

XXII. *On the Ciliated Groove (Siphonoglyphe) in the Stomodæum of the Alcyonarians.*

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[PLATES 50, 51.]

MANY years ago the distinguished naturalist GOSSE (2) described two ciliated grooves in the stomach of the Sea Anemones, the function of which is to keep up the circulation of sea-water whilst the animals are retracted, and which he called the gonidial canals (“demicanaux” of HOLLARD (8) and “schlund-rinnen” of the German writers).

These grooves are situated on what are now known as the dorsal and ventral sides of the stomach, and their presence has been confirmed and their histology more thoroughly investigated by R. and O. HERTWIG in their great work ‘Die Actinien’ (7).

Concerning them these authors say: “An unseren Durchschnitten durch die verschiedenen Actinienarten sind sie überall leicht zu erkennen und schienen sie sich uns durch eine besonders starke Bewimperung auszureichen.”

In the genus *Cerianthus* only one groove is present (HAIME) (6), and this is of great depth.

In consequence of the histological difficulties which attend the investigation of the *Alcyonarians*, their minute anatomy has not been very thoroughly investigated, and the presence of the ciliated groove on the ventral side of the stomodæum has been generally overlooked. The text-books of comparative anatomy do not mention it, nor can I find any reference to it in any memoirs except that of the HERTWIGS (*l.c.*), where it is simply stated to be present on the ventral side of the stomodæum, and a rough diagrammatic sketch given of it in *Alcyonium*; and in a paper on *Sarcodictyon* by GOSSE (3).

In the present communication I shall give the result of a series of investigations carried on during the last twelve months, for the purpose of tracing this ciliated grove through the various genera of *Alcyonaria*, and in referring to the various parts I shall throughout employ the following terms: I shall call the hollow communication between the mouth and the body-cavity, which is formed by an invagination of the

epiblast, the stomodæum; the portion of it that lies in the region of the mouth, the outer portion; and the portion that communicates with the body-cavity I shall call the inner portion; the general cavity of the polyps, which is sometimes short, but sometimes enormously elongated, I shall call the body-cavity; and in referring to the dimorphic forms I shall use the terms "autozooids" and "siphonozooids" which Professor MOSELEY (15) has introduced in place of the terms "polyps" and "zooids" used by Professor KÖLLIKER and others.

In *Alcyonium palmatum* the stomodæum presents in transverse section a rhombic-shaped cavity, with long lateral walls and short dorso-ventral walls; it is wide in its outer portion, but becomes considerably narrowed towards its opening into the body-cavity, so that one might describe it as a funnel which is laterally compressed (Plate 50, figs. 1 and 2).

The ciliated groove, commencing about one-third of the total depth of the stomodæum from the mouth, is continued along its ventral side as far as its opening into the body-cavity.

The stomodæum is lined by a columnar ciliated epithelium, varying in thickness from .004 millim. to .002 millim.

The ciliated groove is distinguished by the following peculiarities: the epithelium is thicker than it is over the rest of the stomodæum, being at least .005 millim. thick, the free edges of the columnar epithelium cells of which it is composed are very clear and definite, and the cilia are remarkably long and strong, being from .006 millim. to .007 millim long.

Of the genus *Alcyonium* I have examined three other species, namely, *A. digitatum*, *A. pulmonaria*, and *A. pachyclados*, but owing to the larger number of spicules in these species, they are not so favourable for histological manipulation.

An examination of living specimens of our English *Alcyonium digitatum* revealed the fact that the cilia of the groove, moving almost simultaneously, produce a current of water from without inwards, whereas the cilia lining the rest of the stomodæum produce currents in the opposite direction. Thus a complete circulation is brought about in the polyps; the inward current produced by the cilia of the groove is probably aided by the cilia of the ventral mesenterial filaments, whilst an outward current, commencing on the dorsal and lateral mesenteries, is taken up by the action of the cilia lining the general surface of the stomodæum.

It is evident from anatomical and physical considerations that the chief part of the propulsion of these currents is performed by the cilia lining the groove on the ventral side of the stomodæum, and consequently I propose to call this groove "the siphonoglyphe."

I may summarise the characters of the siphonoglyphe in the genus *Alcyonium* as follows:—

The siphonoglyphe is present along the inner two-thirds of the ventral wall of the stomodæum (Plate 50, fig. 2), it is formed by that portion of the wall of the stomodæum

which lies between the attachment of the two ventral mesenteries only, it is marked by a distinct thickening of the epithelium, and the cilia are long and strong.

In the genus *Clavularia*, in which the non-retractile polyps stand apart from one another on a flat creeping stolon, the siphonoglyphe is marked by a considerable thickening of the wall of the stomodæum, but the cilia are comparatively short and delicate. Moreover, the siphonoglyphe does not extend over so great an area as it does in *Alcyonium*, for in a series of transverse sections no trace of it can be found in the outer two-thirds, but only in the inner third of the stomodæum.

In the genera *Spongodes* and *Nephtya* the siphonoglyphe has about the same area and extent that it has in *Alcyonium*. My specimens of *Nephtya* are not very well preserved, but, although the general histology is not easy to make out, the general features of the siphonoglyphe are quite manifest. My specimens of *Spongodes* are, however, beautifully preserved, and in them the cilia which line the general surface of the stomodæum may be easily seen. In most *Alcyonaria* which have been preserved in spirit these cilia are not easy to observe.

In the genus *Briareus* a very definite siphonoglyphe is present with long and delicate cilia.

In *Tubipora* the siphonoglyphe is well marked, and provided with a dense armature of long and strong cilia.

I was fortunate enough to obtain a fine specimen of the rare *Cælogorgia palmosa* from Zanzibar. This genus, which resembles many of the Gorgonian Alcyonarians in the complex branching of its axis, and in the fact that the polyps are not completely retractile, differs from them in that there is no axial skeleton, but a single large canal runs along the axes of the colony and its branches. In transverse section the cavity of the stomodæum presents the appearance of a short T, the cross portion of the T being the siphonoglyphe (Plate 50, fig. 3). The siphonoglyphe is beset with cilia, which, though very much longer than those of the rest of the stomodæum, are shorter and more delicate, comparatively speaking, than those found on the siphonoglyphe of other forms.

Passing on now to those forms which exhibit the phenomenon of dimorphism.

In the genus *Sarcophyton*, the dimorphism of which was first pointed out by KÖLLIKER (9), and subsequently confirmed by MOSELEY (14), the autozooids possess a siphonoglyphe which is not so well marked as it is in the preceding genera. It is only present along the inner third of the stomodæum, it never occupies a greater portion of the wall of the stomodæum than that between the two ventral mesenteries, there is no marked thickening of the epithelium of the stomodæum, and the cilia themselves are neither so numerous nor so strong as they are in other cases (Plate 50, fig. 4). In the siphonozooids, however, the siphonoglyphe is very well marked; there is a decided thickening of the epithelium; it extends along nearly the whole of the ventral side of the stomodæum, from the mouth to the body-cavity; it extends round the wall

of the stomodæum frequently as far as the insertion of the ventro-lateral mesenteries, and the cilia are characteristically long and strong (Plate 50, fig. 5).

