The Medusæ of Millepora murrayi and the Gonophores of Allopora and Distichopora.

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With Plates XXIX and XXX.

I. The Medusæ of Millepora murrayi.

In 1884, Quelch (11), while examining the structure of the hard parts of a new species of Millepora (M. murrayi), discovered a number of small cavities which he supposed to be the receptacles of the ova or embryos like the ampullæ of the Stylasteridae.

Professor Haddon has recently placed in my hands some excellently preserved specimens of a species of Millepora that he collected on the reefs of one of the islands in Torres Straits. This species seems to be closely allied to Quelch's Millepora murrayi, but the identification is a matter of some difficulty, as the pieces at my disposal are small.

On making a series of sections through a portion of a decalcified branch I discovered a number of medusiform structures, each bearing a large saucer-shaped spermarium. They are situated immediately beneath the surface, and covered by an operculum of modified ectoderm cells.

Sections made by von Koch's method of grinding hard and soft parts together in solid Canada balsam show further that these medusæ exactly fit into the ampullar cavities of the skeleton, and form the only explanation of their presence.
The eggs of this species are, as in *Millepora plicata* (6), very small and contain no yolk, and I have seen no embryos and no parasites that could cause or fit into these cavities. Quelch's ampullæ, then, are the cavities that contain male medusæ.

**The Structure of the Medusæ.**—The medusæ may be found in all stages of development in the different parts of the same branch. They are very irregularly distributed, and it is difficult at present for me to give any hints to guide naturalists in the search for them. They are never found, so far as my experience goes, close to the free extremities of the branches. In my specimens they were found in greatest abundance at a distance of three quarters of an inch to one inch from the free extremity, but a few specimens were found quite close to the attached base of the colony. Some branches appear to be devoid of them.

All the stages of development may be found with care and patience, but the stage represented in fig. 10 is the most frequent in my preparations.

A central manubrium (*Man.*) hangs in the sub-umbrella cavity bearing the large spermarium (*Sperm.*). It is composed of irregular endodermal cells, and contains a considerable cavity continuous with the cavity of the subjacent coenosarcal canals.

The spermarium appears to be double in section, but is really saucer-shaped. It contains a large number of spherical spermoblasts lying in a homogeneous fluid (?). It is covered by a very thin coat of flattened ectoderm cells continuous with the inner ectodermic lining of the umbrella.

The umbrella is composed of three layers: a median layer of solid endoderm continuous with the endoderm of the manubrium, and an inner and outer sheath of ectoderm continuous with one another at the free rim of the umbrella.

The inner sheath of ectoderm is, as mentioned above, continuous at its proximal side with the thin coat of ectoderm covering the spermarium. The outer sheath is continuous with a sheath of ectoderm (*Gon.*) lining the cavity of the
ampulla; and this again is continuous with the superficial ectoderm of the colony.

At the margin of the umbrella both ectoderm and endoderm are thicker than they are elsewhere, and the medusa presents in consequence a thickened rim at its free border. There are no radial or ring canals. In medusae at this stage no cavity is apparent between the outer wall of the umbrella and the ectoderm lining the ampulla.

Above the codonostome (i.e. mouth of the umbrella) there is an operculum (op.) of flattened ectoderm cells continuous with the superficial ectoderm and the ectoderm lining the cavity of the ampulla, which completely closes the gonangium.

Different Forms of the Medusa.—The spermarium varies immensely in size. Sometimes it is simply a thickened ring round the manubrium, sometimes it nearly fills the cavity of the umbrella. In consequence perhaps of this variation in the size of the spermarium, the appearance of the manubrium varies. In fig. 10 the manubrium is a large well-developed structure with a considerable lumen. In fig. 9, which represents a younger stage, there is no manubrium at all apparent, but the spermarium simply rests on an irregular mass of vacuolated endoderm cells. Many intermediate conditions between these two extremes may be observed. Further, the condition of the endoderm of the manubrium presents many variations. In some cases the cell outlines are well marked, and the nuclei regular in position and spherical in shape. In other cases the endoderm is a loose vacuolated tissue in which no cell outlines can be distinguished, and the nuclei are irregular in shape and scattered through the spongy substance of the tissue.

It is not my purpose to offer in this place any explanation of these appearances. I wish merely to call attention to them before passing on to other matters.

Development of the Medusa.—The medusa of Millepora is a transformed zooid. It is not a zooid specially modified from its first appearance to bear the spermarium, but
an ordinary zooid of the colony changed into a medusa after the migration of spermospheres into its ectoderm, and subsequent development there.

The evidence that supports this statement rests upon a number of observed facts, that for convenience' sake may be arranged under the following heads:

1. The various stages in the transformation of the zooids into medusae that can be observed in sections of the decalcified corallum.

2. The absence of any structure that can be compared to the ectodermic invagination, called the entocodon or glockenkern, that characterises the early stages in the development of the medusa of the Hydroidea.

3. The position of the medusae in the colony.

4. The presence of large nematocysts in the superficial ectoderm above the younger forms of medusae.

1. The most important of these, and the only one upon which much stress can be laid, is the first. The others afford the necessary confirmation.

