which the tribe is subdivided are numerously represented in the Gallery.

1st Family, **Calappidæ.**—In *Calappa* the carapace is extended on both sides to form an arched shield which completely roofs over the last four pairs of thoracic legs, while the first pair of thoracic legs, or chelipeds, are themselves expanded upwards to form when flexed a front shield for the body. In *Mursia* the lateral prolongations of the carapace form great protective spikes. Examples of both of these forms are shown in Case 68.

2nd Family, **Matutidæ.**—In *Matuta* all the legs, except the chelipeds, are modified to form paddles for swimming. *Matuta* is one of the commonest shallow-water crabs of the Indian Seas.

3rd Family, **Leucosidæ.**—A large family, most of the members of which are small and timid, and live concealed in the mud of the sea-bottom. Many of them have the carapace beautifully sculptured, the sculpturings in *Oreophorus* giving the animal a deceptive resemblance to the coral shingle in which it lives. Specimens of the following Indian genera are shown—*Philyra, Myra, Myrodes, Parilia, Randallia, Leucosia, Nursia ,Lithadia, Ixa, Iphis, Oreophorus.*

4th Family, **Dorippidæ.**—The last pair or last two pairs of legs are very small, and they spring from the dorsal surface or back of the cephalothorax and end in sickle-like claws. In these claws is often held, as in a frame, a valve of a mollusk shell which the crab carries as a roof or shield. The upper surface of the shell is usually taken possession of by a sea-anemone, the sea-anemone furnishing an additional protection to the crab which the crab repays by

transporting the sea-anemone to fresh feeding grounds. This is another instance of that permanent association of two animals of different species for mutual benefit which is known as "commensalism."

Dorippe and *Ethusa* (Case 68) are Indian representatives of this family, the first being a common shallow-water form, the last occurring in the great depths of the ocean.

5th Tribe, Anomola, Case 68.—The three families, *Dromidæ*, *Homolidæ* and *Raninidæ*, of which this tribe consists, were formerly placed with the *Anomura*. They are here united with the Crabs in accordance with the teaching of the late Professor Wood-Mason.

1st Family, Dromidæ—represented in the collection by *Dromia* and *Cryptodromia*. These Crustaceans commonly live commensal with Sponges, the sponge forming a cap beneath which the crab is completely hidden: they are common on the coral reefs of the Andaman Islands.

2nd Family, Homolidæ—represented in the collection by *Paromolopsis* from the depths of the Andaman Sea and *Hypsophrys* from the depths of the Laccadive Sea. In the *Homolidæ* the orbits are very incomplete, and the last pair of legs are very small and are placed on the back.

3rd Family, Raninidæ—represented by *Ranina*, *Raninoides*, *Notopus*, and *Lyreidus*, all from the Indian Seas. In shape these curious Crustaceans have a resemblance to a frog. The carapace is long and the last pair of thoracic legs, which are very small, are carried on the back.

γ. DECAPODA ANOMURA.

[Cases 42 and 49].

The *Anomura* are in many respects intermediate between the *Macrura* (Lobsters) and the *Brachyura* (Crabs).

If we compare the disarticulated specimen of the Hermit-crab, *Cenobita rugosa*, in Case 49 with the similar specimens of the Prawn and the Crab between which it is placed, we notice that the carapace, while much resembling that of both, differs from both in not including the last thoracic segment, which forms a completely separate and distinct ring. The cephalothorax again, while relatively much larger than the abdomen, and relatively larger than that of the Prawn, is not nearly so greatly developed as that of the Crab; and conversely the abdomen, though relatively much smaller than the thorax, and not nearly so important a part of the body, or so straightly extended as it is in the Prawn, is yet not a rudiment tucked up out of sight, as it is in the Crab.

The cavities for the antennules and eyes, so characteristic of the Crab, are wanting, but yet these organs are considerably more concealed beneath the carapace than they are in the Prawn. Again the third pair of maxillipeds are not expanded at the base as they are in the Crab, and yet are not quite claw-like as they are in the Prawn. Furthermore, the last two pairs of thoracic legs are quite peculiar in being rudimentary.

The abdominal appendages, like those of the Crab (the specimens in both cases being male), are incomplete and rudimentary.

Most of the *Anomura* are marine, and frequent shallow water; some, however, inhabit the great depths of the ocean, and a few are found in brackish estuaries, or living entirely on land.

Of the three tribes into which the *Anomura* have been subdivided, all are well represented in Indian waters and in the Gallery.

1st Tribe, Hippidea, Case 42.—This tribe includes two small families—the *Hippidæ* and the *Albuneidæ*.

1st Family, Hippidæ—represented by *Hippa* and *Remipes*. These are small mole-like Crustaceans which burrow in the wet sand of the

seashore: the abdomen is long and narrow, and is tucked up under the thorax, as in crabs.

2nd Family, Albuneidæ—represented by *Albunea*, which much resembles *Hippa* both in form and in habit.

2nd Tribe, Paguridea, Case 42.—This tribe includes the Hermit-crabs, most of which are marine; though several, such as *Birgus* and many Cenobites, are terrestrial, being specially abundant in the dense damp jungles of the islands of the various archipelagos of the Indo-Pacific. Of the four families included in this tribe, three—the *Paguridæ*, the *Cenobitidæ*, and the *Parapaguridæ*—are found in the Indian region.

1st Family, Paguridæ—Hermit-crabs or Soldier-crabs. The Hermit-crabs differ from all the higher Crustaceans in having the abdomen not encased in a calcareo-chitinous exoskeleton like the rest of the body, but covered only with a soft skin. For the protection of this soft vulnerable abdomen they possess themselves of a mollusk shell, which they change periodically as they grow in size, and the spiral curvature of which leads to a corresponding partial spiral curve in the abdomen. They are common in tidal pools, and are represented in the Gallery by specimens of *Pagurus*, *Clibanarius*, and *Diogenes*.

2nd Family, Parapaguridæ.—The *Parapaguridæ* are a deep-water family, differing from the *Paguridæ* only in the structure of the gills. They are represented in the collection by specimens of *Parapagurus abyssorum*, *Pylocheles*, and *Pagurodes*.

Parapagurus abyssorum is invariably found living commensal with a colony of sea-anemones (*Epizoanthus*), as is well seen in the beautiful specimen exhibited. *Pagurodes* also lives commensal with a sea-anemone.

3rd Family, Cenobitidæ.—These differ from the *Paguridæ* chiefly in having larger antennules. Several of the species are terrestrial. The family is represented by specimens of *Cenobita* and *Birgus*. Of *Cenobita*, which much resembles *Pagurus*, several species are found swarming in the jungles of the Andaman and Laccadive Islands. *Birgus* is a gigantic land Hermit-crab which does not take possession of a shell, and has the upper surface of the abdomen not soft as in other *Paguridea*, but covered by hard calcareo-chitinous plates. The lower unexposed surface of the abdomen is, however, soft. In the Indian region *Birgus* is known to occur only in the jungles of the little island of South Sentinel in the Andaman group. In *Birgus* observe that the fifth pair of legs is tucked up beneath the carapace within the breathing chamber. Observe also that the female is furnished with a single bilobed hairy leg on one side of three of its abdominal segments: these legs are found in the female only, and are used for carrying the eggs in the breeding season.

The gills in *Birgus* are present, but are much reduced in size, and respiration is principally effected by the lining membrane of the gill-chamber, which is thickened, spongy and very vascular, and has its surface increased by being raised into large branching excrescences. A spirit preparation in Case 54 shows one side of the gill-chamber of a small female *Birgus* laid open to display this modification of its lining membrane.

3rd Tribe, Galatheida, Case 42.—This tribe includes two families—the *Porcellanidæ*, which have a strong general resemblance to the Crabs; and the *Galatheidæ*, which have rather a resemblance to the Lobsters. The frontal region is prominent, and there are imperfect orbits and imperfect fossæ for the lodgment of the antennules. The abdomen is large and symmetrical, and ends in a large caudal fin or swimmeret. The last pair of thoracic legs is small, and is usually carried either alongside of, or beneath, the carapace.

1st Family, Galatheidæ. The majority of the *Galatheidæ* inhabit deep water: they are represented in the Gallery by specimens of *Galathea* from a moderate depth, and of *Munida*, *Munidopsis* and *Galacantha* from the great depths.

2nd Family, Porcellanidæ. The *Porcellanidæ* are found hiding under rocks and stones in tidal pools, and are very common in India. The members of this family have a large abdomen, but it is bent up beneath the thorax as in the Crabs. The Indian genera represented are *Porcellana* and *Petrolisthes*.

In their growth, as already stated, the *Macrura Decapoda*, like the *Stomapoda*, usually pass through several metamorphoses, the various stages of which differ very greatly from the adult form. Some of these larval forms are shown in Case 54, *e.g.*, the *Mysis* stage of the Prawn, the *Zoœa* and *Megalopa* stage of the Crab, and the *Phyllosoma* stage of the *Scyllaridæ* and *Palinuridæ*; and in Cases 55 and 57 are series of enlarged drawings.

Before leaving the *Crustacea* mention must be made of the genus *Nebalia*, an example of which is exhibited in Case 54. *Nebalia* is in some respects intermediate between the Entomostracous and Malacostracous *Crustacea*, since the abdomen has more than seven segments and ends in a caudal fork as in *Apus*, and since the thoracic limbs are bilobed plates. By Professor Ray Lankester *Nebalia* is independently graded by itself, between the *Entomostraca* and *Malacostraca*, as the sole remaining representative of a third group named by him *Leptostraca*.

APPENDIX TO CRUSTACEA No. 1.

2. ARTHROPODA PŒCILOPODA.

[Western Wall-case 56].

The only living representative of this group, *Limulus*—

the King-crab—has long been included among the *Crustacea*, but the researches of modern embryologists show that it has much nearer affinities with the next class of the *Arthropoda*, namely, with the *Arachnida* or Spiders.

The body of *Limulus*, which is enclosed in a chitinous armour, consists of three portions—(1) a large horse-shoe-shaped cephalothorax, (2) a hexagonal abdomen, and (3) a long rigid post-anal spine. The cephalothorax bears on its convex upper surface at the sides two large compound eyes, and in front two small simple eyes; and in its concavity are seen six pairs of legs, the basal joints of which are thickly beset with spiny teeth and serve as jaws. The legs of *Limulus* are, in short, in what is known as an indifferent condition, being used both in progression and prehension, and in the mastication of food, and they illustrate excellently the fact that the jaws and legs of *Arthropoda* are "homologous organs," in other words that Arthropod jaws are derived from legs. On the under surface of the abdomen are five pairs of broad leaf-like feet, all of which carry a series of gill-plates arranged like the leaves of a book.

Limulus is found in India in the muddy salt waters of estuaries.

APPENDIX TO CRUSTACEA No. II.

3. ARTHROPODA PYCNOGONIDA.

[Western Wall-case 58].

Pycnogonum—the "Sea-spider"—has been at different times classed with the *Crustacea* and with the *Arachnida*: it differs from both, and by modern zoologists is placed in a class by itself.

Pycnogonum has a long suctorial proboscis with a pair of many-jointed palps at its base, and a very small abdomen with four pairs of long many-jointed legs. The male has in addition a pair of shorter legs, which spring from the back, and are used for carrying the eggs during the development of the young.

In *Pycnogonum*, as in the Spiders, the stomach is prolonged into the legs, almost to their end.

Most of the *Pycnogonida* are small, and are to be found crawling about among the sea-weed between tide-marks, but some of the deep-sea species are of gigantic size—the specimen of *Colossendeis gigas* from the depths of the Andaman Sea, exhibited in Case 58, having a span of over eighteen inches.

The stomach of this specimen is distended with mud, so that its tubular prolongations into the legs is beautifully displayed. This specimen is a male, and also shows well the position and nature of the egg-carrying legs.

4. ARTHROPODA ARACHNIDA.

[Western Wall-cases 58, 60-62].

The *Arachnida* include the worm-like *Pentastomida*, the Mites and Ticks, the Spiders, the Spider-like *Phalangiida*, the Scorpion-spiders, the Book-scorpions, and the Spider-like *Solifugæ*.

The Class thus contains a great variety of forms which, in addition to the fact that they are all built on the Arthropod plan of a succession of segments or somites, have the following characters in common :—(1) that they breathe air, commonly by tracheal sacks or "lungs," but sometimes by true tracheal tubes, (2) that the head and thorax are always fused together to form a single mass, (3) that they possess two pairs of organs that can be used as jaws, and four pairs of legs—six pairs of limbs in all, and (4) that the abdomen has no limbs.

The disarticulated specimen of the scorpion in Case 61 shows the number and arrangement of the appendages of the Arachnid body.

i.—ARACHNIDA ARANEIDA. (True Spiders).

[Western Wall-case 60].

We may very well commence the study of the *Arachnida* with the large specimens and preparations of the

Trap-door Spiders *Mygale* and *Scurria* in Case 60, these being types of the order *Araneida* or true Spiders.

In these the segments of the head and thorax are consolidated to form a cephalothorax, which is enclosed in a firm chitinous integument and bears six pairs of "appendages",—the first pair, or "chelicerae", or jaws, ending in fang-like poison-claws placed on either side of the mouth; the second pair being many-jointed "palpi", or feelers, the basal joints of which are expanded to form a second pair of jaws; and the remaining four pairs being long many-jointed legs. On the dorsal (upper) surface of the cephalothorax, towards the front and sides, are eight (in a minority of Spiders six) large simple eyes. Behind the cephalothorax, and attached to it by a narrow stalk, is the large soft swollen abdomen, in which, in the adult, no signs of segmentation can be detected. On the under surface of the abdomen, in front, are seen the two pairs (in the great majority of Spiders, however, there is only a single pair) of slit-like orifices of the tracheal sacks, or "lungs". At the end of the abdomen, round the vent, are seen the wart-like eminences upon which the spinning-glands open, two of these in *Mygale* and *Scurria* being of great length.

In the Spiders the female is usually very much larger than the male.

The rapacity and voracity of Spiders is well known: some, such as *Mygale*, lie in wait for their prey in burrows in the earth, the mouth of the burrow being provided with a hinged lid (Trap-door Spiders): others, such as *Lycosa*, run their prey down: others, such as *Salticus*, capture their prey by springing on it from a distance: others, such as the common House-spider, *Tegenaria*, entrap their prey in funnel-like webs: the webs of others, such as *Pholcus* are irregular in shape: while the webs of a large number of Spiders, such as *Epeira* and *Gasteracantha*, have a beautiful wheel-like symmetry.

In the family of Spiders that spring upon their prey

(*Saltigradæ*, of which *Salticus* and *Plexippus* are examples), there are certain species which resemble ants and often live with the ants in their nests. By means of its resemblance to the ants, and its association with them, the spider is believed either to escape the notice of enemies to which ants are distasteful, or to be enabled to make unsuspected attacks upon insects that do not fear ants. This deceptive resemblance of an animal of one species to an animal of a quite differet species or class, for the purpose of deceiving either enemies or prey, is known as "mimicry", the species that profits by the resemblance being known as the mimic. Specimens of an ant-like *Salticus* with specimens of the ant that it mimics are shown in Case 60, and in Case 97B of the Insect series there are some enlarged drawings and photographs illustrative of this phenomenon.