It is exceedingly probable, from these facts, that the great part of the circulation in *Sarcophyton* is carried on by the siphonozooids, whilst the autozooids carry on the same function to a much smaller extent.

The genus *Paragorgia* is also dimorphic, a fact which seems to have been previously overlooked, and here we find a condition concerning the siphonoglyphe slightly different from that found in *Sarcophyton*.

After a careful examination of numerous autozooids, both in the retracted and expanded condition, I could find no trace of a true siphonoglyphe. There seems to be no marked thickening of the epithelium on the ventral side of the stomodæum, nor are the cilia markedly longer or stronger in that region (Plate 50, fig. 6).

In the siphonozooids, however, the siphonoglyphe is remarkably strong, and extends as far round the stomodæum as the insertion of the latero-ventral mesenteries, whilst the long cilia reach half-way across its lumen (Plate 51, fig. 8).

In *Paragorgia*, as in *Siphonogorgia*, the ova are borne by the siphonozooids, and frequently they are so full of them as to cause the stomodæum to be pushed to one side and the mesenteries to be broken (Plate 51, fig. 7).

A similar condition to this was found in the genus *Heteroxenia*. No trace of a siphonoglyphe could be seen in the autozooids, whilst a well-marked one was found in the stomodæum of the siphonozooids.

Amongst the Pennatulida I have examined two genera, *Pennatula* and *Renilla*. In the autozooids of *Pennatula* I could find no siphonoglyphe, nor in the autozooids of *Renilla*. KÖLLIKER (9) does not mention any ciliated groove in any of the numerous Pennatulids he examined, nor does MARSHALL (17) in *Pennatula*, *Funiculina* and *Virgularia*. I think therefore I am justified in concluding that the siphonoglyphe does not exist in the autozooids of the Pennatulida. In the siphonozooids, however, a well-marked siphonoglyphe exists; in *Pennatula* it occupies a considerable portion of the stomodæum (Plate 51, fig. 10), and is armed with numerous long and strong cilia; in *Renilla* it is remarkable for its enormously long cilia, which stretch right across the lumen of the stomodæum (Plate 51, fig. 9).

Thus it will be seen that in the dimorphic Alcyonarians the siphonoglyphe has a tendency to disappear from the autozooids and to become very prominent in the siphonozooids. In *Sarcophyton* it still remains in the autozooids, but considerably diminished both in size and importance; in *Paragorgia*, *Heteroxenia*, and *Pennatulida* it has completely disappeared from them, whilst in all forms a well-marked siphonoglyphe is present in the siphonozooids.

In the genus *Heliopora*, some specimens of which Professor MOSELEY has kindly placed at my disposal, a siphonoglyphe of moderate dimensions is present.

Amongst the Gorgonidæ I have examined only two genera, *Villogorgia* and *Primnoa*, and in neither of these could I find any trace of a siphonoglyphe. In the genus

Villogorgia, although my specimens were most excellently preserved, I could find no cilia on any part of the stomodæum. I do not wish to assert for a moment that they do not exist, but if they do they must be exceedingly minute to show no trace in preserved specimens. The epithelial cells are filled with minute highly refracting particles, which conceal their outlines in exactly the same way as MARSHALL has described in the stomodæum of *Funiculina* (17, p. 14).

An interesting feature in the stomodæum of *Villogorgia* is the presence of a deep groove on the dorsal side (Plate 51, fig. 11), which is not beset, as the siphonoglyphe is, with long cilia. The epithelium of this dorsal groove is thinner than it is in other parts of the stomodæum. I have found nothing that corresponds with this dorsal groove in any other Alcyonarian.

In the genus *Primnoa*, again, I could find no trace of a siphonoglyphe, either in fully grown polyps or young buds (Plate 51, fig. 12).

VON KOCH does not describe a siphonoglyphe in any of the numerous Gorgonidæ he has examined (*Isis*, *Gorgonia*, *Sclerogorgia*, &c.), so that it seems to me probable that it does not exist in the stomodæum of Gorgonidæ, or, at any rate, in those Gorgonidæ with polyps that are not completely retractile.

It must be remembered in reference to VON KOCH's evidence that this author did not describe a ciliated groove in *Tubipora*, where it is undoubtedly present; but in this genus the stomodæum of the retracted polyps is so folded and creased that unless exceedingly thin sections are made it is easily overlooked, whereas in the non-retractile polyps of many Gorgonidæ where the stomodæum is not much folded a simple series of transverse sections would show it at once were it present.

General observations on the presence of the siphonoglyphe in the Alcyonaria.

In the three genera which have been described of simple *Alcyonaria* which do not form colonies, namely—*Monoxenia* (HÆCKEL, 5), *Hartea* (WRIGHT, 20), and *Haimea* (M. EDWARDES, 18), no siphonoglyphe has been described, and considering the small area that the circulation of these animals has to traverse, it seems to me probable that it does not exist in them. Where, however, a wider circulation was introduced, owing to the formation of complicated colonies, the aid to the circulation afforded by a siphonoglyphe became necessary.

In *Clavularia*, in which the colony consists of a number of polyps standing on a thin stolon, the circulation is not very extensive, and consequently we find that the siphonoglyphe is not very strong. In genera such as *Alcyonium*, *Spongodes*, *Nephthya*, &c., where there are long body-cavities and a considerable amount of gelatinous sarcosoma, a stronger circulation is necessary, and consequently we find that the siphonoglyphe has assumed more important proportions.

As long as the siphonoglyphe is confined to that portion of the wall of the stomodæum which lies between the two ventral mesenteries there is probably but little interference with the other functions of the stomodæum; but when the necessities of the circula-

tion require a stronger propulsive power than would be supplied by such a siphonoglyphe, certain of the polyps are arrested in their development in order that they may supply that additional power, and the colony becomes dimorphic.

The dimorphic *Alcyonaria* invariably present a considerable amount of fleshy sarcosoma, or else large spaces in which a circulation of sea-water is maintained, and it is usually the case that the circulation is entirely maintained by individuals which have become specially modified for that purpose—the siphonozooids.

Following this line of reasoning it is not difficult to understand the absence of the siphonoglyphe in the Gorgonidæ. In these animals there is always present a hard axis which may be either horny or else horny and calcareous. This axis frequently occupies the greater bulk of the colony (*e.g.*, *Primnoa*), so that the sarcosoma remains as a thin bark covering it. The result of this arrangement is that the canal system does not traverse so large an area as it does in such forms as *Paragorgia*, &c., in which there is no solid axis to the colony. The less the extent of the area supplied with canals the less the need of a strong propulsive arrangement, and consequently the siphonoglyphe is proportionately useless and disappears, the diminished circulation being carried on by the ordinary cilia of the stomodæum.

In the genus *Calogorgia* we have an example of an Alcyonarian which resembles the Gorgonidæ in many respects, but differs from them in the important fact that a single large canal occupies the position of the solid axis of the other forms. We must suppose that there is a constant circulation going on in this axial canal as well as in the ordinary canals of the colony, and corresponding with this we find a well-marked siphonoglyphe in the polyps for carrying on this more extensive circulation.

In the genus *Solenogorgia* described by GENTH (1) there is a somewhat similar condition, large canals being present in the axis of the colony and again in *Solenocaulon* described by GRAY (4). A re-examination of these genera would probably reveal the fact that their polyps possess a well-marked siphonoglyphe such as we find in the genus *Calogorgia*.

The genus *Heliopora* presents us with a condition which is not so easy to understand. The sarcosoma of the other forms of *Alcyonaria* is here represented only by a delicate layer of tissue covering the skeleton, but at the same time, owing to the large amount of space occupied by the cœenchymal tubes, there must be a considerable amount of fluid constantly circulating throughout the colony. It is, therefore, somewhat surprising to find but a feebly-developed siphonoglyphe in the stomodæum of the polyps. It may be, however, as Professor MOSELEY has suggested to me, that a rapid circulation would be of no particular advantage to a colony which possesses but a small amount of living sarcosoma, or indeed by hurrying away the food particles, it might be positively disadvantageous to it. This may possibly account for the feeble siphonoglyphe.

There is however a considerable difficulty in accounting for the presence of a siphono-

noglyphe in the polyps, whilst holding the view that the cœnenchymal tubes represent siphonozooids in which the stomach, mesenteries, &c., have degenerated.

The tendency of the dimorphic forms is, as I have pointed out, to throw the siphonic function upon the siphonozooids and to eliminate it from the autozooids.

If, for any reason, it was of advantage to any dimorphic Alcyonarian to diminish the power of the circulation, this would be done by the gradual atrophy of the siphonoglyphe in the autozooids, and were this diminution insufficient the siphonozooids, or their siphonoglyphe alone, would become smaller and smaller. An example of this kind of process is presented by *Renilla*. In this genus there is but a small amount of fleshy sarcosoma, but there are large canal spaces which occupy the greater part of the colony, and here we find, owing probably to the need of only a feeble current, very small siphonozooids. In *Pennatulula*, which presents a considerable quantity of sarcosoma, the siphonozooids are comparatively large.

In *Heliopora*, on the view that the cœnenchymal tubes represent siphonozooids, we should have to suppose that the siphonozooids became smaller and smaller, then completely atrophied, and subsequently a siphonoglyphe re-appeared in the autozooids. This would obviously necessitate a stage in their history in which there was no siphonoglyphe, which would be a condition very difficult to understand.

It is also difficult to believe that the mouth, stomach, and mesenteries would have all completely disappeared in this way, for even in the lowermost depths of the long body-cavities of such forms as *Tubipora*, *Alcyonium*, &c., two or more ridges remain, indicating the position of the mesenteries, and we should at least expect to find some such trace of the mesenteries in the degenerate siphonozooid.

Remarks on the classification and phylogeny of the Alcyonaria.

At present it can hardly be said that the classification of the *Alcyonaria* is in a satisfactory condition for two reasons, firstly, because no serious attempt has yet been made to trace the probable steps of the phylogeny of the group, and secondly because it is based on external zoological differences between genera rather than on the general features of their anatomy.

Taking the classification in CLAUS'S 'Grundzuge der Zoologie' as the one most generally adopted, we find such obvious incongruities as the following: the grouping together of such colonial genera as *Alcyonium*, *Clavularia*, &c., with the simple isolated *Haimea*, *Hartea*, &c., the position of *Paragorgia* amongst the Gorgonidæ, and so on. Recently, G. von KOCH (13) has suggested a classification that is based on the varieties of the skeleton, but it seems to me that the Pennatulidæ and Gorgonidæ are not so closely related as to justify their position in the same division of the same group (*Axifera*).

In presenting the following speculations on the phylogeny of the *Alcyonaria*, I am fully aware that the great difficulties of this group are only just beginning to be

appreciated, but I do so in order to point out the part which the presence or absence of a siphonoglyphe may play in the arrangement of the group, and some other points upon which the classification may turn.

There can be little doubt, I think, that the ancestral form of the *Alcyonaria* was not colonial, but was a simple isolated individual differing but slightly from the isolated genera which exist at the present day.

The fact that the three genera of isolated *Alcyonaria* are remarkably rare, present but few species, and have a wide geographical distribution (Monoxenia, coast of Arabia, Haimea, Fiji Islands, and Hartea, west coast of Ireland), point to the conclusion that they are the representatives of an ancient group which may have been much larger than it is now.

It might therefore be advisable to separate these genera as a distinct group, which might be called the PROTO-ALCYONARIA.

The next step in the phylogeny was the formation from such an isolated ancestor of a colony. The formation of the colonies may have taken place in two ways: first, by the formation of buds from the first formed polyp; and secondly, by the intermediation of a stolon upon which the young buds were formed.

A colony formed in this second way would with slight modifications give us a form such as our modern *Clavularia* or *Cornularia*.

In the genus *Tubipora* there is a stolon which I shall point out in a subsequent paper is very similar to the stolon of *Clavularia*. *Tubipora* might in fact have been derived from a *Clavularia*-like ancestor, in which the following modifications took place: The polyps became considerably elongated, and the spicules of the body-wall fused together to form a hard tubular support for them. These long polyps then became connected by canals which eventually joined together to form the horizontal platforms traversed by a network of the canals, and from them new polyps budded as they do from the original stolon.

If this reasoning is subsequently proved to be accurate it will be necessary to separate those forms with a stolon from the rest of the *Alcyonaria* into a separate group, which might be called the STOLONIFERA.

In the great majority of the *Alcyonaria* we have sufficient evidence, I think, to prove that they are formed by budding from the first-formed polyps which usually remain in the centre of the colony.

Taking a hypothetical ancestor, x , which probably had a conformation somewhat as follows: A central large polyp from which sprung, in a fan-shaped manner, a number of lateral buds of which those nearest the central polyp were the largest, we should have the rest of the *Alcyonaria* formed from it by modifications in several directions. In one direction we have the well-marked group of the *Pennatulida*. This group probably sprang from the ancestral stock at a very remote period, as is shown by the changes which have taken place in the central polyp, the arrangement of the subsequently formed polyps upon it, and the complete and universal dimorphism of

the colonies. In another direction arose the ancient group of which *Heliopora* is a survival. This group, which was formerly placed amongst the *Tabulata*, was probably very rich in genera and species in palæozoic times, but it is gradually becoming extinct.

In another direction arose the modern genus *Alcyonium* and its numerous allies. This genus differs from the ancestral form α chiefly in the fact that the polyps are capable of being retracted within the sarcosoma, but in other respects is probably more closely related to it than any other genera. The fact that the polyps are capable of being retracted is not one of very great importance, for we find both in this family and in the Gorgonidæ, that nearly allied genera differ from one another in this respect. The dimorphic genus, *Sarcophyton*, is probably closely related to *Alcyonium*. The presence of dimorphism is not sufficient to warrant the supposition that they sprang from different stocks, for this condition occurs in so many widely different genera that it is reasonable to suppose that it was introduced more than once in the course of the evolution of the group.

As an example of this we find that the genus *Xenia*, which probably followed another line of evolution from the hypothetical ancestor, is not dimorphic, whereas the genus *Heteroxenia*, very similar to it in other respects, is dimorphic.