The true Spiders are represented in Case 60 by specimens of the following genera, almost all of which are Indian:—*Mygale, Scurria, Atmetochilus, Cyriopagopus; Epeira, Nephila, Nephilengys, Acrosoma, Gasteracantha, Actinacantha, Stanneoclavis, Cœrostris, Meta, Cyclosa, Tetragnatha; Pholcus; Tegenaria; Thomisus; Sphedanus, Leptoctenus, Thelictopis, Palystes, Heteropoda, Ocyale, Hippasa, Lycosa; Salticus, Plexippus, Cyllobelus, Cytæa.*

ii.—ARACHNIDA PHALANGIIDA.

[Western Wall-case 58].

The *Phalangiida* very much resemble the true Spiders, from which they differ (1) in having the rings or somites of the abdomen separate and distinct, (2) in having the abdomen joined to the cephalothorax along its whole breadth, and not merely by a stalk, (3) in having the mandibles or "cheliceræ" in the form of small "chelæ" or pincers, (4) in being without spinning glands, and (5) in breathing not by tracheal sacks, but by true tracheæ.

Their legs are usually of great length. The specimens of *Phalangium*, *Gagrella*, and *Maracandus* in Case 58 represent this small Order.

iii.—ARACHNIDA SCORPIONIDEA. (True Scorpions).

[Western Wall-cases 61—62].

The Scorpions are characterized by their long abdomen consisting of thirteen separate and distinct segments, the first seven of which are short and wide and form a broad "pre-abdomen", while the last six are long and narrow and form, by their union, a long narrow "post-abdomen". The terminal segment of the post-abdomen, or "tail", contains the poison-gland and ends in an up-curved spine, which is perforated at its tip, like the eye of a needle, for the discharge of the poisonous secretion.

The first pair of appendages, or "cheliceræ", are short pincers; the second pair, or "palpi", resemble the chelipeds of a lobster, and have the basal joint broadened to form a jaw on each side of the mouth; and the remaining four pairs are crawling-legs, each ending in a double claw.

The eyes are found on the upper surface of the cephalothorax—a large pair being placed in or near the middle, and from two to five smaller eyes being found in a line or in a patch near the front edge on either side.

The Scorpions breathe by "lungs" like those of Spiders: of these there are four pairs, which open on the under surface of the third to the sixth abdominal segments, as may be seen in several of the exhibited preparations.

The Scorpions are carnivorous, feeding principally on insects which they seize with their large pincer-like palps and sting to death with the poison-spine at the end of the "tail."

The females are viviparous, and several specimens, with developing eggs and embryos, are mounted in Case 62.

The Indian genera exhibited in Case 62 are *Buthus*, *Pandinus*, *Palamnæus*, *Scorpiops*, *Liocheles*, *Isometrus*, and *Androctonus*.

iv.—ARACHNIDA PEDIPALPI. (Scorpion-Spiders).

[Western Wall-case 62].

The Scorpion-spiders have strong resemblances both to Scorpions and to Spiders. As in the Scorpions the segments of the abdomen are separate and distinct, but the abdomen itself is either simple, or if there is a post-abdomen it is in the form of a lash-like appendage without any poison-spine.

The jaws or "chelicerae" are like those of Spiders, and probably contain a poison-gland ; the "palps", on the other hand, are of the cheliped form like those of Scorpions.

The lung-sacks are two pairs, placed like those of the Spider *Mygale*, as may be seen by comparing the preparations displaying the lung-sacks of both, in Cases 60 and 62 respectively. There are eight eyes, the disposition of which is intermediate between that found in the Spiders and Scorpions.

This small Order is represented in Case 62 by specimens of *Phrynus* and of several species of *Thelyphonus*, all from India.

v.—ARACHNIDA PSEUDOSCORPIONIDEA. (Book-Scorpions).

[Western Wall-case 58].

The Book-scorpions are small *Arachnida* somewhat resembling Scorpions in shape, but having no post-abdomen or caudal poison-spine. They are found in old books and beneath rotting bark, etc.

This small order is represented in Case 58 by specimens of *Chelifer*.

vi.—ARACHNIDA SOLIFUGÆ.

[Western Wall-case 62].

The *Solifugæ*, represented in Case 62 by fine specimens of *Galeodes*, have a resemblance to the Spiders, their palps also, like those of spiders, being leg-like ; but they

differ from spiders (1) in having stout pincer-like "cheliceræ"; (2) in having the segments of the abdomen all separate and distinct, instead of fused together into a single mass; (3) in having only two eyes, instead of eight or six; and (4) in breathing by tracheæ, instead of by tracheal sacks or "lungs".

Galeodes is common in dry sandy regions like the Punjab and Baluchistan. Its bite is very severe.

vii.—ARACHNIDA ACARINA. (Mites and Ticks).

[Western Wall-case 58].

The *Acarina* form a large Order distinguished among *Arachnida* by having the segments of the head, thorax, and abdomen usually fused together into a single globular mass.

The "cheliceræ" and "palps" are often modified for piercing and sucking; and the four pairs of legs are used for crawling, clinging, and sometimes for swimming. Very many of them are parasites. Various species of *Ixodes* and *Trombidium* in Case 58 represent this order.

viii.—ARACHNIDA PENTASTOMIDA.

[Western Wall-case 58].

The specimen of *Pentastomum* in Case 58 is a good example of this small Order of parasitic and degraded Arachnids.

In *Pentastomum* the body is quite worm-like, being made up of a succession of rings without appendages. Even jaws are absent, their place being filled by two pairs of chitinous hooks placed on either side of the mouth. *Pentastomum* lives as a parasite within the nasal passages of the Dog.

5. ARTHROPODA PERIPATIDEA.

[Western Wall-case 63].

This Class of air-breathing Arthropods contains the single genus *Peripatus*, a specimen of the New Zealand species of which is exhibited in Case 63.

The external form of *Peripatus* is much like that of a caterpillar: the body consists of numerous segments, and bears a pair of antennæ and numerous pairs of stumpy jointed legs (fifteen pairs in this species), each of which ends in a pair of small claws. One of the most interesting characters of *Peripatus* is that the openings of the breathing-tubes, or tracheæ, are scattered over the body-surface, instead of having a definite arrangement, such as they have in all other air-breathing Arthropods.

6. ARTHROPODA MYRIAPODA. (Centipedes and Millipedes).

[Western Wall-case 63].

In the *Myriapoda* the body has a considerable resemblance to that of the appendiculate Annelids, consisting of a succession of similar segments, each of which has a pair of short appendages.

On the head are a pair of antennæ, a pair of patches of eyes, and either two or three pairs of jaws.

Breathing is performed by tracheæ, or tubes which ramify throughout the body and open at definite points along each side: the openings of the tracheæ, which are known as "stigmata", are indicated by pointers in the preparations in Case 63.

The *Myriapoda* are divided into two Orders, the *Chilopoda* or Centipedes, and the *Chilognatha* or Millipedes.

i.—MYRIAPODA CHILOPODA. (Centipedes).

[Western Wall-case 63].

In the Centipedes the segments of the body are flattened, and their integument is hardened above and below to form a dorsal plate or "tergum", and a ventral plate or "sternum", but is soft at the sides, where, in alternate segments, as is shown in the preparation of *Scolopendra* in Case 63, the "stigmata", or openings of the tracheæ, are found. Each segment carries a pair of jointed legs which end each in a sharp claw. The antennæ are long, and the

second pair of legs is modified to form a pair of great poison-claws, the basal joints of which are broadened out to form additional jaws. The Centipedes are all carnivorous. Specimens of the following Indian genera are exhibited :— *Scolopendra, Otostigma, Mecistocephalus, Orphnæus, Himantarium, Scutigera.*

Compare the large (aberrant) "compound" eyes of *Scutigera* with the small simple eyes of *Scolopendra.*

ii.—MYRIAPODA CHILOGNATHA. (Millipedes).

[Western Wall-case 63].

In the Millipedes the segments of the body are either arched or completely rounded, and, with the exception of the first three to seven, each carries two pairs of legs. The antennæ are short and there are no poison-claws. Tracheæ open on each side of each segment of the body. The Millipedes feed almost entirely on vegetable matter. Specimens of the following Indian genera are exhibited :— *Glomeris, Sphæropæus, Zephronia; Acanthodesmus, Paradesmus, Spirostreptus, Spirobolus.*

Observe the two patches of simple eyes, well displayed in the specimen of *Spirostreptus aterrimus.*

7. ARTHROPODA HEXAPODA. (Insects.)

[Desk-Cases 70—125].

The Insects occupy the two series of low narrow Desk-cases that lie between the large Shell-cases traversing the middle of the Gallery and the Cabinet-cases containing the *Protozoa* and *Cœlenterata* on either side.

The dissected preparations of the common Cockroach (Case 70B) the common Grass-hopper (Case 75B) and the large Wasp (Case 95A) give a good idea of the external characters of a typical insect. The body consists of (1) a head, made up of several (four) segments fused together to form a single piece; (2) a thorax, formed of three seg-

ments known in succession as prothorax, mesothorax, and metathorax; and (3) an abdomen, formed of a varying number—never more than ten—of separate segments.

The head has the following "appendages":—(1) a pair of jointed antennæ, (2) a pair of upper jaws usually formed for biting or piercing, (3) a pair of jointed lower jaws, often formed for chewing or piercing, known as maxillæ, and (4) a second pair of maxillæ, which are usually fused together to form a lower lip or "labium". One or both pairs of maxillæ usually carry "palps" (maxillary palps, and labial palps). Besides these true "appendages" there also occur on the head a pair of large compound eyes, and often also several small simple eyes or "ocelli", and an unpaired "labrum," or upper lip, in front of the mouth-opening. The dissection of the Cockroach (Case 70B), displays the structural details of the typical biting and chewing mouth.

In the *Lepidoptera* (Butterflies and Moths) the mouth-parts are profoundly modified for sucking, the first pair of maxillæ being grooved and much elongated and closely apposed to form a long suctorial tube, or "proboscis", and the palps of the second pair of maxillæ (labial palps) being thickened and enlarged to form stout hairy cushions, between which the proboscis is coiled up when not in use, while all the other mouth-parts are rudimentary—(see the enlarged drawing in Case 97C). In the *Hymenoptera* (Bees, Wasps, Ants) the mouth-parts are adapted for both biting and sucking or licking—(see the enlarged drawing in Case 97C).

In the *Diptera* (Flies) and *Hemiptera* (Bugs) the mouth-parts are modified for piercing and sucking, the mandibles and both pairs of maxillæ, and even sometimes the upper lip being greatly elongated for these purposes.

Enlarged drawings of all the principal modifications of the mouth-parts of Insects are shown in Case 97C, the homologous parts being coloured alike throughout the series.

The thorax in a typical adult insect bears the following

appendages:—(1) on the prothorax a pair of jointed legs, (2) on the mesothorax a second pair of legs and a pair of wings, and (3) on the metathorax a third pair of legs and a second pair of wings. The modifications undergone by the legs for running, leaping, burrowing, clinging, swimming, for seizing prey, for protection by resemblance to other natural objects, are too numerous to be mentioned here: they should be studied in the exhibits of the typical groups, along with the modifications, degenerations, and suppressions, that occur in the wings. The structural details of the insect leg should be studied in the dissected preparation of the Grasshopper in Case 75B.

The abdominal segments in the typical adult nsect are all destitute of appendages, but in some larvæ (*e.g.*, caterpillars) stumpy legs ("prolegs") are found.

The last one or two abdominal appendages are prolonged in the males (and females) of some insects as rods or pincers, and in the females alone of some insects as stings and ovipositors.

In most Insects, as in many *Crustacea*, the main developmental changes, instead of being completed within the egg, are continued long after the embryo has been hatched and has become an independent individual. In these insects the adult form is reached only after a series of moults or "metamorphoses". The typical as well as the most familiar series of insect metamorphoses ("complete metamorphosis") occurs in the Butterflies and Moths, in which the embryo leaves the egg as a worm-like "*larva*", or caterpillar. After feeding voraciously for some time the larva encysts itself, either in a simple chitinous envelope or in a silky "cocoon", and remains for a time quiescent as a "*pupa*", or "chrysalis". In the quiescent pupa stage the post-embryonic development is completed, the perfect winged insect at length emerging as an "*imago*".

The number of species of Insects is so vast that to adequately illustrate the group within the limits assigned to it in this Gallery would be an impossibility. The objects therefore of the small collections here displayed are to

compare some of the more obvious external structural characters of Insects, and to illustrate the natural classification of this Class of *Arthropoda*, as well as to exhibit some stages in the life-history of certain insects that affect agricultural industries.

i. HEXAPODA THYSANURA.

[Case 70A].

The familiar "fish insect", which eats books and clothes, illustrates this small Order. The *Thysanura* are wingless insects with hairy or scaly integument and rudimentary mouth-parts. They have a general external resemblance to centipedes. They do not pass through a metamorphosis. By some zoologists they are regarded as aberrant *Orthoptera*.

ii. HEXAPODA ORTHOPTERA.

[Cases 70B—78C].

Insects with typical biting and masticating jaws, and with two pairs of wings, the front pair of which are often parchment-like. In the females of some species, however, the wings are absent or rudimentary, as may be seen in some of the exhibits of *Mantidæ*. The abdomen usually ends in rods or stylets, which in the female (as in the locusts) may be used as ovipositors.

In many *Orthoptera* (*e.g.*, the Crickets, Locusts, and Grasshoppers) the males produce powerful musical sounds by the rhythmical scraping together of file-like plates which are developed either at the bases of the hard fore-wings or on the inside of the "thighs" of the last pair of legs: in the first case the wings of opposite sides are scraped across one another, one wing serving as a bow and the other as a fiddle; and in the second case the thigh is used as a bow, being scraped against the fore-wing which acts as a fiddle. It is only very exceptionally that these sound-producing or stridulating organs are possessed by the female also.

The young of typical *Orthoptera* differ from the adults chiefly in the absence of wings, and the metamorphoses consist of a series of moults in which the wings are gradually acquired.

The *Orthoptera* form a large Order of which the following family-types are represented in the Gallery:—

1st. **Forficulidæ**, or Earwigs, (Case 70B);
2nd. **Blattidæ**, or Cockroaches, (Cases 70B and 70C);
3rd. **Mantidæ** or Praying-insects, (Cases 71A-74C);
4th. **Phasmidæ**, or Stick-insects and Leaf-insects, (Case 75A), the wingless forms resembling sticks, the winged forms resembling leaves;
5th. the **Acridiidæ**, or Grasshoppers, (Cases 75B-77A);
6th. the **Locustidæ**, (Cases 77B-77C);
7th. the **Achetidæ**, or Crickets, (Case 77C).