The lines which evolution took in producing the large number of genera of *Primnoaceæ*, *Gorgonaceæ*, &c., are much more difficult to make out, but the following represents perhaps as near an approximate to them as our present knowledge permits.

Taking *Siphonogorgia* as a form intermediate between the ancestral type and the true Gorgonidæ, we find that the chief diversion lies in the fact that the colony has assumed an arborescent shape, and a support for it is produced by a more copious development of spicules in the axial portions of the colony. The body-cavities of the polyps, however, remain long, as they were in the ancestral form. Most probably there was another stage between *Siphonogorgia* and this ancestral form which was not dimorphic. From *Siphonogorgia*, *Paragorgia* differs chiefly in the fact that the body-cavities of the polyps have become reduced in length, and a complicated system of canals occupies the position which they formerly occupied. If *Corallium* is dimorphic, as RIDLEY (19) and MOSELEY (16) consider it to be, it was derived from an ancestor similar to *Paragorgia* in which, by a fusion of the spicules, a solid rod occupies the axis of the colony. The rare genus *Pleurocorallium* differs from *Corallium* in the fact that the polyps are not retracted into the cœnenchym, but this condition may be simply due to a more copious development of spicules in the walls of the polyps, thereby offering a physical difficulty to the retraction of the polyps.

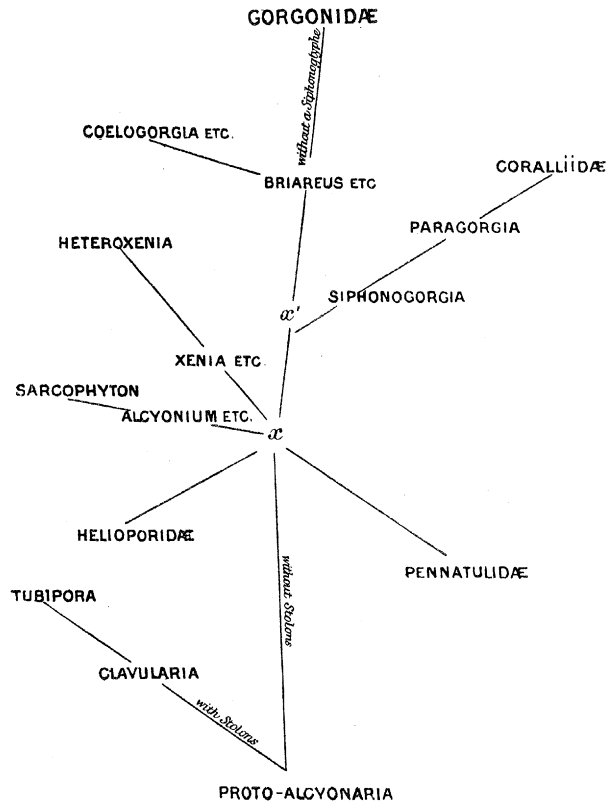
Passing by the form which I suppose at one time existed similar to *Siphonogorgia* but not dimorphic, we should obtain such forms as *Briareus*, in which the body-cavities of the polyps are short; there is no solid axis and no dimorphism, and from such genera, *Cælogorgia*, *Solenogorgia*, &c., might be obtained by the development of large canals in the axis of the colony, or again by the development of horny or calcareous axes, we should obtain the remaining families of Gorgonacæ, Primnoaceæ, &c.

In the Primnoaceæ I have shown that there is no siphonoglyphe, and the negative evidence of other authors affords us strong evidence for supposing that it is absent in the Gorgonaceæ. In both these families there is only a thin layer of cœnenchym covering the solid axis. If these two facts are mutually dependent upon one another, as I suppose them to be, there is sufficient reason for separating those forms which have only a thin cœnenchym covering the axis, and into which the polyps are never completely retracted, and in which there is no siphonoglyphe, into a distinct group.

This group might retain the name of the Gorgonidæ, whilst other genera which do not possess these characters and which were formerly included in the Gorgonidæ, might be placed in another group of the *Alcyonaria* altogether.

Provisionally, then, the *Alcyonaria* might be divided into the following groups :—

1. The Proto-Alcyonaria, containing the simple isolated genera.
2. The Stolonifera containing those forms with stolons such as *Tubipora*, *Clavularia*, *Sarcodictyon*, &c.
3. The Pennatulida constituted exactly as it is at present.
4. The Gorgonidæ, containing the Primnoaceæ, Gorgonaceæ, and the other families which possess no siphonoglyphe.
5. The Alcyonidæ containing all the remaining Alcyonarians.



In conclusion I should mention that my researches have been carried on in the morphological laboratory of the Oxford University Museum, and I had the great advantage of using a very valuable collection of Alcyonarians brought by Dr. GULLIVER from Zanzibar; and to the beautiful state of preservation in which I found them, many of my best results are due.

My best thanks are due to Professor LANKESTER for some excellent specimens of *Paragorgia*, *Villogorgia* and *Briareus*, and I am also deeply indebted to Professor MOSELEY, who freely placed his numerous preparations at my disposal, and whose constant aid and advice have been of invaluable assistance to me.

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DESCRIPTION OF THE PLATES.

The following lettering is used throughout.

- st.* Stomodæum.
si. Siphonoglyphe.
siph. Siphonozoid.
aut. Autozoid.
m.f. Mesenterial filament.
sp. Spicules in the body-wall.
sp'. Spicules in the walls of the stomodæum.
sp''. Spicules in the sarcosoma.
c.c. Gastrovascular canals.
ep. Epithelium.
p. Used in figs. 11 and 12 for the spaces left after the skeletal plates have been dissolved in acid.
ov. Ova.
t. Tentacles.
v. Ventral side.
d. Dorsal side.

Fig. 1. A diagrammatic sketch of a longitudinal section through a polyp of *Alcyonium digitatum*, showing the wall of the siphonoglyphe on the ventral side with its long cilia pointing towards the body cavity, and the wall of the stomodæum on the dorsal side, which is not so thick, and beset with but small cilia. The arrows indicate the directions the currents of water take in a living polyp.

Fig. 2. Transverse section through a polyp of *Alcyonium palmatum* in the middle region of the stomodæum. The siphonoglyphe is seen on the ventral side of the stomodæum, armed with its long cilia, and in its substance are seen imbedded the long spicules.

Fig. 3. Transverse section through a polyp of *Calogorgia pulmosa*. The lumen of the stomodæum is seen to be T-shaped in section, the cross portion of the T forming the siphonoglyphe is armed with long, delicate cilia, and the rest of the stomodæum with short, dense cilia.

Fig. 4. Transverse section through an autozoid of *Sarcophyton pulmo* (semi-

diagrammatic). The siphonoglyphe is here feebly marked, and armed with comparatively short cilia.

- Fig. 5. Section through a portion of a colony of *Sarcophyton* in a plane at right angles to the long axes of the polyps. A number of siphonozooids are seen in transverse section, separated from one another by a fleshy sarcosoma, traversed in all directions by the gastrovascular canals. The siphonoglyphe in all is seen to be well developed and situated on the same side of the stomodæum. Portions of two autozooids are seen at the sides of the drawing.
- Fig. 6. Transverse section through the stomodæum of an autozooid of *Paragorgia arborea*. The stomodæum is seen to be thrown into folds, and the epithelium is armed with short cilia throughout. There is no marked thickening of the epithelium, nor lengthening of the cilia on the ventral side.
- Fig. 7. Transverse section through a siphonozooid of *Paragorgia* (semi-diagrammatic). The siphonoglyphe, of very large proportions, is seen in the stomodæum. The gastrovascular canals are seen anastomosing in the sarcosoma. The spicules are omitted.
- Fig. 8. Vertical section through a portion of a colony of *Paragorgia arborea*. A number of siphonozooids are seen in longitudinal section, some of which contain ova. The branching canal system is represented as it appears in section, and numerous spicules are seen imbedded in the substance of the sarcosoma.
- Fig. 9. Transverse section through the stomodæum of a siphonozooid of *Renilla*. The siphonoglyphe has not a very great extent, but is armed with enormously long cilia, which extend across the lumen of the stomodæum.
- Fig. 10. Transverse section through a siphonozooid of *Pennatulula*. The siphonoglyphe here is of considerable size, and armed with long cilia.
- Fig. 11. Transverse section through a polyp of *Villogorgia*. This drawing was kindly done for me by Mr. G. C. BOURNE, of New College, Oxford, and accurately represents the appearance of one of my sections through a polyp of *Villogorgia*, which was stained in borax carmine after decalcification by means of nitric acid. The epidermic cells lining the stomodæum are not easily differentiated from one another, owing to the numerous highly refracting particles which they contain. The cilia lining the stomodæum cannot be seen with the highest power. There is no siphonoglyphe, but a deep groove (*g.*) runs down the dorsal side of the stomodæum.
- Fig. 12. Transverse section through a polyp of *Primnoa lepadifera*. The stomodæum is lined by small cilia, but no siphonoglyphe is present. No trace of the dorsal groove of *Villogorgia* can be seen.

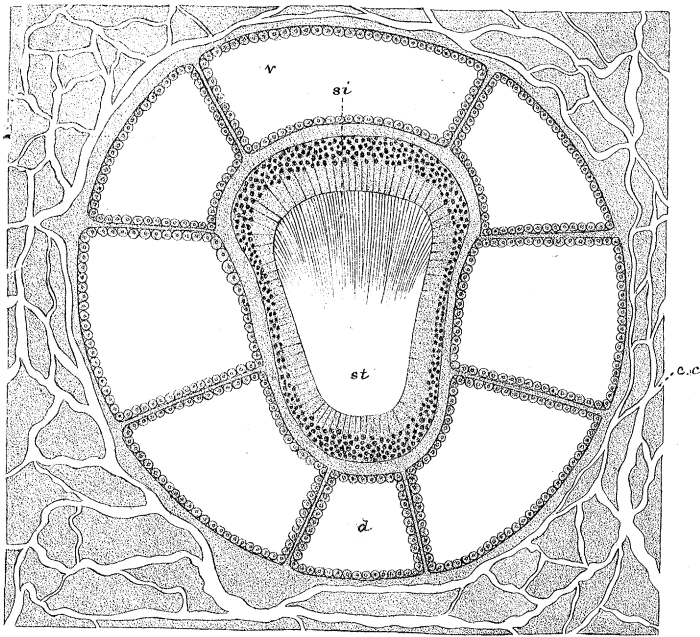


Fig. 7.

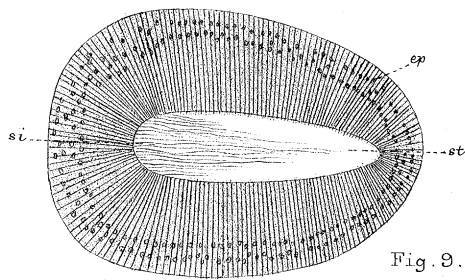
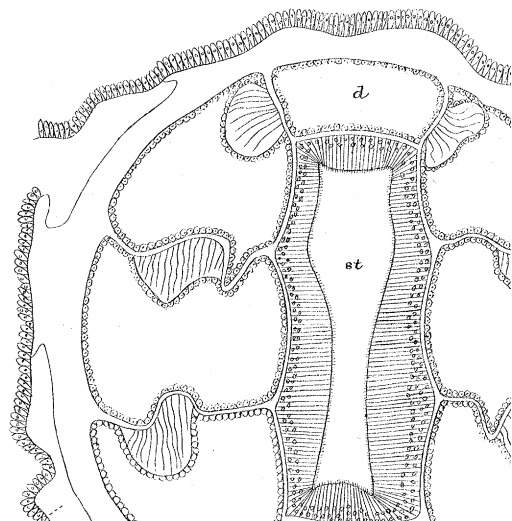
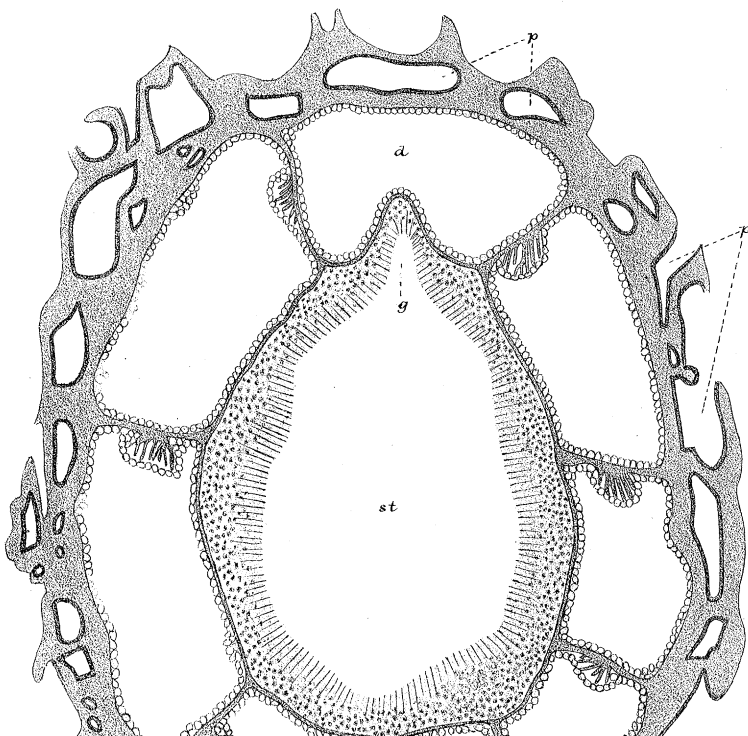
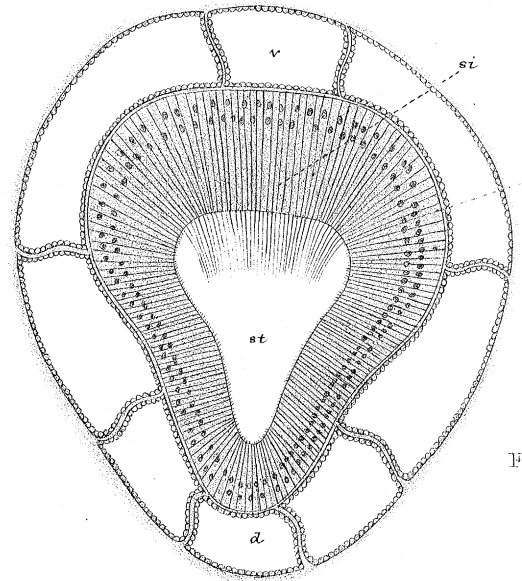


Fig. 8.