In the above seven families, which constitute the sub-Order *Orthoptera genuina*, the fore-wings are hard and parchment-like.

Family 8th, the **Termitidæ**, or Termites, popularly known as "White Ants", although they are not ants at all. The Termite communities consist of sexually-perfect males and females, both of which are winged, and of sexually-aborted males and females, or "neuters", which are wingless. The neuters are of two kinds, namely (1) "soldiers", with large mandibles for fighting, and (2) ordinary "workers" with smaller mandibles. Besides males and females, soldiers and workers, the Termite communities also contain wingless larvæ and pupæ. The females, or "Queens", when distended with eggs are of enormous size. In Case 78B specimens of Queens, Soldiers, Workers, and pupæ are shown; and in Case 78A is a series of enlarged drawings illustrating all the forms of *Termes lucifugus*.

Family 9th, the gnat-like May-flies (Ephemeridæ) the larvæ of which are aquatic. Specimens of May-flies, along with an enlarged drawing of an aquatic larva, are shown in Case 78B.

The 10th Family represented is that of the Libellulidæ or Dragon-flies (Case 78C) the larvæ of which also are aquatic. These three families,—Termites, May-flies, and Dragon-flies have both pairs of wings, when present, thin and membranous like those of the *Neuroptera*, and are hence known as *Pseudoneuroptera.*

iii. HEXAPODA NEUROPTERA.

[Case 79A].

Insects usually with biting mouth-parts and with thin membranous wings. Metamorphosis "complete". The Ant-lions in Case 79A represent this Order. The larval ant-lion, a specimen of which, along with a much-enlarged drawing, is shown, digs little funnel-like pits in the sand, at the bottom of which, in concealment, it lies in wait for prey.

iv. HEXAPODA STREPSIPTERA.

[Case 88B].

This small Order of degraded parasitic insects is represented by specimens and enlarged drawings of *Stylops* in Case 88B showing the larva; the male, with contorted rudimentary forewings and well developed hindwings; and the maggot-like wingless and legless female. The larvæ and the maggot-like females live as parasites within he abdominal cavity of wasps and humble-bees. It should be mentioned that by some modern entomologists the *Strepsiptera* are regarded as an aberrant family of *Coleoptera* (Beetles) approaching the *Cantharidæ.*

v. HEXAPODA HEMIPTERA. (Rhynchota).

[Cases 79B-80C].

Insects with the mouth-parts usually modified for piercing the integument of animals and plants and sucking

the underlying juices. An enlarged drawing of the mouth-parts is shown in the series in Case 97C.

This large Order includes (1) the wingless Lice, the Plant-lice, and the Lac and Cochineal Insects, which together constitute the sub-Order *Hemiptera Aptera;* (2) the Cicadas, in which both pairs of wings are well developed and are usually membranous throughout, constituting the sub-Order *Hemiptera Homoptera;* and (3) the Bugs of all kinds, which have the bases of the fore-wings hard and horny, and form the sub-Order of *Hemiptera Heteroptera.*

vi. HEXAPODA DIPTERA.

[Cases 81A-81C].

This large Order includes the common Flies, the Flesh-flies, the Gad-flies, the Gnats, Mosquitoes, and Crane-flies, and the wingless Fleas. In all, the mouth-parts are modified for piercing and sucking, as is shown in the enlarged drawing in Case 97C, and only one pair of wings—the fore-wings—is developed, the hindwings being reduced to small knobs known as "halteres". In the Fleas both pairs of wings are microscopic rudiments.

vii. HEXAPODA LEPIDOPTERA.

[Cases 98A to 125C].

This very large Order includes the Butterflies and Moths, in which the mouth-parts are peculiarly modified to form a sucking-tube or "proboscis" as already described (see also Case 97C). Both pairs of wings are well developed, except in the females of a few species of moths, in which the wings are quite rudimentary, and are partially or completely covered with the microscopic scales and hairs that form the beautifully variegated coloration of the butterfly's wing. The metamorphoses of these insects are too familiar to need further mention.

The *Lepidoptera* are divided into two sub-Orders, namely (1) the *Rhopalocera*, or Butterflies, (Cases 98A to 115A)

in which the antennæ are clubbed at the tip, and are always carried either erect or extended; and (2) the *Heterocera*, or Moths (Cases 115B to 125C) in which the antennæ vary considerably in form, but are not clubbed at the tip, and are never held erect or extended in repose, but are then almost invariably folded away beneath the wings. A good collection illustrative of both sub-Orders is exhibited in Cases 98A to 125C. For the Indian *Rhopalocera*, or Butterflies, the student should consult Mr. de Niceville's "*Butterflies of India, Burma, and Ceylon*", published by the Calcutta Central Press Company.

viii. HEXAPODA COLEOPTERA.

[Cases 82A-93B].

This very large Order comprises the Beetles, which are characterised by having mouth-parts of the typical biting and chewing type; by having the forewings hardened to form horny "elytra", or cases for the protection in repose of the membranous hindwings, which alone are used in flight; and by passing through a complete metamorphosis. In some cases the elytra alone are present; or the elytra may be soldered together: and in a few forms, *e.g.*, the females of some species of glow-worms, the wings are altogether wanting.

ix. HEXAPODA HYMENOPTERA.

[Cases 93C—97B].

Insects with the mandibles adapted, like those of *Orthoptera*, *Neuroptera*, and *Coleoptera*, for biting, but with the 1st maxillæ and 2nd maxillæ (labium, or lower lip) elongated and peculiarly modified for licking and sucking (Bees). Wings are sometimes absent, but are usually present, and then the forewings interlock with the hindwings on each side by means of hooklets on the outer edge of the latter. The abdomen is much narrowed at its junction with the thorax to form a stalk, and in the

female the abdomen ends in an ovipositor, which has sometimes a poison-gland connected, to form a poison-spine or "sting". The metamorphosis is complete.

The Order, which includes the Saw-flies, Gall-wasps, Ichneumon-flies, Ants, Solitary wasps, Social wasps, Solitary Bees, and Social Bees, is illustrated in Cases 93C—97B. The marvellously complex economy of the social *Hymenoptera*, especially of the Ants, can only be mentioned here. The communities consist (1) of winged males which are usually short-lived, (2) of winged females, which are usually very few in number, and (3) of a vast number of usually sexually-undeveloped females which may be either winged (Bees) or wingless (Ants), and are known as "workers". Among the ant communities the "workers" are sometimes of two kinds—"soldiers" with large mandibles, and "true workers".

Practically, owing to the transient existence of the males and the paucity of the sexually-perfect females, a community usually consists of a "Queen" and a horde of "workers", with larvæ and pupæ.

PHYLUM V OF THE COELOMATA.

ECHINODERMATA.

[Eastern Wall-cases 17—36].

The members of this phylum are characterised by the *radial symmetry* of the body. It is only in some of the atypical *Holothuroidea* that bilateral symmetry occurs.

The *Echinodermata* form a very definitely circumscribed group, and their relations to the other great groups are by no means agreed upon.

The *Echinodermata* are marine animals usually of a quinque-radial or five-rayed star-shape and covered with a skin which is always thick and stout and is often so impregnated with lime-salts as to form a rigid stony case. For further protection the hard stony integument is often

thickly covered with stout calcareous spines, and some of these are often modified to form beak-like or pincer-like organs known as "pedicellariæ," examples of which are shown in Wall-case 18.

The *Echinodermata* are specially characterized by the possession of a "water-vascular system," by which a watery fluid is distributed through the body, assisting respiration and the excretion of waste products and aiding in locomotion. This system is also in communication with the external sea-water.

The details of the water-vascular system, which are shown diagrammatically in the enlarged drawing in Case 18, and are also displayed in several dissections, are typically as follows:—

Through a sieve-like usually external plate, known as the "madreporic plate," the sea-water percolates and passes along a canal, known as the "stone-canal," into a circular canal which surrounds the gullet. On this "circular canal" there are usually found several reservoirs known as "Polian vesicles," and from the circular canal five radial or "ambulacral" canals branch off, one into each ray of the body. From both sides of the ambulacral canals erectile tubes are given off, and these, which are known as "ambulacral feet" or "tube feet," pass through pores in the body-wall and project outside the body. The tube-feet commonly end in a sucker, and it is by the contraction of the turgid tube-feet, when the suckers are firmly adherent to some external object, that the typical Echinoderm travels. Sometimes the water-vascular system is prolonged into branching tentacles which surround the mouth, as is seen in the Holothurian, *Thyone*, exhibited in Case 35.

The alimentary canal differs much in the different groups of the *Echinodermata:* its details in several of the groups are shown by dissections with explanatory notes. In some groups the mouth is armed with powerful teeth, specimens of which are exhibited (Cases 28-29).

Special breathing organs are not generally found in the *Echinodermata*. The water-vascular system aids in respiration, as does also the general surface of the body-cavity and its contained organs, and often also the general external surface of the body.

The *Echinodermata* possess blood-vessels, in which colourless blood circulates; they are hard to trace, but can be seen in the dissection of *Holothuria* in Case 36. They also possess a nervous system, and in the Star-fishes there are simple eyes, which are placed at the tips of the rays, but are hard to trace.

The *Echinodermata* do not usually produce offspring by budding, but when an animal such as a Star-fish loses one of its rays, not only can a new ray be grown from the stump, but it appears that the detached ray also can often by growth and budding give rise to a new Star-fish. (See specimens in Case 18).

In some Star-fishes the rays are thrown off whenever the animal is disturbed, so that this regeneration of new rays must be a very common event. The ordinary reproduction of new individuals, however, is always sexual—the sexes being with few exceptions separate.

The *Echinodermata* are divided into five great Classes —(1) the *Asteroidea* or Star-fishes, (2) the *Ophiuroidea* or Brittle Star-fishes, (3) the *Crinoidea* or Sea-lilies, (4) the *Echinoidea* or Sea-urchins, and (5) the *Holothuroidea* or Sea-cucumbers.

I. ECHINODERMATA ASTEROIDEA (STAR-FISHES).

[Eastern Wall-cases 17—24.]

The Star-fishes are characterized by their pentagonal or five-rayed shape. Some, however, have more than five rays (*e.g.*, the *Acanthaster* exhibited in Case 24 has twenty-one, and the *Brisinga* in Case 23 has thirteen). On examining a typical Star-fish we find it to consist of a central flat disk with five regular flat-pointed rays, the whole being encased in a thick leathery integument hardened

by spiny or granular plates of lime. On the under surface of the disk we find, in the centre, a large mouth, and radiating from the mouth five channels or furrows—the ambulacral furrows—from which the ambulacral tube-feet by means of which the Star-fish progresses, emerge in rows. On the upper surface of the disk we find, in the centre, usually but not always, the anus, and near the margin of the disk and between two of the rays, the madreporic plate. In some forms there is more than one madreporic plate—*e.g.*, the *Acanthaster*, in Case 24, has eight. In some forms—*e.g.*, *Astropecten*—there is no anus. The more apparent details of the internal structure of the Star-fishes (such as the arrangement of the water-vascular system, the stomach with its pouches extending into the rays, the genital glands, etc.) are shown in several dissections to which explanatory notices are attached.

The Star-fishe sare all marine, and live at all depths, from the tide-marks down to depths of nearly three thousand fathoms. The shallow-water species prefer hard ground, such as rocks and reefs and beds of hard sand, where they find in abundance the *Mollusca* and the small *Crustacea* upon which they feed. The deep-water or abyssal species dwell upon the ooze of the ocean-bottom, and some of these species appear to gorge themselves with the ooze for the sake of the minute particles of living or dead animal-matter that it contains. Many species of Star-fishes are gregarious—that is to say they live together in large swarms; and some species have been observed to pair at the breeding season. In one family of Star-fishes, of which the magnificent specimen of *Hymenaster nobilis* in Case 23 is an example, the eggs are carried about in a nest-like pouch on the back of the animal until the young are hatched.

The *Asteroidea* are represented by species of the following genera, all from the Indian Seas :—

(1) From the littoral, and from shallow-water :—*Archaster; Craspidaster, Astropecten, Luidia, Stellaster,*

Goniodiscus; Pentaceros, Culcita, Asterodiscus; Anthenea; Asterina; Linckia, Ophidiaster, Nardoa, Chætaster, Fromia; Echinaster, Acanthaster; Asterias.

(2) From the deep-sea: — *Pararchaster, Pontaster, Dytaster, Persephonaster, Pseudarchaster; Porcellanaster, Styracaster, Hyphalaster; Dipsacaster; Pentagonaster, Calliaster, Milteliphaster, Nymphaster, Paragonaster, Mediaster, Anthenoides; Palmipes; Zoroaster; Hymenaster, Marsipaster; Pedicellaster; Brisinga, Freyella.*

2. ECHINODERMATA OPHIUROIDEA. (BRITTLE STAR-FISHES).

[Eastern Wall-cases 24-26.]

The *Ophiuroidea* resemble the *Asteroidea* in external form; but the arms, which very rarely exceed five in number, are relatively much longer and more attenuated, and are much more clearly and sharply marked off from the disk; and the disk is more circular and relatively of much smaller size. In the *Asteroidea*, again, as is seen in the dissections in Cases 19 and 21, the stomachal cæca pass into the arms, as do also the generative organs; but in the *Ophiuroidea*, as is seen in the dissections in Case 25, the viscera are entirely confined to the disk and do not extend into the arms. In the *Ophiuroidea* also an anus is *always* wanting.

On examining a typical Ophiuroid, such as the large specimens of *Ophiothrix galateæ* in Case 26, we see that the animal consists of a small round disk, in which the viscera are lodged, and of five long thin snaky arms orrays.

The disk, on the upper surface, is seen to be covered with small scales the surface of which is beset with little spinelets, while the arms are enclosed in much larger scales or plates, of which those at the sides bear long flat spines in several series. Five pairs of plates at the margin of the disk, near the bases of the arms, are much enlarged: these are known as the "radial shields."

On the under surface of the disk we see, in the centre, the mouth bounded by five pairs of mouth-plates (one of

which is the madreporic plate) with their adjacent mouth-shields, each mouth-plate bearing a series of teeth and tooth-papillæ; and radiating from the mouth-shields, the five "arms," or rays, with their large transverse under-plates. The rays, however, have no open ambulacral groove as they have in the Star-fishes, but the ambulacral groove is completely closed in by a series of ventral or "super-ambulacral" plates, between which and the side-plates the tube-feet emerge.

The under surface of the disk, beyond the mouth-shields, is thickly beset with little spinelets, and on this surface, on either side of the base of each arm, is seen a broad fissure known as the genital cleft, through which the reproductive glands discharge their contents.

The *Ophiuroidea* live at all depths, from between tide-marks down to the abysses of the ocean. They appear to flourish best in the seas of the tropics, as is illustrated in the Andaman Sea, where the trawl is never worked at depths of 100 to 250 fathoms without bringing up scores of specimens (*Ophiacantha*, *Ophiocamax*, *Ophioglypha*), and where at low-water the pools of the coral reefs are often full of writhing masses of brittle-stars (*Ophiothrix*, *Ophiocoma*, *Ophiomastix*).