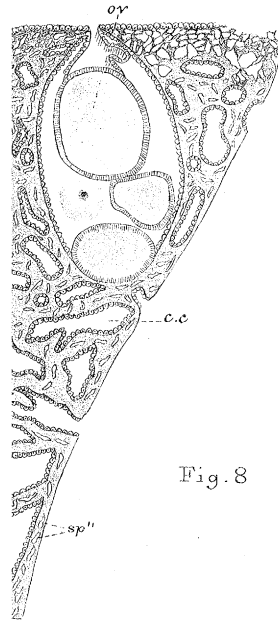


Fig. 8

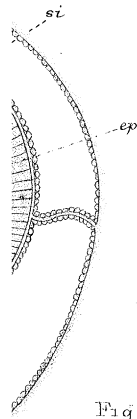
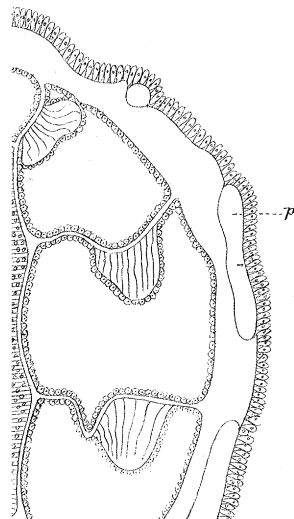


Fig. 10.



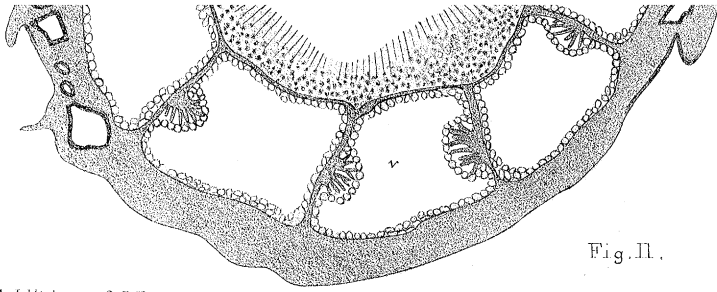
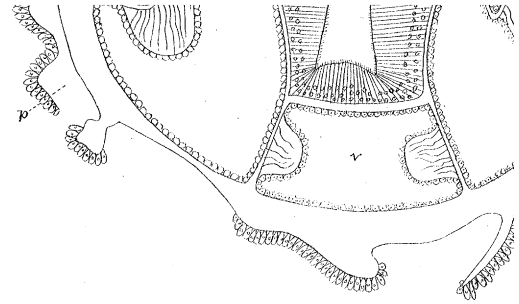


Fig. II.

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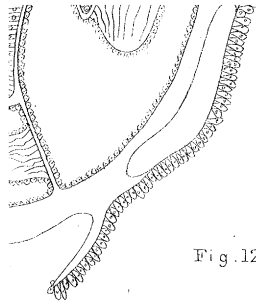


Fig. 12

West, Newman & Co. Imp.

Fig. 1.

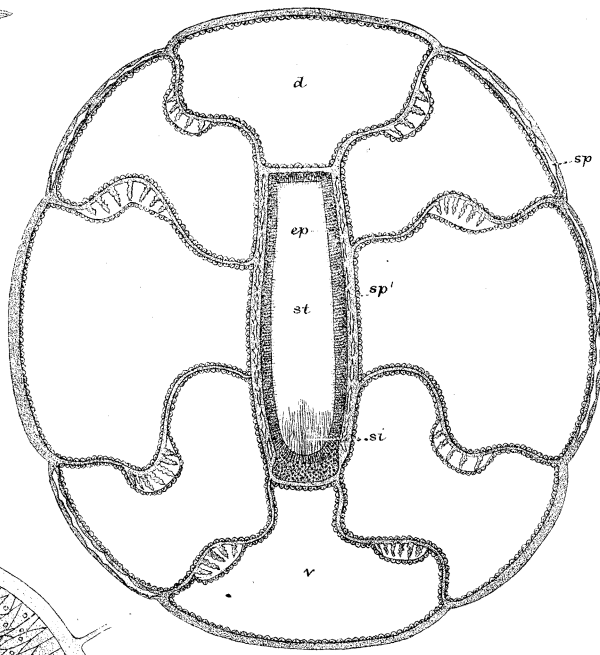
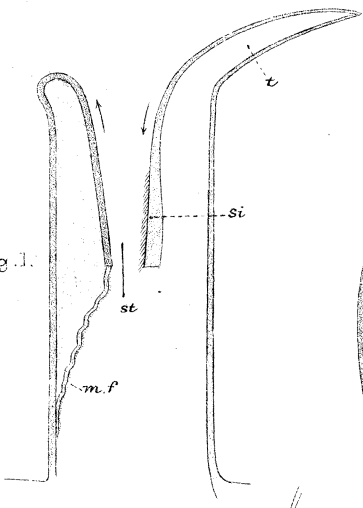


Fig. 2.

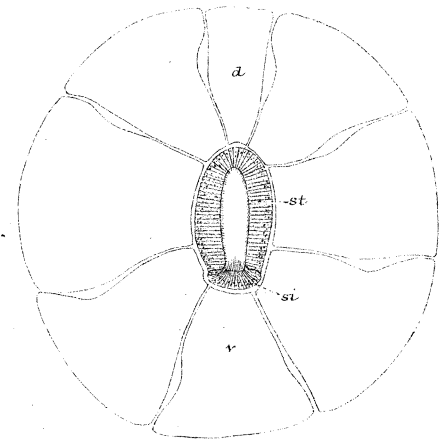


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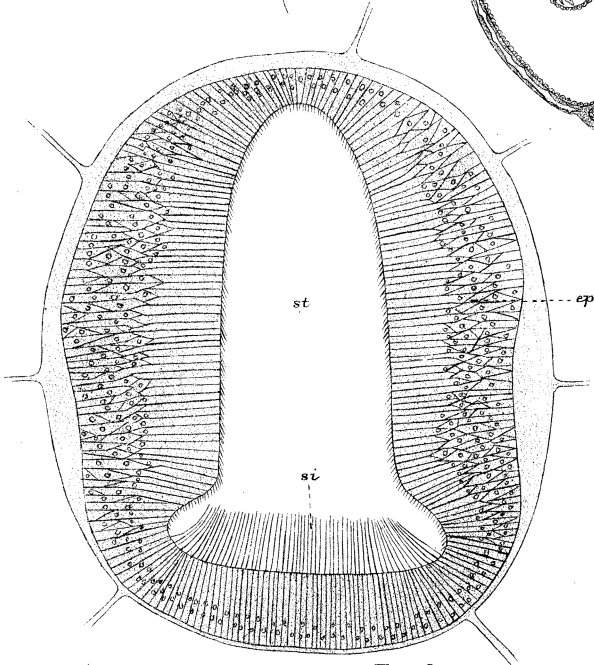


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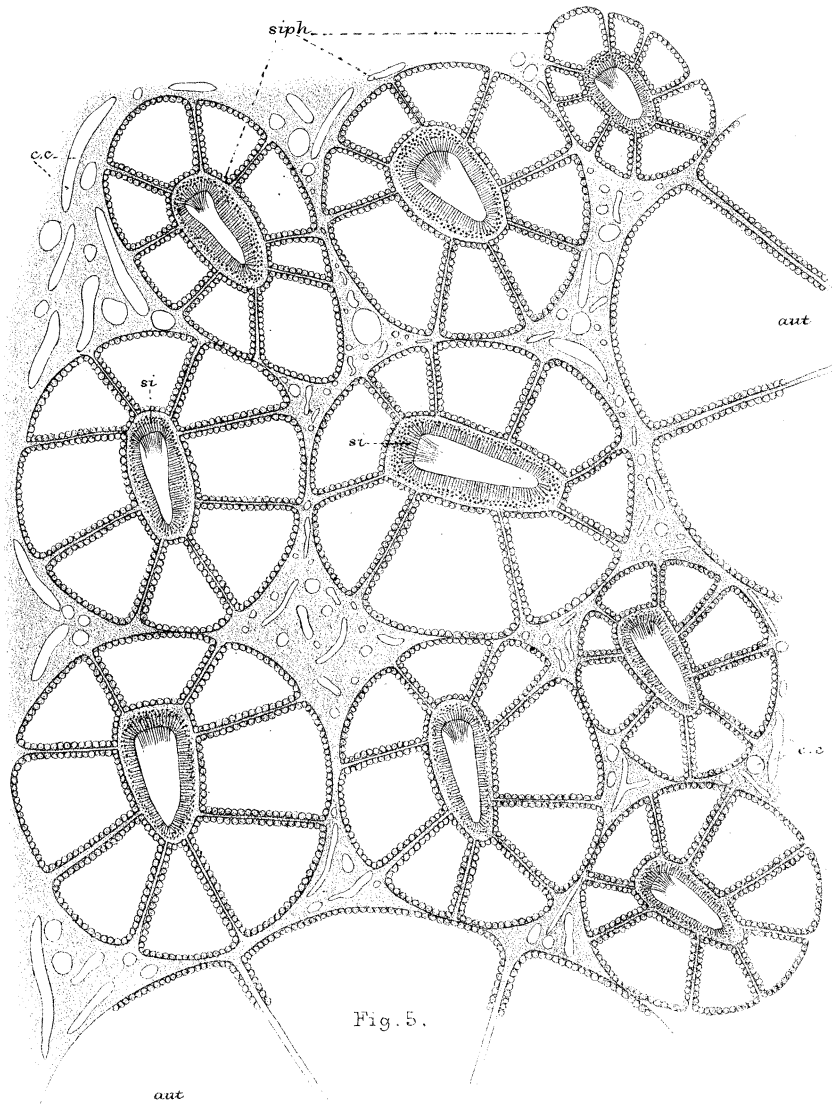


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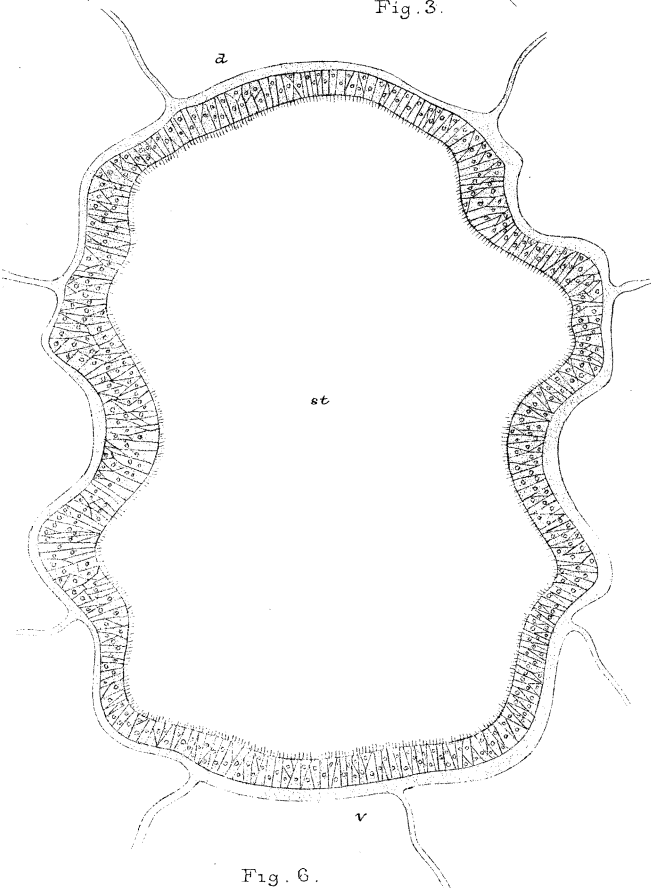


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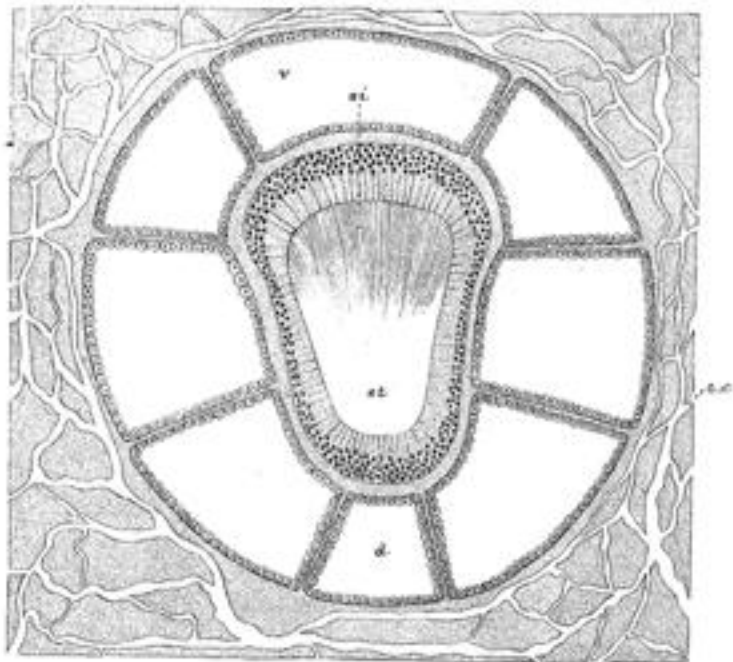


Fig. 7.