The *Ophiuroidea* consist of two families—the *Ophiuridæ* or typical forms, in which the rays are simple and unbranched; and the *Astrophytidæ*, in which the arms are usually branched.

1st. The Ophiuridæ are represented in the exhibited collection by specimens of the following genera, all from the Indian Seas:—

From the reefs:—*Pectinura*, *Ophiolepis*, *Ophiozona*, *Ophiocnida*, *Ophiophragmus*, *Ophiocoma*, *Ophiarthrum*, *Ophiomastix*, *Ophiothrix*, *Ophiocnemis*.

From the great depths:—*Ophiernus*, *Ophioglypha*, *Ophiomusium*, *Ophiocamax*.

2nd. The Astrophytidæ are represented by several forms from the depths, none of which, however, appear to corre-

spond with any hitherto described species or genera, with the exception of an *Astroschema* (*Astroschema flosculus*) from 88 fathoms in the Bay of Bengal.

3. ECHINODERMATA CRINOIDEA (SEA-LILIES, FEATHER-STARS).

[Eastern Wall-case 27].

The *Crinoidea* somewhat resemble the *Ophiuroidea*, especially the *Astrophytidæ*, in external form, consisting of a central disk, in which the viscera are lodged, and of slender arms radiating from the disk, which lodge the ambulacral canals: but the disk of the Crinoids, instead of being flat and depressed, is either conical or cup-shaped, and is often attached by a long stalk; and the arms are divided from their base into numerous feather-like branches.

There are two families of *Crinoidea*—the *Pentacrinidæ* or stalked Crinoids, and the *Comatulidæ* or free-swimming Crinoids, which are stalked only in the young state.

1st. The principal external characters of the Pentacrinidæ may be learned from an examination of the specimen of *Metacrinus* in Case 27. In *Metacrinus* we find a long stalk by which the animal is fixed, back downwards: it consists of a series of pentagonal stony (calcareous) segments joined together one above another: at regular intervals along the stalk are seen whorls of similarly segmented branchlets known as "cirri". At the end of the stalk comes the disk, which consists of a small stony (calcareous) cup placed mouth upwards. From the edge of the disk spring five arms, which are built up of stony segments, and each of which divides and subdivides several times into long branches fringed on both sides with feathery processes known as "pinnules". The concave inner surface of the cupped disk is covered by a thick leathery skin, and in the centre of it can be

seen the orifice of the mouth: the inner concave surface of the arms and of their branches is also covered with the same thick skin, through which the ambulacral feet emerge. As in the *Ophiuroidea*, the viscera are confined to the disk, and the ambulacral water-vascular system extends along the arms and pinnules.

2nd. The chief characters of the Comatulidæ may be learned from an examination of the fine specimens of *Actinometra* in Case 27. In *Actinometra* the animal is only fixed in its larval stages: in its adult stages it is free. Here we find a conical disk, with a flat oval surface, from which five long much-branched feathery arms radiate. The under surface of the disk—which is really the upper or dorsal surface, for the animal moves about on its back, face upwards—is covered with a pyramid of stout calcareous plates, from which one or two whorls of stout segmented "cirri" radiate. The cirri are prehensile, and by means of them the animal anchors itself to foreign objects. The upper surface of the disk—which is really the under or ventral surface—is covered with a leathery skin channelled by the wide ambulacral grooves as they pass to the arms, and presents to view, near the margin, the depressed oval mouth, and near the centre the long tubular anus. The arms are merely a repetition of those of *Metacrinus*. In neither *Metacrinus* nor *Actinometra* do we find a madreporic plate, this structure being absent in the *Crinoidea*, in which Class the ambulacral system is filled from the general body cavity or cœlom.

The greater number of the *Crinoidea* are extinct, and their fossil remains form vast beds of limestone rock, in the Palæozoic formations (Cambrian, Silurian, Devonian, and Carboniferous) known as Crinoidal Limestone.

The existing *Crinoidea* usually occur at some depth. In the Indian area the *Comatulidae* are commonly dredged on rocky bottoms at from 15 to 60 fathoms, and the *Pentacrinidæ* occur in the Andaman and Laccadive Seas at and near 500 fathoms.

This Class of the *Echinodermata* is represented in the

collection by fine specimens of *Pentacrinus*, *Metacrinus*, *Actinometra* and *Antedon*,—all from theIndian Seas.

The extinct species are represented by fossil specimens of *Pentacrinus* from the Permian, and of *Pentatremites* from the Carboniferous.

4. ECHINODERMATA ECHINOIDEA (SEA-URCHINS, SEA EGGS).

[Eastern Wall-cases 28—34].

In the *Echinoidea* the body is spherical, or heart-shaped, or disk-shaped, and is always enclosed in a shell or test formed of calcareous plates which in all living forms, except *Phormosoma* and *Asthenosoma*, are immovably sutured together. These calcareous plates are always more or less densely covered with movable spines—there usually being a close covering of small spinelets, with very much larger spikes interspersed. Three-pronged pedicellariæ are very commonly found among the spinelets, these in *Cidaris*, for example, being large enough to be easily distinguished by the naked eye.

The external characters of a typical Regular Echinoid are well shown in the specimen of *Heterocentrotus trigonarius* (Case 28), which has been dried, denuded of all its spines, and coloured.

Here, looking from above, we find the plates of which the test is composed to fall into twenty meridional rows arranged in ten pairs. Five of these paired rows of plates are narrow, and are closely perforated with numerous pairs of pores. These pores are for the passage of the ambulacral tube-feet. The perforated plates are therefore known as ambulacral plates, and the five rows of them are collectively known as the "radii". They are coloured crimson in the specimens.

Alternating with the radii are five also double rows of very much broader plates which are not perforated: these are known collectively as the "interradii", and are coloured blue in the specimens.

The poriferous radii and the imperforate interradii do not meet at the apex of the test, but the apex of the test is occupied by a star-shaped area formed by ten plates surrounding a central orifice. This central (apical) orifice is the "periproctal area", and in life it is covered in with small scaly plates, and is perforated by the anus. Of the ten plates which surround the periproctal area, five are seen to occupy the summits of the radii, while five much larger ones occupy the summits of the interradii: those which surmount the radii are known as "radial plates" (formerly termed "ocular plates"), while those which surmount the interradii are known as "basal plates" (formerly termed "genital plates"). Each basal plate is conspicuously perforated by a large pore for the duct of the underlying genital gland, and one of the basal plates is much enlarged and spongy. This large spongy basal plate is the madreporic plate, through which the sea-water filters into the stone-canal, and so to the water-vascular system.

Looking from below we see that neither the radii nor interradii quite meet at the lower pole of the shell, but we find there a large orifice. This is known as the peristomial area, and in life it is filled up with a scale armour of little plates, except in the centre where the mouth lies.

The intact peristomial area, with the mouth and the five large teeth characteristic of the Regular Echinoids, are seen in the neighbouring specimen of *Dorocidaris* (Case 28).

The arrangement of the mouth and of the five jaws, with their "pyramids", which work on the "braces" and "compasses" and enclose the sharp-pointed teeth, is shown in the neighbouring dry preparation of the mouth-parts of *Salmacis* (Case 28).

Alongside of the jaws of *Salmacis* is shown half of the test of the individual from which the jaws were removed: this preparation is meant to exhibit the internal upstanding processes (or "auricles") of the ambulacral plates, which support the "pyramids" and give attachment to the

muscles which move the jaws. Next to this preparation is dried and denuded test of *Cidaris*, also opened to display the "auricles", which however in *Cidaris* are upstanding processes of the *interradial* plates. The "auricles" which, like the "pyramids", jaws, and teeth, are five in number, are known collectively as the "perignathic girdle".

The division of the shell into radii and interradii corresponds with certain constant arrangements of the internal organs: a radial water-vessel, accompanied by a nerve and a blood-vessel, traverses each radius, while a generative gland lies in each interradius.

The details of the digestive, water-vascular, and reproductive systems are shown in the spirit preparations of *Salmacis* (Case 29), which also display well the mouth-parts *in situ*, and the muscles by which they are moved.

The above remarks apply only to the Regular Sea-urchins—the *Cidaroida* and *Diadematoida*—that have spheroidal tests, at the poles of which the alimentary canal opens.

There are, however, two large groups of Irregular Sea-urchins, in which the test is no longer spherical or even circular, and in which the mouth and anus are often excentric.

The first of these groups is the *Clypeastroida*, of which we may take *Echinodiscus lævis* as a type.

In *Echinodiscus lævis* (Cases 32-33) we find the body to have the form of a flat shield-shaped cake or irregular disk. On the flat under (ventral) surface we find, in a central position, the mouth, and nearly midway between the mouth and the edge of the disk the anus. Radiating from the mouth are the ambulacral grooves, which bifurcate and branch again and again, and have pores so minute as to be visible only with a pocket-lens.

On the upper (dorsal) surface we notice, in the centre, the basal (genital) plates all fused together to form a single large pentagonal madreporite, in only *four* of the angles of which are genital pores found. Radiating from the apical madreporite is a regular five-rayed "rosette", each petal of which is formed by series of ambulacral pores.

The principal internal characters of the *Clypeastroida* are exposed in the spirit-dissection of *Echinodiscus lævis* (Case 33), where the mouth is seen to be armed with teeth which, however, are more horizontal than vertical; the "pyramids" are broad and flat, and are united together to form a large pentagonal plate, and there are no braces and compasses. The nature of the mouth-parts, as of the "perignathic girdle" and of other parts of the interior of the test, is shown in several dry preparations in Case 32.

In the *Spatangoida* the test is very commonly heart-shaped. Looking at such a form as *Lovenia*, Cases 33-34, on the under (ventral) surface, at the broader end of the "heart," we find the toothless valvular opening of the mouth, while at the apex of the "heart" the periproct is seen. On the upper (dorsal) surface, near the centre, we notice the five small basal (genital) plates, three or four of which are perforated, while the fifth, which is imperforate, forms a small "madreporite". Radiating from the genital plates is an irregular ambulacral "rosette" of five rays, four of which are conspicuous by their breadth and by the size of their pores, while the fifth by reason of the minuteness of its pores is at first sight likely to be overlooked. Owing to the absence of teeth no "jaws" and no "perignathic girdle" are found among the *Spatangoida*.

The *Echinoidea* are found in all seas, and at all depths from tide-marks to the abysses of the ocean. In the Indian region the Regular Echinoids are met with in profusion on the coral reefs—*Cidaris* and *Phormosoma*, however, being most abundant at depths of 150 to 500 fathoms: the *Clypeastroida* are very common in shallow muddy water, as for instance along the estuarine coasts of the great rivers of the Bay of Bengal: while the *Spatangoida* have been obtained in greatest number on muddy bottoms in 400 to 600 fathoms.

Such being their range, their habits of life are various: the shallow-water forms live on Molluscs and *Crustacea*, on sea-weed and even on decaying vegetable matter; the deep-

water and toothless forms appear to extract nourishment from the organic matter, animalcules, etc., found in sea-mud.

The *Echinoidea* are represented in the exhibited collection by the following genera—all from the Indian Seas: —*Cidaris*, *Dorocidaris*, *Porocidaris*, *Phyllacanthus*, *Goniocidaris*; *Phormosoma*, *Asthenosoma*; *Diadema*, *Echinothrix*, *Astropyga*; *Temnopleurus*, *Salmacis*, *Mespilia*; *Heterocentrotus*, *Colobocentrotus*, *Echinometra*, *Stomopneustes*, *Echinostrephus*; *Toxopneustes*, *Tripneustes*, *Prionechinus*, *Fibularia*, *Clypeaster*, *Laganum*, *Peronella*, *Echinodiscus*, *Arachnoides*, *Echinolampas*; *Brissus*, *Metalia*, *Brissopsis*, *Maretia*, *Lovenia*, *Homolampas*.

Besides the above, a small collection of Australian forms is exhibited, and a good collection of fossil types. The fossil specimens are distinguished by a red wafer.

ECHINODERMA HOLOTHUROIDEA (SEA-CUCUMBERS).

[Eastern Wall-cases 35-36].

The *Holothuroidea* are long worm-like or cucumber-shaped Echinoderms with a thick leathery skin which is usually soft and strengthened, though but slightly, with scattered microscopic spicules and perforated platelets of various form composed of carbonate of lime. In one small group of deep-sea *Holothuroidea*, however, represented in the collection by the beautiful specimens of *Deima*, the integument consists of a continuous mosaic of large calcareous plates which form a rigid test not unlike that of a Sea-urchin. In the Holothurians the water-vascular system undergoes a remarkable modification; it becomes more respiratory and less locomotor in function, the ambulacra being reduced in number to three or to two, or even disappearing altogether (*Synapta*, *Caudina*), while round the mouth the system becomes extended into a crown of large and often much-branched oral tentacles: these are displayed, fully extended, in the specimen of *Thyone* in Case 35.

In cases where the ambulacra are reduced to three, these are commonly placed close together on one face of the body, which then becomes a flattened ventral surface or "foot", upon which the animal progresses like a snail or slug, while the opposite surface becomes a strongly convex back. This is excellently shown in the specimens of *Mulleria miliaris* in Case 36, which have a strong resemblance to a slug. In the beautiful specimens of *Deima* this modification of the form of the body, showing a flat ventral surface, or "foot", for progression, and a convex hogged back, is even better marked; but in *Deima* instead of three ventral ambulacra there are only two.

The external characters of the typical Holothurian are conspicuously easy to note. The body is elongate and more or less cylindrical, tapering at both ends. At one end (oral pole) we find a large mouth surrounded by a crown of tentacles, which last, however, are very commonly retracted within the mouth. At the opposite end (anal pole) is seen the anus, which is often surrounded with a ring of more or less calcareous papillæ, or "teeth".

The details of the internal structure of the *Holothuroidea*—the digestive system, the internal respiratory system, the water-vascular system, the generative system, etc.—are very clearly shown in the series of dissections in spirit of *Holothuria*, *Stichopus*, and *Mulleria*, in Case 36. The dissected specimens of *Stichopus* and *Mulleria* exhibit very beautifully a curious feature in the life of these animals: in the *Stichopus* the body-cavity is seen to be occupied by a long eel-like fish of the genus *Fierasfer*, the head of which lies in the cloaca of the *Stichopus*: in the *Mulleria* the cloaca is occupied by a small crab. At first sight it might appear as if the fish and the crab were parasites upon the animal in which they are found, and lived at the expense of their host; but that this is not so is proved by the fact that both the fish and the crab have all their organs of nutrition, respiration, circulation, excretion, locomotion, volition, etc., fully and perfectly developed,—a state of

things that is never found in parasitic animals, which always show a degradation of some or all of these organs.