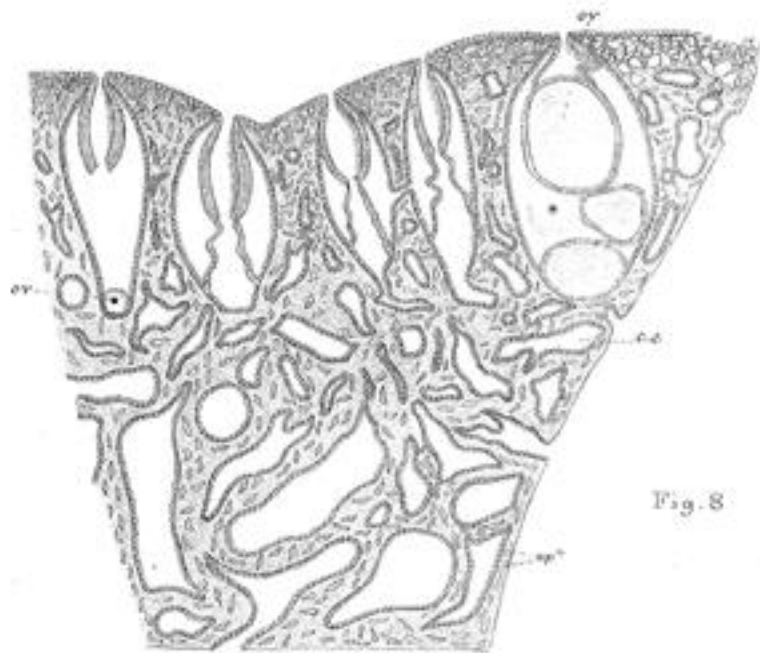


Fig. 8

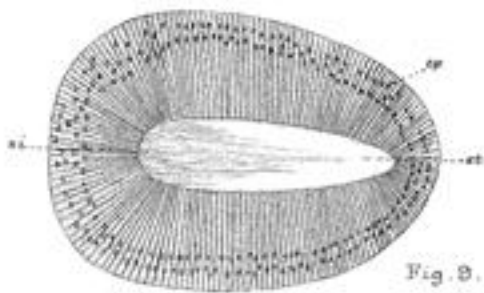


Fig. 9.

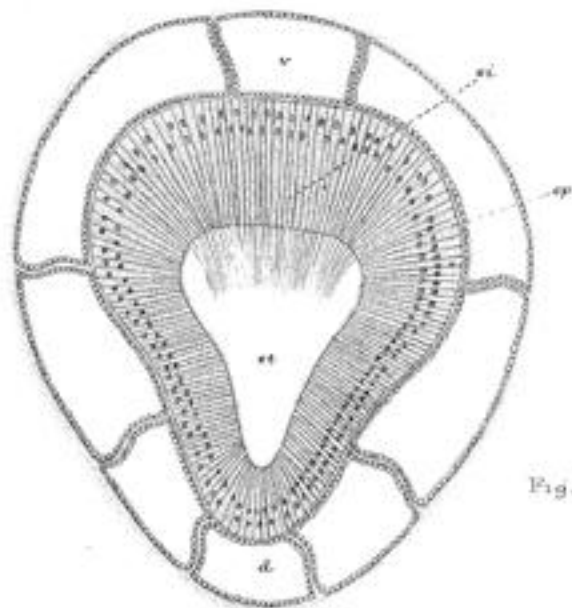


Fig. 10.

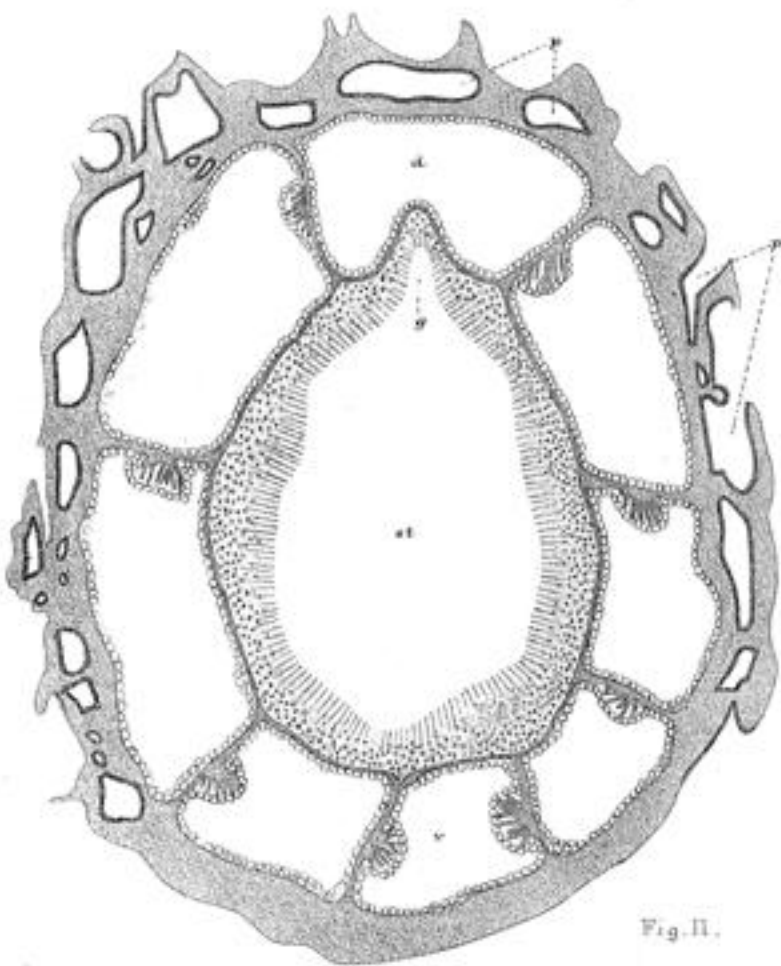


Fig. 11.

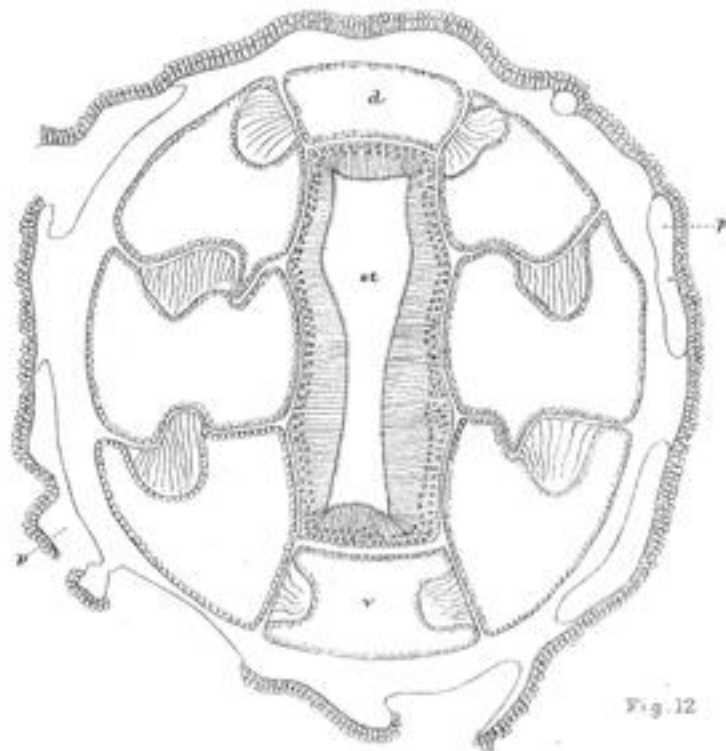


Fig. 12