The fish and crab are really "commensals" or messmates with the Holothurians with which they live. "This living together of two animals is known as 'symbiosis'. It differs essentially from parasitism, in which one organism preys upon another, the host deriving no benefit but only harm from the presence of the parasite. In symbiosis on the contrary the two organisms are in a condition of mutually beneficial partnership".—(Jeffery Parker). The Holothurian furnishes a safe retreat for the fish and the crab, while the fish and the crab probably serve the Holothurian by keeping it clean in some way.

[Another excellent instance of symbiosis is illustrated in Case 16, where the coralla of *Heterocyathus* are found to be tenanted each by a small worm. In this case the *Heterocyathus* serves the worm by affording it a safe retreat, while the worm returns the service by carrying the *Heterocyathus* about from one feeding ground to another, thus transforming it from a fixed and sedentary into a freely locomotive animal].

The *Holothuridea* are found at the bottom of all seas from the surf line to the greatest depths of the ocean. They live, as is well illustrated in the dissected specimens, upon sand and mud, with which they gorge themselves for the sake of the small amount of organic matter (remains of dead animals, living animalcules, etc.) that is contained in its interstices, very much in fact as earthworms do.

The *Holothuroidea* are represented in the exhibited collection by the following genera from the Indian area:—

(1) Deep-sea forms—*Deima, Orphnurgus, Pannychia, Lætmogone, Euphronides, Psychropotes, Benthodytes, Apodogaster; Eupyrgus, Ankyroderma, Trochostoma:*

(2) Shallow-water and Reef forms—*Synapta, Haplodactylus Caudina; Cucumaria, Colochirus, Ocnus, Thyone, Thyonidium, Stichopus, Holothuria, Bohadschia, Mulleria.*

PHYLUM VI OF THE CŒLOMATA.

MOLLUSCA.

[Desk-cases 126A-179B and E-XVE].

The *Mollusca* occupy the long double row of desk-cases that traverses the middle of the gallery, as well as the three short rows of desk-cases that run at right angles to the first—one at each end of it and one bisecting it.

A typical Mollusk—*e.g.*, a Gastropod—is an animal with a soft non-segmented body protected by a hard calcareous shell into which, as into a house, the body can in most cases be completely withdrawn. In the typical Mollusk we can distinguish (1) a well-marked head with (*a*) a mouth and a pair of short broad mouth-tentacles or "lips", and (*b*) a pair of long cylindrical cephalic tentacles, upon some part of which the eyes are usually carried; and (2) a body enveloped in a fold of skin or "mantle", the under or ventral part of the body being thickened to form a great solid muscular protrusible foot for progression, while the thin-walled upper or dorsal part contains the viscera and is permanently lodged within the cavity of the shell. The shell is formed by the calcification of the surface layer of the special fold or outgrowth of the wall of the dorsal part of the body already spoken of as the "mantle" or *pallium*, which in the typical mollusk completely envelopes the body and foot like a cloak or skirt. The space between this mantle-cloak and the body is known as the "mantle-chamber" or "sub-pallial space": it contains the breathing-organs, and receives the openings of the excretory organs, and often of the reproductive organs also. A good simple example of a molluscan "foot", "mantle", shell, and "mantle-chamber" is furnished by the common Limpet, placed above Case 128.

The internal structure of a typical mollusk may be studied in the dissections of the large Snail placed above

Case 179, in which there can be seen (1) the alimentary canal coiled and embedded in a dark digestive gland or "liver", and ending in the fore-part of the mantle-chamber on the right side; (2) the two-chambered heart into which the blood-vessels that branch over the breathing-organ are collected; (3) the excretory organ or kidney running alongside the great blood-vessel that proceeds to the heart; (4) the coiled reproductive glands with their ducts and accessory glands (in one case a part of the duct is full of eggs); (5) the nerve-ganglia, collected in three pairs in the vicinity of the front part of the alimentary canal, with the nerve-cords that connect the ganglia. There should also be noticed opening into the front part of the alimentary canal, (6) the arborescent salivary glands with their long ducts, and (7) the sack containing the "odontophore", an organ to be presently described. All these parts can be easily seen in the dissections.

The Mollusk shell, as already stated, is formed by the calcification of the superficial layer of the mantle, and therefore increases in size as the mantle grows. The variations in the shape of the shell will be afterwards considered.

The Molluscan "foot" is a characteristic organ of the highest importance: it is often divided by constrictions into three distinct parts,—a front, a middle, and a hind part, known respectively as "propodium", "mesopodium", and "metapodium", which may undergo various modifications and suppressions.

Another characteristic Molluscan organ is the "tongue", or "odontophore", or "radula". It is a horny strap, the upper surface of which is generally covered with small sharp teeth arranged in rows like a rasp: in use it is worked backwards and forwards by special muscles, and in repose it lies coiled up in a sheath at the floor of the mouth. The typical odontophore is well shown in the dissected specimen of the Limpet above Case 128, in which it is of enormous length.

The sexes may be distinct, or may be united in the same individual, as they are in the Land-snails. Reproduction takes place by means of eggs, which in the case of many marine *Mollusca* are glued together in masses or capsules of remarkable form. Several of the most peculiar forms of these egg-capsules are shown on the stand that rises above the desk-cases, and among them a curious form shaped like a ruff and much resembling a Sponge or a Sea-mat in general fabric.

Mollusca are found in all situations—on dry land at all elevations, in swamps, rivers, lakes and ponds, on the reefs and rocks of the sea-shore, at the surface of the open seas, and in the deepest abysses of the ocean.

The Molluscan phylum is divided by Professor Ray Lankester, whose classification is here followed, into two great branches, namely, (1) the *Glossophora*, in which there is a distinct head provided with an odontophore; and (2) the *Lipocephala*, in which neither head nor odontophore are present.

I. 2. 3. MOLLUSCA GLOSSOPHORA.

[Cases 126A-171C, and E-XVE].

This branch includes three Classes, namely, (1) the *Gastropoda*, (2) the *Scaphopoda*, and (3) the *Cephalopoda*, which are distinguished from one another chiefly by the form of the foot.

I. GLOSSOPHORA GASTROPODA.

[Cases 126A-168C, and E-XVE].

In the *Gastropoda*, of which the Garden Snail is an example, the foot has usually a broad flattened sole-like surface for progression. A shell is usually present, and has the form of a cone, which may be simple, but more commonly is coiled in a spiral—sometimes of many whorls. The direction of the spiral is most usually from right to left. The simple cone is seen in the Limpets (*Patella*), Case 128: an elongated tube with an indefinite loose spiral coil occurs in *Siliquaria* and *Vermetus*, Case 140X:

the close produced spiral is shown in *Turritella*, Case 140X, and the close plane spiral in *Rotella*, Case 131A, and *Marisa* 148A. All manner of intermediate forms occur.

The mouth of the shell, which is polished and often thickened and everted, is known as the "peritreme", and the axis round which the shell is coiled is the "columella", each turn of the coil being called a "whorl". The columella is sometimes closed below by the peritreme, but sometimes remains open, the opening being known as the "umbilicus".

The mouth of the shell can commonly be closed by a horny or shelly plate known as the "operculum": this is secreted by the upper surface of the hinder portion of the foot, or metapodium.

There are two subdivisions of this very large Class—(1) the *Gastropoda Isopleura*, in which the body with all its contents is bilaterally symmetrical; and (2) the *Gastropoda Anisopleura*, in which only the head and foot are bilaterally symmetrical, while the visceral mass and mantle are twisted completely over to the right side, the intestine ending alongside or above the animal's head.

a. GASTROPODA ISOPLEURA.

[Cases 126A—126B].

The principal Order of this sub-Class is that of the *Polyplacophora* or Chitons.

The Chitons are distinguished among all *Gastropoda* by the nature of the shell, which consists of eight imbricating plates arranged in a row, and deeply immersed in the rough leathery mantle. They are common inhabitants of the rocks of all shores, and are well represented in Case 126A-B. The sexes in the Chitons are distinct.

b. GASTROPODA ANISOPLEURA.

The anisopleurous or asymmetrical Gastropods are subdivided into four Orders according to the nature of the breathing organs, namely, (1) the *Zygobranchia* with a pair of gill-plumes; (2) the *Azygobranchia* with

only one gill-plume—the right—functionally developed; (3) the *Opisthobranchia*, in which the gill-tuft, often uncovered by the mantle, is placed often on the after end of the body and always *behind the heart;* and (4) the *Pulmonata*, in which the free edge of the mantle is fused with the body-wall so as to convert the mantle-chamber into a closed sack, open only in front, which is used as a *lung*.

i. GASTROPODA [ANISOPLEURA] ZYGOBRANCHIA.

[Cases 126C—129B].

The *Zygobranchia* are characterised by the possession of a pair of gill-plumes, by the absence of special genital ducts, and by the large simple cap-like shell. The Order includes three families of herbivorous marine littoral mollusks, namely, (1) the *Haliotidæ* or Earshells, (2) the *Fissurellidæ* or Key-hole Limpets, and (3) the *Patellidæ* or true Limpets: all three are widely distributed, the *Haliotidæ* being most numerous in the Australian region, and the *Fissurelidæ* in South America. All three families are well represented in Cases 126C—129B. The sexes in the *Zygobranchia* are distinct. In the true Limpets the gill-plumes are rudimentary, and the functional breathing organ is a fringe at the circumference of the mantle—see the preparation above Case 128.

ii. GASTROPODA [ANISOPLEURA] AZYGOBRANCHIA.

[Cases 129C—166B].

In the *Azygobranchia* owing to the torsion of the visceral mass to the right the important organs (gill-comb, kidney, etc.) on the left side have atrophied and disappeared The sexes are distinct, and special genital ducts are present. A large spiral shell, often of many whorls, is present, and the mouth of it is often closed by a horny or stony operculum. The Order is a very large one and includes both terrestrial and freshwater as well as a

vast number of marine forms: it is divided by Professor Ray Lankester into two sections—a larger section, known as *Reptantia* or Creepers, in which the foot forms a disk for crawling; and a very much smaller section, known as *Natantia* or Swimmers, in which a part of the foot forms a fin-like swimming organ.

REPTANTIA.

There are three sub-Orders of crawling Azygobranch Mollusks, namely, (1) the *Holochlamyda*, in which the free edge of the mantle is simple or very slightly produced, and the lip of the shell therefore unnotched or only slightly notched; (2) the *Pneumochlamyda*, in which the mantle-chamber forms a lung-sack, as it does in the Snails, with which, however, they must not be confused; and (3) the *Siphonochlamyda*, in which the edge of the mantle forms a long tube or siphon which notches deeply the lip of the shell.

α. GASTROPODA AZYGOBRANCHIA HOLOCHLAMYDA.

[Cases 129C—148A].

Lip of shell not channelled, or only slightly so (*Cerithiidæ*). The animals are mostly vegetarian: many live in the sea, many in salt and brackish swamps, some in freshwater, and some on dry land. They are grouped by Professor Ray Lankester into 19 families, 18 of which are thoroughly well represented in the exhibited collection.

1st Family, Trochidæ [Cases 129C 132C].

This is a very large Family of marine gastropods, the species of which are commonly found not far from low-water mark. They feed principally on sea-weed, and are universally distributed. A few species live in the depths of the ocean. The shells are mostly pyramidal or turbinate, and are furnished with an operculum which may be either stony or horny. Most of the genera of this large family are represented in Cases 129C—132C.

2nd Family, Neritidæ [Cases 133A—134A].

The members of this family are almost entirely inhabitants of the tropics: most of them are marine and littoral, but some (*Neritella*, *Navicella*) occur in rivers, and some are amphibious in certain estuarine localities. They are all herbivorous. Specimens of all the known genera are to be found in Cases 133A—134A. The shells are cap-like, the last whorl being large, and the preceding whorls being small and often more or less absorbed. The operculum is either horny or may be a thin calcareous plate.

3rd Family, Pleurotomaridæ [Case 134A].

A small family of herbivorous gastropods found for the most part among the coral-reefs of the Indo-Pacific. The shells of *Stomatia* have a resemblance to those of *Haliotis*.

4th Family, Scalaridæ [Case 134B-C].

The members of this small family are predaceous, and though widely distributed occur in greatest abundance in Eastern Seas. The shell, which is closed by a horny operculum, forms a most elegant tapering spiral, the whorls of which are ornamented by numerous equidistant cross-ribs. *Scalaria* secretes a purple fluid when molested.

5th Family, Janthinidæ [Case 135A].

The *Janthinidæ* or "Violet Snails" are predaceous mollusks which live at the surface of the open ocean, being kept afloat, as by a buoy, by a long cluster of air-vesicles developed on the "foot." The shells are commonly cast ashore on the coasts of India after strong southerly gales. *Janthina* is able to secrete a purple fluid, by which the thin shell is beautifully dyed. Observe the spirit specimen of a female *Janthina* above Case 135, showing the vesicular float-like foot, with the egg-capsules suspended from its under surface.

6th Family, Cerithidæ [Cases 135B—136C].

Of the species of this large family some are marine, some, as *Pyrazus* and *Telescopium*, inhabit mangrove swamps and brackish marshes, and a few (*Cerithidea*) are amphibious. Some species of *Cerithium*, secrete a green fluid when molested. The shells have the form

of long pointed many-whorled spires, the lip of which is often notched and channelled, and they are closed by a horny operculum.

7th Family, Melanidæ [Cases 137—139B].

A large family of freshwater mollusks abounding throughout the warmer regions of the world. The shells are spiral turrets, often of great length, and are usually covered with a thick dark-coloured epidermis, and closed by a horny operculum. Very commonly the top of the spire is eroded and decollated, but often (*e.g.*, *Faunus*) is quite perfect. The animals appear to prefer muddy water, and are herbivorous.

8th Family, Pyramidellidæ [Cases 140A, B].

The shells in this family are most usually long acutely-pointed many-whorled spires, with the lip often notched and slightly channelled. The animals are marine, and are probably predaceous. Operculum horny.

9th Family, Turritellidæ [Case 140X].

The "Screw Shells" are marine and are widely distributed. In the *Turritellidæ* proper the shell is an elongate beautifully tapering spire: in the *Cæcidæ* it is a spiral disk in the young stage, but in the adult, by the loss of the spire, it becomes a simple tube: in the *Vermetidæ* also it becomes in the adult a loosely and irregularly twisted tube, much like a worm-tube. The shells are usually furnished with a horny operculum.

10th Family, Xenophoridæ [Case 140X].

The "Carrier-shells" are marine, and have the remarkable habit of strengthening and protecting their own shells with the dead shells of other species of *Mollusca*, the protective pieces being arranged with beautiful regularity round the edges of the whorls. The foot is also remark-

able in being cylindrical and in being divided into two portions—an after portion which carries the horny operculum, and a front portion on which the animal hops.

11th Family, Naticidæ [Cases 140Y—141A].

This is a large and geologically ancient family of predaceous marine mollusks. The animals have a small head, and an enormous foot for burrowing, and they are usually blind. The shells generally have the last whorl of great size and the spire small, and are either globose or ear-shaped: the operculum is either well developed and stony, or horny and rudimentary. The *Naticidæ* are of universal distribution and are very abundant in tropical seas.

12th Family, Marsenidæ [Case 141A].

A small family of carnivorous marine mollusks in many respects resembling the *Naticidæ*. The shells, which are very fragile and are often covered with an epidermis, or are sometimes hidden by the foot, resemble those of *Sigaretus* among the *Naticidæ*, but have no operculum.

13th Family, Acmæidæ [Case 141B].

The *Acmæidæ* are known as "False Limpets" from the resemblance of their shell to that of the Limpets. The animal, however, differs from the Limpet in having a single true gill-plume on the right side of the neck; whereas in the true Limpet the gill-plumes are minute rudiments placed symmetrically one on each side of the neck, and the functional gill, as may be observed in the spirit specimen above Case 128, consists of a fringe of filaments hanging from the inner surface of the mantle throughout its whole circumference. The *Acmæidæ* are widely

distributed, and in habit and manner of life resemble the true Limpets.

14th Family, Capulidæ [Cases 142A, B].

The *Capulidæ* are known as "Cup and Saucer Limpets". They also resemble the true Limpets both in habit and in form, but differ from them in having a single true gill-plume, well developed and on the right side of the neck, as among the *Acmæidæ*. The shell differs from the simple cap-like form of the Limpet and False Limpet in having either the aperture partly covered in behind (*e.g. Crepidula*), or the dome furnished with a more or less complete shelly cup (the rudiment of a columella) for the special protection of the viscera (*e.g.*, *Crucibulum*).

15th Family, Littorinidæ [Cases 143A—145B].

The Periwinkles form a very large and very widely distributed family of herbivorous gastropods, the great majority of the species of which are marine and littoral, often living above high-water mark. The shells are turbinate with the lip smooth and unnotched: in some species they resemble *Trochus* shells, from which, however, they may be distinguished by the dull (non-nacreous) interior,—the shells of the *Trochidæ* being always brilliantly pearly (nacreous) within.

Hydrobia and its alliance, and *Assiminea* and its alliance, live in brackish and fresh waters, some species of these genera, like the true Periwinkles, being amphibious. The shells of the *Littorinidæ* are closed by a horny operculum.

16th Family, Paludinidæ [Cases 145C—147A].

The "River Snails" resemble the Periwinkles. They inhabit rivers, lakes, ponds, and marshes throughout the northern hemisphere. They are viviparous. The shells, which generally have the spire produced, are thin, are

covered with a dark epidermis, and are closed by a horny operculum.

17th Family, Valvatidæ [Case 147B].

The *Valvatidæ* are a small family of pond-snails, occurring chiefly in the temperate parts of the northern hemisphere. The animal is remarkable—see the enlarged drawing in Case 147B—in having its gill-comb exposed. The shell, which is covered with epidermis, is a spiral, usually coiled in a nearly horizontal plane, and is closed by a horny operculum.

18th Family, Ampullaridæ [Cases 147C—148A].

These are pond and river snails found principally within the tropics. Although the animal possesses a gill, it also has a part of the mantle-cavity shut off to form a lung-sack, so that it can live as well on dry land as it can in freshwater. The shell is a short spiral covered with dark epidermis and closed by an operculum which is sometimes stony.

β. GASTROPODA AZYGOBRANCHIA PNEUMOCHLAMYDA.

[Cases XVI A, B, C].

In this sub-Order of crawling Gastropods the gill is absent, and the mantle-edge is adherent to the body in the greater part of its extent to form a lung-sack. The species of this large group are all, like the true snails, terrestrial, but they differ from the true snails in many important details of internal organization and also in possessing an operculum to close the shell. This sub-Order comprises the three families of the *Cyclostomidæ*, *Helicinidæ*, and *Aciculidæ*.

γ. GASTROPODA AZYGOBRANCHIA SIPHONOCHLAMYDA.

[Cases 148B—166B].

In this sub-Order of crawling Gastropods the edge of the shell is notched, or is drawn out to form a long narrow channel, for the passage of a corresponding process of the mantle. The animals are almost exclusively marine

and are generally predaceous. The following are the principal families :—

1st Family, Strombidæ [Cases 148B—150A].

"Wing shells" and "Scorpion shells". Among the members of this family the shell of the adult usually differs very considerably from that of the young. In the young it usually has the form of a simple close-coiled spiral cone, but in the adult the outer lip of the mouth of the shell generally becomes greatly expanded in the form either of a simple wing (*Strombus*), or of a wing festooned with great spreading curving claws (*Pteroceras*): a series of specimens of *Pteroceras*, in Case 149C, shows this difference between the young and the adult shell in its most marked degree. The spirit specimen of *Rostellaria delicatula*, placed above Case 150, shows the characters of the typical animal, with its long snout and its long cylindrical foot for hopping. Observe the characteristic small horny operculum *in situ* on the foot.

2nd Family, Aporrhaidæ [Case 150B].

A small family of Wing shells, no member of which is known to occur in Indian Seas.

3rd Family, Dolidæ [Cases 150 C—151B].

"Tun shells", "Helmet shells", "Fig shells".

In this family the shells are large and inflated, with the whorls ribbed or varicose, and the peritreme deeply notched in front: they are sometimes remarkably thin and light, and sometimes (*Cassis*) remarkably thick and heavy, especially at the lip. The thick shells of *Cassis* are used in the manufacture of cameos.

The animals generally have a very large foot. In *Dolium* and its allies there is no operculum.

4th Family, Tritonidæ [Cases 151B—152C].

"Trumpet shells".

The Tritons are for the most part tropical, and reach their maximum in the Eastern Seas. The shells have usually a prominents pire and numerous ribs or varices,

are often brightly coloured, and are closed by a horny operculum.

5th Family, **Cypriædæ** [Cases 153A—154C].

The Cowries are remarkable for their richly coloured and beautifully polished convoluted shells, which outwardly appear to consist, in the adult, of a single whorl with the outer lip remarkably rolled in, the other whorls of the spiral being almost entirely concealed. In young individuals, however, the spire is distinct and prominent, and the outer lip has a simple sharp edge. The animal is notable for its large foot and for the lobe-like extensions of its mantle, which fold over the shell from each side, nearly meeting in the middle line above. The Cowries are characteristic of tropical seas, especially those of the eastern hemisphere. An operculum is absent. Observe the longitudinal vertical section of a Cowrie shell in Case 154C.

6th Family, **Pedicularidæ** [Case 150B].

This is a very small family, consisting of a few species of a single genus of small gastropods parasitic on Corals. In the younger stages the shell of *Pedicularia* is regular, but in the adult the degradation resulting from the parasitic habit leads to marked deformity.

7th Family, **Conidæ** [Cases 155A—156B].

The "Cones" are remarkable for their magnificently coloured shells, and are characteristic inhabitants of the shallow seas of the tropics, especially of the eastern hemisphere. They are excessively predaceous, and are said to be capable of inflicting a dangerously venomous bite. The shell of the Cone, like that of the Cowrie, often appears to consist, to outward view, of a single whorl, owing to the fact that the last whorl envelopes and conceals the others. The operculum, when present, is small.

8th Family, **Terebridæ** [Cases 156B-C].

The beautiful "Augur shells" are also characteristic of the seas of the eastern tropics. The shells are long,

slender, polished and acutely pointed, and consist of a spiral of many whorls.

9th Family, Pleurotomidæ [Cases 157A-B].

The "Hare-lip shells" although universally distributed are most numerous in tropical seas. About eighty species are also known from depths of 200 to 2,500 fathoms. In the typical forms the shell has a long channel for the siphon, and is deeply cleft in the outer lip near the "suture", the mantle also having a corresponding cleft.

10th Family, Cancellaridæ [Case 157B].

In this family also the majority of the species inhabit the seas of the tropics. The shell is "cancellated", or marked with a fine lattice-work of cross-ribs. The animals are said to be vegetarian.

11th Family, Muricidæ [Cases 157C—160A].

This is a very large family, the constituent species of which are widely distributed, though most abundant in warm and tropical seas. The shells are often beautifully and regularly "variced" or ribbed, the ribs being sometimes foliated and frilled and sometimes ornamented with rows of long spines. In the animal, an adrectal gland is highly developed and secretes a colourless fluid, which, on exposure to the air, turns purple; and it was from a species of *Murex* that the famous Tyrian purple was manufactured.

12th Family, Buccinidæ [Cases 160A—162B].

The type genus of this large family—the Common Whelk (*Buccinum*)—is confined to the colder temperate and the polar seas; but several of the largest genera—*e.g.*, *Nassa*, *Purpura*, *Ricinula*—occur in great abundance in Indian waters. The shells vary greatly in form; in many species they have a large and well-produced spire, but in some genera—*e.g.*, *Purpura*, *Ricinula*, *Cuma*, *Rapana*—the spire is short, being sunk in the last whorl, which is very large. The species of *Purpura* secrete a purple dye.

Observe the peculiar form of the shell of *Magilus* in Case 162B: *Magilus* lives in crevices in growing coral-stocks, and as the coral spreads, the *Magilus*, in order to avoid being overgrown and buried, continuously lengthens its shell at the mouth, until at last the shell comes to be nothing more than a long irregular tube, not unlike a large worm-tube.

13th Family, Mitridæ [Cases 162C—164B].

The species of this large family are almost exclusively tropical, and are specially numerous in eastern seas. The shells are very beautifully sculptured and coloured, and have generally a long sharp spire. The inner lip of the mouth of the shell is marked by several oblique folds and ridges, and an operculum is either rudimentary or absent.

14th Family, Olividæ [Cases 164B—165B].

The shells of the *Olividæ* somewhat resemble those of the *Cyprædæ* by reason of their polish and shape, the last whorl, which is of great size, more or less completely enclosing and concealing the spire. The inner lip of the Olive-shell, however, is marked by several prominent oblique folds, and the outer lip is not rolled in as it is in the Cowries. The animals of the two families, moreover, differ in several respects, but most markedly in the structure of the odontophore. An operculum is commonly absent.

15th Family, Volutidæ [Cases 165C—166B].

This family includes the large "Boat-shells" and "Melon-shells" of the Indo-Pacific shores. It also includes the small cowrie-like Marginellas, which, however, can always be distinguished from cowries by the oblique folds on the inner lip that characterize all the Volute shells.

NATANTIA.

[Case 166C].

In the Section of Swimming Azygobranch Gastropods, which corresponds to the Order *Heteropoda* of authors,

the visceral hump is generally reduced in size, while some part of the foot—usually the middle portion, or mesopodium—is specially developed to form a fin, upon which an adhesive sucker is commonly found. The shell, when present, is small and thin, and like the rest of the animal is transparent, in harmony with the environment. The animals are pelagic, swimming at the surface of the open seas in the warmer parts of the world, and in habit are predaceous. Professor Ray Lankester divides the Section into three sub-Orders, namely, (1) the *Atlantacea*, in which the visceral hump, mantle, and shell are large; and all parts of the foot are well developed,—the whole form, in short, being not very different from the ordinary Azygobranch type; (2) the *Carinariacea*, in which the visceral hump, mantle, and shell are small, and the foot is not demarcated from the rest of the body, except in its middle portion, or mesopodium, which forms a large fin; and (3) the *Pterotracheacea*, in which the visceral hump is still further reduced in size, the mantle rudimentary, and the shell absent, the foot being similar to that of the *Carinariacea*. The group is exemplified in Case 166C, by models and enlarged drawings, and by some shells and spirit specimens. The last, which are placed above Case 166C, illustrate the transparency of the body.

iii. GASTROPODA [ANISOPLEURA] OPISTHOBRANCHIA.

[Cases 167A—168C].

In the adult forms of this degenerate Order the foot is large, and the visceral hump small; the mantle is always small and is often entirely wanting, and in correlation with the condition of the mantle the shell is almost always more or less delicate and deficient, or is completely absent. In the larval stage, however, the larval nautiloid shell of the typical Mollusk is present. The typical gill-plume is sometimes present unmodified, is in other cases present

in a modified form, and is sometimes altogether absent: when present it arises *behind* instead of beside the heart. The *Opisthobranchia* are all marine: the majority are found either in the tidal pools of reefs, or not far below low-water mark; a few are pelagic, inhabiting floating sea-weed; and a very few have been dredged from a considerable depth in the ocean. The reef forms, especially those of the tropical seas, are often of remarkably fantastic beauty of form and splendour of coloration.

In habit the *Opisthobranchia* vary, many being extremely rapacious, while others feed entirely on sea-weed. Several of the tropical forms have the power of emitting—probably for protection against enemies—acrid and offensive odours; and the Sea-hare when molested can secrete an abundant cloud of purple fluid for purposes of concealment. All these secretions probably come from glands in the skin. All the Opisthobranchs are hermaphrodite.

The Opisthobranchs are divided into two sections, namely, (1) the *Palliata*, or *Tectibranchiata*, in which the mantle and generally a thin shell are present covering the breathing-organs; and (2) the Slug-like *Nonpalliata*, or *Nudibranchiata*, in which, in the adult, the mantle and shell are wanting, leaving the gill-plume, when it exists, exposed.

β. OPISTHOBRANCHIA PALLIATA.

[Cases 167A—C].

There are two sub-Orders of mantle-bearing Opisthobranchs, namely, (1) the *Ctenidiobranchia*, which have a functional gill-plume and usually a thin shell; and (2) the shell-less *Phyllidiobranchia*, in which the place of the gill-plume is taken by a pair of fringes on the inside of the mantle. The *Phyllidiobranchia*, which include but one small family, are represented in the Case by drawings. The *Ctenidiobranchia*, which comprehend (1) the *Tornaellidæ*, (2) the large family of the *Bullidæ* or "Bubble

shells", (3) the *Aplysiidæ* or Sea-hares, and (4) the *Pleurobranchidæ* or "Umbrella-shells", are illustrated in Cases 167 A—C by spirit specimens, drawings and models, and by a large series of shells. On comparing the shells of these four families, we find a regular degradation from the stout operculated spiral shell of *Tornatella* to the thin light simply-rolled shell of *Bulla*, which in life is largely concealed by the side-lobes of the foot; and thence, through the simple calcareous disk of *Umbrella*, to the paper-like plate of the Sea-hare, which in life is hidden in a fold of the mantle.

α. OPISTROBRANCHIA NON-PALLIATA.

[Cases 168A—C].

In the Slug-like non-palliate or naked-gill forms the mantle, and consequently the shell, are absent in the adult, and the gill-plume, therefore, when present, is exposed. Professor Ray Lankester subdivides the group into three sub-Orders, namely, (1) the *Pygobranchia*, in which the gill-plume has the form of a coronet of tentacles round the anus; (2) the *Ceratonota*, in which there is no gill-plume, and the back is covered with hollow filaments, or "cerata", which no doubt assist in respiration; and (3) the *Haplomorpha*, comprising a few simple degraded more or less worm-like forms which are only recognised as Mollusks by the possession of the molluscan odontophore. This section is well represented by models in Cases 168A—C, and by some fine spirit specimens, from the Andaman and Laccadive Reefs, placed above the Case.

iv. GASTROPODA [ANISOPLEURA] PULMONATA.

[Cases i—viii at South end, and ix to xv at North end of Gallery].

This great Order, of which about 10,000 species are known, includes the Snails and the Slugs, the great

majority of which are terrestrial herbivorous animals, though some of the Snails, *e.g.*, *Limnæus*, *Planorbis*, etc. live in fresh water, and a few Snails, and Slugs also, live on rocks between tide-marks in the warmer seas. All however, whatever their habitat, breathe not by means of a gill, but by means of a "lung-sack" which is formed by the mantle-chamber, the edge of the mantle being fused with the dorsal wall of the body, except at one point in front for the admission of air. Even in those aquatic forms that breathe air dissolved in water the breathing-organ is the "lung-sack", into which water, instead of air, is admitted.

In the majority of the Pulmonates a well developed shell is present, but is never closed by an operculum; in the Slugs, however, the shell is a rudimentary plate which is generally hidden ("internal shell") and in the marine slugs (*Onchidium*) there is no shell at all.

The *Pulmonata* must be carefully distinguished from the group of terrestrial Azygobranchs — the *Pneumochlamyda* — which also breathe air by means of a lung-sack formed by the closure of the mantle-chamber. In the *Pulmonata*, or Snails and Slugs, the odontophore is armed with numerous small and equal-sized denticles, the sexes are united in the same individual, and the shell when present, is never closed by an operculum. In the *Pneumochlamyda*, on the other hand, the teeth on the odontophore are in a few series of unequal size, the sexes are distinct, and an operculum is developed on the back of the foot. The *Pulmonata* are divided into two sub-Orders, namely (1) the *Basommatophora*, including the two families of the freshwater Snails (*Limnæidæ*) and the marine *Auriculidæ*, in which the eyes when present are placed at the base of the cephalic tentacles; and (2) the *Stylommatophora*, including the two great terrestrial families of the Snails and the Slugs (*Helicidæ* and *Limacidæ*) and the small family of estuarine and marine Slugs (*Oncidiidæ*), in which the eyes are borne at the summit of the cephalic tentacles. The *Pulmonata* are well represented

in the two series ofCases I to VIII at the south end of the Gallery, and IX—XV at the north end of the Gallery, by a great variety of species from all parts of the world and from all elevations.

2. GLOSSOPHORA SCAPHOPODA.

[Case 169A].

In the very small Class of the *Scaphopoda*, or "Tooth-shells", the foot body and mantle are much elongated: the opposite edges of the mantle meet and unite below the foot to form a tube, on the outside of which a long cylindrical pointed tusk-like shell is developed. The shells, in fact, much resemble the calcareous tubes of certain marine worms. The *Scaphopoda*, which are represented in Case 169A by specimens of *Dentalium*, *Cadulus*, and *Entalis*, live in the bed of the sea, burrowing in the sand with their long scoop-like foot.

3. GLOSSOPHORA CEPHALOPODA.

[Cases 169B—171C].

In this Class, the members of which are all marine and freely locomotive, the foot is modified principally for swimming, but also in part for prehension and for walking. Of the three regions of the foot the front region (propodium) is fused with the head and is usually split into fleshy prehensile "arms" of varying length; the middle region (mesopodium) is expanded on each side to form either a pair of wings (epipodia), or, by the inrolling of the wings and the apposition or actual union of their edges, a short funnel; while the after region (metapodium) is small or absent. The mantle is usually well-developed, and encloses a deep pocket-like mantle-chamber; in one group of Pteropods, however, it is altogether absent. The shell varies; when present it is always light, and is often entirely concealed in a fold of the mantle.

The *Cephalopoda* are divided by Professor Ray Lankester into two branches or sub-Classes, namely (1) the

Pteropoda in which the epipodia, or lateral flaps of the middle region of the foot, are in the form of wings or paddles; and (2) the *Siphonopoda* in which the lateral flaps of the mesopodium are rolled in and united to form a funnel, or siphon, which also serves primarily for locomotion.

a. CEPHALOPODA PTEROPODA.

[Case 169B].

The Pteropods or Sea-butterflies are small hermaphrodite Mollusks usually found in swarms at and near the surface of the open ocean, paddling or flitting by means of their wing-like epipodia. They are divided into two Orders, (1) the *Thecosomata*, in which there is a mantle and a thin glassy casque-shaped or mask-shaped shell, and (2) the *Gymnosomata*, in which a mantle and consequently a shell are absent. In the latter group the "arms", or tentacle-like processes of the forefoot, are fairly well developed and carry suckers, resembling, but on a small and scant scale, those of the Cuttle-fishes. The dead shells of the *Thecosomata* often accumulate in extensive beds at the bottom of the Ocean, forming the deposit known as Pteropod-ooze. The *Pteropoda* are illustrated in Case 169B, by shells, models, and enlarged drawings.

b. CEPHALOPODA SIPHONOPODA.

[Cases 170A—171C].

To this important sub-Class, which includes the largest and most highly organized members of the Molluscan phylum,—*e.g.*, the Nautilus, the Cuttle-fishes, the Squids, and the Octopodes—the name *Cephalopoda* is commonly confined.

As in the Pteropods, the fore-part of the foot is fused with the head, and is split up into prehensile processes or "arms", which, however, are not only more numerous—at least eight or ten in number—but are vastly more highly developed. The middle portion of the foot, however,

though equally important in function, is so far as size is concerned, subordinate: it has the form of a funnel or siphon (whence the name of the sub-Class), through which the water taken into the mantle-cavity is forcibly expelled for the purpose of locomotion.

The mantle is very complete and very muscular; it encloses a wide and deep mantle-chamber, in which the gills are placed, and into which the intestine and the excretory and reproductive organs open.

Except in the *Octopodes*, a true shell secreted by the mantle is present, and although sometimes, *e.g.*, *Nautilus*, the shell encloses the body, it usually is itself enclosed and entirely concealed in a dorsal fold of the mantle, and becomes an "internal shell": in this case it is sometimes, as in the Squid, a rudiment of quill-like form and paper-like consistency.

The Siphonopods possess, besides the characteristic odontophore, a pair of horny or calcareous jaws, shaped like a parrot's beak, specimens of which are shown in Case 170. The sexes are distinct.

The spirit specimens and dissections of a common Indian species of Cuttle-fish, placed above Case 170, give a good illustration of the Cephalopod type.

An examination of this series shows the animal to consist of a somewhat rounded head, and an oval or conical body, the shape of which is determined by the thick fleshy mantle. The skin both of the head and body is thickly set with large pigment-cells, or "chromatophores", the play of which in life leads to transient chameleonic changes of colour.

The edge of the mantle projects round the base of the head like a collar, the intervening space being the entrance into the mantle-chamber. From the head spring the long fleshy prehensile arms, or prolongations of the fore part of the foot: these are ten in number, and are beset on their inner surface with most beautifully formed, cup-shaped, cartilaginous suckers arranged in rows. In

the centre of the space enclosed by the bases of the arms is the mouth with its great parrot-like beak. On each side of the head is a large and very perfect eye, and in the space behind and between the eyes is the "siphon".

Along each side of the oval body is a fold of the mantle which acts as a fin.

If we cut the body down the antero-dorsal surface—as has been done in one of the exhibited specimens, we come upon the shell or "cuttle-bone": it lies immediately beneath the skin in a closed cavity formed by an overgrowth of the mantle, and has the form of a light oval plate.

If we open the body from the base of the siphon down the hinder surface, we enter the mantle cavity, in which is seen, on each side, a large gill-plume (coloured in the specimen), and in the space between the gill-plumes the compact globular mass of the viscera, held together in a thin but tough bag. On dissecting this off—the exhibited specimen is a male—we see on the observer's right the reproductive organ, and its duct opening not far from the base of the siphon; on the left the stomach, much concealed; and in the middle line the ink-bag, with its duct running alongside the intestine, and ending beside the vent at the base of the siphon. The other viscera apparent are the renal organs: these conceal the heart and great blood-vessels, which lie behind them, but leave unconcealed on each side the great globular dilation of the vein at the base of each gill-plume.

The secretion of the ink-bag, which is known as sepia, is copiously ejected into the water by the cuttle-fish when molested, in order to cover its escape.

Cuttle-fishes are found in all seas, in greatest abundance near shore, but sometimes at the surface of the high seas, and sometimes in the depths of the ocean. Their locomotion is effected either by means of the "arms", on which the animal walks head downwards, or by swimming. Some cuttle-fishes, as the Sepia, can

certainly swim forwards by the undulation of the side-flaps of the mantle; but the typical and characteristic motion is by a series of jerks backwards, this being effected by the forcible expulsion through the siphon—the mantle being kept closely applied to the body so as to close the mantle-chamber in front—of the water contained in the mantle-chamber.

Cuttle-fishes are highly rapacious, and some species reach such an enormous size as to be dangerous even to man.

The curious bunches of eggs of *Sepia* are shown above Case 170. The remarkable "hectocotylus arm", or arm charged with packets of sperm-cells, which the male sheds into the mantle-chamber of the female, is shown ready for detachment in the model of *Argonauta*, in Case 171.

The siphonopodous *Cephalopoda* are divided into two Orders, namely (1) the *Tetrabranchiata* in which there are two pairs of gill-plumes, and (2) the *Dibranchiata*, in which there is a single pair. The Tetrabranchiata are represented by the single existing genus *Nautilus* drawings and shells of which are shown in Case 170. The shell of the Pearly Nautilus, as may be seen in the vertical sections in the Case, consists of a plane spiral of many chambers, of which only the last one is inhabited by the animal, the others containing only air. The series of chambers represent stages in the growth of the animal, each chamber having been at one time inhabited, and having been deserted and shut off as the animal outgrew it: the whole series is connected, as can be seen in the section, by a calcareous tube, known as the "siphuncle", which traverses the middle of each chamber and keeps the smallest and earliest formed chamber in communication with the largest and latest formed. The animal of *Nautilus* differs from all other existing *Siphonopoda* in the following among other particulars:—there are two pairs of gill-plumes; the processes of the fore-part of the foot are not sucker-bearing "arms", but are bunches of sheathed ten-

tacles; the halves of the funnel, or siphon, are not united but are only placed in close apposition, so that the siphon appears to be fissured; and there is no ink-bag.

The *Dibranchiata* include all the existing Siphonopods with the exception of the Pearly Nautilus. In all of them the gills are a single pair, the processes of the propodium are sucker-bearing arms, the halves of the siphon are united to form a complete tube, an ink-bag is present, and the shell, when it exists, is "internal", as already explained.

The *Dibranchiata* form two sub-Orders, namely (1) the *Decapoda* (Sepias and Squids) in which the "arms" are ten in number and an internal shell is present, and (2) the *Octopoda* (Octopus and Argonaut) in which the "arms" are eight in number and a true shell is absent.

In Cases 170C–171C there are life-size models, representing the chief types of both sub-Orders, along with explanatory drawings, and specimens of the "internal shells" of *Spirula*, *Sepia* and *Loligo*. The shell of *Argonauta* (the Paper Nautilus), specimens of which also are exhibited, requires a word of explantion. It is not formed by the mantle, that is to say, is not a true shell. It is found in the female only, and is secreted by two of the "arms", which are specially dilated, and are closely applied to the body to hold the shell on.

The large drawing of the female Argonaut in Case 171C shows the nature of the dilated "arms", and their relation to the body in life. Observe that the male of *Argonauta*, models of which are shown, is much smaller than the female, and is, like all other *Octopoda*, shell-less.

4. MOLLUSCA LIPOCEPHALA.

(Lamellibranchia: Pelecypoda).

[Desk Cases 172-179].

The *Lipocephala*, or *Lamellibranchia*, or Bivalves, differ from all other *Mollusca* (1) in the non-development of the head, and (2) in the absence of the odontophore.

In this large and uniform Class, the body is compressed and is enclosed in a bivalve shell. The two halves of the shell are right and left, and are articulated across the back of the animal by a spring-hinge formed by interlocking teeth and elastic ligaments; they can, with few exceptions, be widely separated along the free or ventral surface, but can also be kept tightly closed by a special muscle or, more commonly, pair of muscles—the "adductor muscles of the shell"—which stretch across the upper part of the cavity of the shell from one valve to the other.

The shell as usual is secreted by the superficial layer of the mantle, and the latter, therefore also consists of two lobes which line and are more or less adherent to the corresponding valves of the shell, the line of attachment being known as the "pallial line".

Between the two mantle-lobes lies the body, which consists of a dorsal mass containing the viscera, and of a large muscular tongue-shaped or hatched-shaped "foot".

The space between the body and the mantle, on each side, is the mantle-chamber: it contains the gills, which have the form of delicate plates or leaves, instead of plumes. There is a pair of gills on each side. Immediately in front of the gills, on each side, is usually found a pair of small flaps very similar in appearance to the gills, from which they seem to have been derived: these are the labial palps, and are used for drawing food towards the mouth which lies between them in the middle line. The lobes of the mantle are often, like the valves of the shell, separate from one another, so as to gape when the shell is opened; but just as often they are more or less united together beneath the foot—a chink, however, being left for the protrusion of the latter organ—thus closing the mantle-chamber below. When the mantle-chamber is thus closed, the lobes of the mantle grow out behind to form two retractile tubes, or "siphons", which are sometimes of great length. These tubes are placed one above the other, the lower one (inhalant, incurrent or branchial siphon) admits water, containing air and the

microscopic particles on which the Bivalve feeds, into the mantle-chamber; and by the upper one (exhalant, excurrent, or anal siphon) the effete water, charged with excreted waste, leaves the mantle-chamber. Even in those Bivalves in which the mantle-lobes are separate beneath the foot the existence of these two channels—incurrent below, and excurrent above, can be demonstrated, although there are no tubular siphons, but only two slight folds of the posterior edge of the mantle separated by a limited line of cohesion. It is only in a few forms (*e.g.*, the Oysters, etc.) that no definite siphons occur. When the mantle-lobes are separate their thickened edges are often fringed with tentacles, and are sometimes furnished with a row of eyes (see the specimen of *Amussium* mounted in spirit above Case 179). The tentacles are often confined to the posterior edge of the mantle, where they surround the incurrent orifice (see the specimen of the Fresh water Mussel above Case 173).

As in other typical *Mollusca*, the intestine, the excretory organs, and the reproductive organs open into the mantle-chamber, which also in the Bivalves sometimes serves as a brood-pouch in which the eggs are hatched.

The sexes among the Bivalves are sometimes separate, and are sometimes united in the same individual. In the latter case, as in some Oysters, the male and female elements may be matured, not at the same time, but at different seasons.

The nature of the Lamellibranch shell should be studied in the several preparations in Case 172A.

The "valves" are, as already stated, right and left: they are usually, though not always, equal and symmetrical, and are often covered with an outside skin, or epiderm, of varying thickness.

In each valve we find, typically, a turned-in beak, or "umbo", which generally looks forwards and marks the front of the contained animal: the usually short and blunt portion of the shell below the umbo is therefore the front

end, and the usually long and more acute portion of the shell is the posterior end. The free edge of the shell corresponds with the ventral surface of the animal, while over the back of the animal the valves interlock along what is known as the "hinge-line".

This interlocking is effected by means of "teeth", of which there are typically three, or three groups, one (or a group) immediately below the umbo known as "cardinal teeth", and two (or two groups) of "lateral teeth" placed respectively before and behind the cardinal. Any or all of these, however, may be absent. The hinge becomes a spring-hinge by the action of certain elastic ligaments the principal one of which passes across, from valve to valve, behind the umbo, usually on the outside. When, by the muscular efforts of the animal, the shell is closed, the hinge-ligament is put upon the stretch; and when, therefore, the muscular effort is relaxed, the tension on the ligament is relieved, and the shell springs open: so that in repose the shell always gapes.

On the inside of each valve, which is almost always polished, we usually find certain constant impressions, namely the pits of attachment of the adductor muscles, and the line of attachment of the mantle—"pallial-line". These should be studied in the series of prepared specimens in Case 172A.

Notice that in one type the pallial-line has an unbroken sweep from the anterior to the posterior adductor, while in another type the sweep is broken by a deep bay—the "pallial sinus"—which lies below the impression of the posterior adductor and marks the situation of the retractor muscles of the siphons.

The Lamellibranch "foot" is usually tongue-shaped, or hatchet-shaped, and of some size. It can be protruded between the valves of the shell and used for creeping. In a few cases—*e.g.*, *Nucula*—it forms a broad "sole" for this purpose. In some forms—*e.g.*, the Cockles—it is curved and is used as a jumping-pole, the Cockle being able

to make the most surprising leaps. In a few forms—*e.g.*, the Razor-shells—it is a long pointed cylinder used for boring in the sand. In many sessile forms—*e.g.*, the true Mussels—the foot is provided with glands, known collectively as the "byssus gland", the secretion of which, toughening on exposure to water, forms a bunch of silky threads—the byssus—by means of which the animal anchors or permanently attaches itself. In the Oysters the foot is altogether absent.

Bivalves are all aquatic, and though there is a large number of nearly similar freshwater forms, the great bulk of the Class is marine, the species occurring at all depths and in all situations.

Their typical habit of life may most easily be studied in the Freshwater Mussel. In repose this animal lies half buried, front downwards, in the mud, with the posterior end, where the "siphons" open, projecting into the overlying water, and the valves of the shell slightly gaping. Currents of water, set agoing by the "cilia" which line the mantle-chamber and gills, and carrying air and the microscopic particles on which the animal lives, pass into the mantle-chamber at the incurrent siphon and sweeping the gills, where they exchange their oxygen for carbonic acid, reach the mouth, where they deliver up their burden of nutriment. Ultimately they pass out at the excurrent siphon sweeping the vent as they go.

The marine Bivalves live either buried in the mud or firmly attached to rocks, etc: many, however, are able to crawl or hop by means of their muscular foot, and some swim with some activity by opening and closing the valves of the shell, like wings. The group of Pholads and Teredos live deeply buried in rock, submerged wood, etc., which they excavate by rotating their often specially hardened shells. The Razor-shells burrow deep in the sand.

Many Bivalves are able to form pearls, which are only derivations of the iridescent pearly layer ("mother-of-pearl," or *nacre*) that lines the shells not only of Bivalves

but also of many Gastropods, etc. The pearl is formed by the deposition of successive layers of nacre round small foreign bodies that have found their way beneath the mantle.

We may follow Professor Ray Lankester in dividing the *Lipocephala* into three Orders, namely, (1) the *Isomya* (*e.g.*, the Freshwater Mussel) in which the anterior and posterior adductors are of much the same size; (2) the *Heteromya* (*e.g.*, the true Mussel of seas and estuaries) in which the anterior adductor is much smaller than the posterior; and (3) the Monomya (*e.g.*, the Oyster) in which only one muscle—the posterior adductor—is present.

i. LIPOCEPHALA ISOMYA.

[Cases 172A—177C].

This large Order is divided into two sub-Orders, namely, (1) the *Integripallia*, in which the siphons, when present, are small and do not lead to an inflection of the pallial line, and (2) the *Sinupallia* in which large siphons are always present and mark the shell with a "pallial sinus".

a. ISOMYA INTEGRIPALLIA.

[Cases 172A—174B].

This sub-Order includes five family-alliances of marine and fluviatile Bivalves.

1st Family Arcacea, [Cases 172 A, B, C].

In this family the edges of the mantle-lobes are not united below the foot and there are no "siphons". The shell, which is usually thick and heavy and covered with a tough epidermis, is very often ribbed like a cockle shell. The "hinge-line" is very commonly quite straight, and the "hinge-teeth" are usually subdivided into numerous denticles of nearly equal size, which are arranged in an equidistant series like the teeth of a comb. The great majority of the species are marine. *Nucula*, *Yoldia*, and *Limopsis*

occur in beds in the mud of the Bay of Bengal at depths of two to five hundred fathoms.

2nd Family Trigoniacea, [Case 172C].

This is a geologically ancient but now small and almost extinct Family. Both the animals and the shells much resemble Cockles. The edges of the mantle-lobes are not united, and there are no siphons. The interior of the shell is remarkable for its magnificent pearly lustre. The hinge-teeth are few and large. One of the finest species of the whole family is *Verticordia eburnea* dredged in the Andaman Sea at a depth of 188—220 fathoms, and described and figured in the *Annals and Magazine of Natural History* for December 1891. A perfect specimen of this beautiful species is exhibited in Case 172C. By some mischance a duplicate of this species found its way in 1893 into the London market and has been redescribed under the name of *Verticordia optima*.

3rd Family Unionacea, [Case 173 A, B].

This large but uniform family includes the various Freshwater Mussels, which are found in rivers lakes and ponds in every part of the world. The lobes of the mantle are not united below, but their fringed and bilobed posterior edges—as may be noticed in the several dissections of *Unio* above Case 173—do cohere slightly below the level of the vent so as to mark off two distinct channels,—an incurrent and an excurrent. The shell is covered on the outside with a thick dark epidermis, and on the inside is almost as lustrous as the Pearl-Oyster. Freshwater Mussels, in fact, not unseldom secrete very good pearls.

4th Family Lucinacea, [Case 173 B,C].

In this not very large but very widely distributed family the shell, typically, is stout and almost circular in outline. The condition of the mantle-lobes varies: sometimes (*Astarte*) they are separate throughout; sometimes

(*Galeomma*) they are united in front and prolonged behind into two siphons; and in other cases (*Lucina*) they are in an intermediate condition, being separate in front and united behind, somewhat as in the Freshwater Mussels, to form siphonal pockets. In *Kellia* the mantle-lobes meet and are produced *in front*, to form a respiratory tube. The *Lucinacea* are marine.

5th Family **Cyprinacea**, [Cases 174 A, B].

This family includes the Clams and Cockles. The condition of the mantle here also varies: in all cases the lobes are united behind to form distinct but short siphons, the free edges of which are usually fringed with tentacles; but whereas in the Cockles they are separate in front, in the Clams they are united, thus closing the mantle-cavity. The Cockles are of universal distribution and occur both in the sea and in freshwater: the Clams are entirely tropical and marine. The Cockles are freely locomotive, using their curved foot for leaping: the Clams, on the other hand, are fixed, either being attached by a strong byssus, like the Tridacnas, and deeply wedged into growing coral-rock; or, as the Oyster-like Chamas, being firmly adherent to the rock by the surface of one valve.

Some species of *Tridacna* reach an enormous size: a specimen nearly four feet long, and more than two men's load in weight, is placed below Case 174.

β. ISOMYA SINUPALLIA.

[Cases 174C—177C].

This sub-Order includes three family-alliances of chiefly marine Bivalves.

1st Family **Veneracea**, [Cases 174C—176B].

In this family, which is one of the largest of the whole Class, the lobes of the mantle, though widely open in front for the passage of the foot, are united below and behind, where they are prolonged out to form two tubular siphons

which are often of great length. The siphons are retractile, and when retracted are lodged in the deep inflexion known as the pallial sinus (see the prepared shell of *Hiatula* in Case 172A).

The shell is usually thick and solid, but is sometimes as in the species of *Tellina*, thin and delicate.

The *Veneracea* are of world-wide distribution, and the great majority of the species are marine, although a few are found in the brackish waters of estuaries. For the most part they live buried in sand or mud in shallow water; but a few species bore into solid rock.

2nd Family Myacea, [Cases 176 B, C—177A].

The typical forms of this family are known as "Gapers", from the fact that the valves of the shell gape even when fully adducted. The lobes of the mantle are united throughout, except for a small chink in front for the passage of the foot. The siphons are generally large and long and are very often bound together along more or less of their extent and enclosed in a common envelope of skin. In many cases the gills are prolonged into the incurrent siphon. The hinge-teeth of the valves in this Family are often ill developed. The *Myacea* are for the most part marine, but a few are estuarine and fluviatile. Their usual mode of life is deeply embedded in sand or mud with the ends of the siphons protruding from between the gaping valves of the shell: some species, however, bore into rock.

3rd Family Pholadacea, [Case 177 B, C].

This family includes the universally distributed Pholads and Shipworms, that work such damage to piers and breakwaters, into which, whether wood or stone, they burrow in swarms. The long cylindrical burrows in which the Shipworms live are more or less completely lined with carbonate of lime, and form shelly protective tubes in which the true shell lies; and in *Aspergillum* the true shell itself becomes incorporated with the protective tube, the two

forming a single structure. This is well seen in the prepared specimens of *Aspergillum* in Case 177C.

In the Pholads the umbonal reign of the shell is protected by a large single or paired shelly plate, and sometimes also the base of the siphons is enclosed in a special shelly cup. The shell in this family, therefore, is always more or less complicated and unlike the ordinary Bivalve shell. Notice the great worm-like tubes of *Kuphus* in Case 177.

It should further be noticed respecting the Pholad shell that there are no hinge-teeth, and that the front part of the valves has a rasp-like surface. It is by its own rotation, with this rasp-like surface foremost, that the animal bores its way into rock or timber.

The animals themselves are worm-like: the mantle is closed, except for a small aperture in front for the foot, the siphons are of great length and are usually united throughout their whole extent, and the gills are prolonged into the incurrent siphon.

ii. LIPOCEPHALA HETEROMYA.

[Case 178A].

This Order includes the Mussels, in which the anterior adductor muscle of the shell (see the prepared specimen in Case 172A) is very much smaller than the posterior, in consequence of the extreme attenuation of the anterior part of the shell.

In the typical Mussels (*Mytilus* and *Modiola*) the lobes of the mantle are quite separate, and no true siphons exist; and the foot secretes a "byssus," by which the animal attaches itself to foreign bodies: the shell is long and pointed in front, and is covered on the outside with a thick epidermis, and there are no hinge-teeth.

Lithodomus does not merely fix itself to the rocks by its byssus, but actually excavates a narrow burrow in which it lies concealed.

The typical Mussels (*Mytilidæ*) are marine and are found in all parts of the world, living together in vast beds.

iii. LIPOCEPHALA MONOMYA.

[Cases 178B—179C].

This Order includes the Oysters, Scallops, Pearl-oysters, etc., in which in the adult the anterior adductor muscle is absent (see the prepared shells of Oyster and Scallop in Case 172A, and the dissected spirit specimens of *Amussium* and *Spondylus* above Case 179).

1st Family Aviculacea, [Case 178 B, C].

The lobes of the mantle are separate throughout and fringed, and there are no siphons or siphonal folds: the foot is small and secretes a byssus for permanent attachment. The shell is generally covered on the outside with a thick, fibrous, often vallanced epidermis, which is commonly of a dark green or black colour. The internal "mother-of-pearl" lining, though often of surpassing lustre, is always limited in extent, sometimes not occupying as much as a fourth of the whole internal area. Hinge-teeth are usually absent. The family though small is widely distributed: it includes many large forms, among them the famous Pearl-Oyster of the Indo-Pacific.

2nd Family Ostracea, [Cases 179 A, B, C,].

In this family, which includes the Scallops (*Pecten*), the Thorny Oysters (*Spondylus*), and the true Oysters (*Ostrea*), the edges of the mantle, which are quite free throughout, are fringed with tentacles, and are often furnished with a row of highly developed eyes (see the dissected spirit specimens of *Amussium* and *Spondylus* above Case 179). There are no siphons. Hinge-teeth are usually absent, but are well developed in *Spondylus*. The Pectens, though able to secrete a byssus for (temporary) attachment, are able to progress with great activity

by the rapid opening and closing of the valves of the shell in a flying fashion. The young of *Spondylus* can also move in the same manner. The Oysters are always, except in their very earliest stages, permanently fixed.

The *Ostracea* are represented in every part of the globe.

The student of Malacology should consult the article *Mollusca* by Professor Ray Lankester in the latest edition (1883) of the *Encyclopædia Britannica.*

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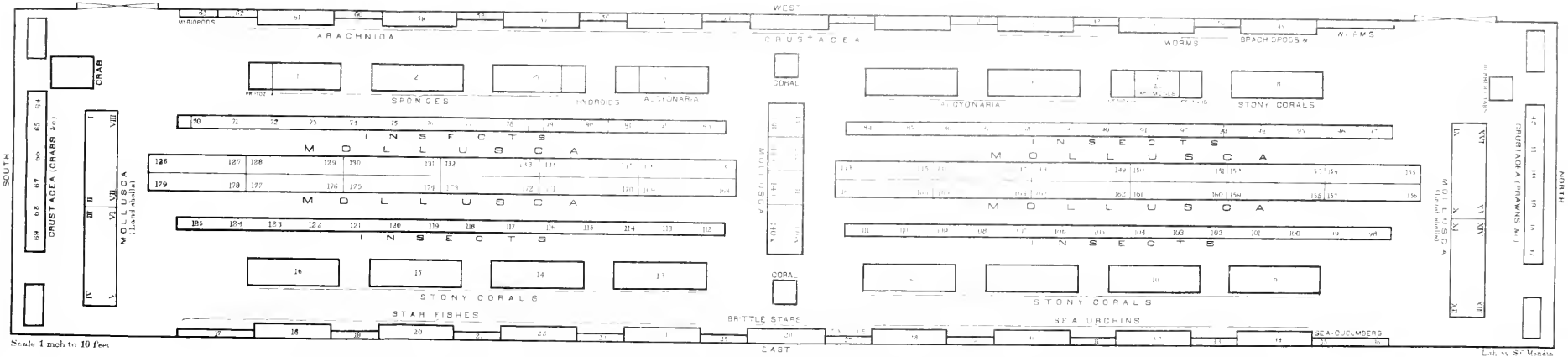

GROUND-PLAN OF THE INVERTEBRATE GALLERY OF THE INDIAN MUSEUM