The earliest recognisable forms of the sperm mother-cells are found in the canals in the immediate neighbourhood of the zooids (Sperm. S2, fig. 1). They migrate from this position into the ectoderm of the zooids, where they collect together to form a spermarium.

That the sperm mother-cells do actually migrate from the germinal epithelium into the zooids seems to me to admit of no doubt. The youngest stages of the germ-cells are never found in any part of the zooids, and the youngest stages of the zooids never bear either germ-cells or spermoblasts. These two observations prove, firstly, that the germ-cells do not arise in fully developed zooids; and secondly, that new zooids or medusae are not formed at the localities in the canals where the germ-cells arise. They must, therefore, move from the position where they are first developed to the position they occupy in the zooid.

In a few cases I have seen two or three spermospheres (Sperm. S2, fig. 1), or aggregations of spermospheres, lying
separately in the ectoderm of the zooids, but in the majority of cases there is but a single cluster or aggregation (figs. 2, 3, and 4). The largest and most fully developed of these lie at the apex of the zooids (figs. 5, 6, and 7).

The conclusions from these facts seem to be that the germ-cells developing in the canals until they reach the stage corresponding to the sperm-morula or spermosphere migrate towards the zooids, fusing into aggregations as they do so. Having reached the zooids they take up a position between the ectoderm and endoderm of their apices, and continue there the later stages of their development.

The spermospheres are most frequently found in the dactylozooids, but in a few cases I have found them in gastrozooids (fig. 3). They have probably no preference for either the one form or the other; but they are found more frequently in the dactylozooids, partly because these forms are more numerous, and partly because the gastrozooids are usually more remote from the larger coenosarcal canals.

The spermarium having been formed at the apex of the zooid certain noticeable changes take place. In the first place by a thickening of the ectoderm the pore becomes narrowed (figs. 5, 6, and 7). The tentacles become flattened out, and the nematocysts disappear. The spermarium sinks into a cup-shaped receptacle on the summit of the zooid, and the endoderm of the edge of the cup grows out, pushing before it the ectoderm.

These changes are represented in the two figs. 6 and 7. In the next stage the cup-shaped receptacle of the spermarium has grown out into a bell-shaped structure (fig. 8). The spermarium is much larger in size, and the pore is completely closed by ectoderm. In the later stages (figs. 9, 10, and 11) the following changes may be noted. The operculum is formed, shutting off all access from the cavity of the gonangium to the exterior. The walls of the bell-shaped outgrowth become considerably attenuated, and lie close against the ectodermic wall of the ampulla. The manubrium is formed probably by
a regeneration of the endodermic tissue and its growth into the centre of the spermarium.

In the last stage I have observed the medusa is completely separated from the canal system, and lies freely within the cavity of the ampulla. The walls of the umbrella, except at the margin, are extremely thin. The manubrial endoderm contains a closed cavity (fig. 11). This stage is probably the last that occurs before the embryo escapes from the corallum. There are no nematocysts developed on the thickened margin of the umbrella, there are no sensory bodies, there is no velum, and no mouth.

2. In the development of the medusae of Millepora that has just been described there is no structure formed at any time that can be compared with the inner fold of ectoderm or "glockenkern" that forms the walls of the sub-umbrella cavity of the medusa of the Hydroidea. Had such a structure been found, there might have been some ground for supposing that this medusa is a bud that grows out of the degenerated tissues of a zooid. The medusae of Millepora are, however, certainly not formed by budding from the zooid in the sense that the medusae of such a form as Corymorpha are budded from the hydranth.

3. The diagrammatic figures that are frequently given of zooids of Millepora, representing a centrally placed gastrozooid in a complete circle of dactylozooids, is perfectly correct for some species of Millepora and the younger branches of others.

In M. murrayi the zooids are scattered over the older parts of the corallum in an irregular manner. The circular systems can be made out, but over and above the zooids in their regular circles there are both gastrozooids and dactylozooids scattered irregularly within and between the circles (cf. Quelch [11], p. 192).

The medusae occur both in the regular circles and irregularly between them, as may be seen by reference to Woodcut 1. When a piece of Millepora is decalcified and cleared in oil of cloves or turpentine, and examined with a low power of the
microscope, the arrangement of the zooids, medusæ, and coenosarcal canals can be very readily observed. The figure I have given was drawn, by the help of the camera, from such a preparation. The larger canals to which I have referred above form a wide-meshed network immediately below the surface. Each mesh is an irregular polygonal figure embracing the whole of one circular system of zooids. The medusæ are always found either upon or quite close to these large canals, and thus they are sometimes without the circles, and sometimes in a position corresponding to that of a dactylozooid of the regular circle.

The position of the medusæ in the colony cannot be used as an argument against my statement of their origin; in fact, whatever bearing it may have is in its favour.

4. When a decalcified specimen of Millepora is examined from above, a cluster of large nematocysts may be seen at the mouths of the gastropores and dactylopores. They may also be seen in sections (figs. 1, 2, 6, 7, Nemat.). When the medusa is formed and the pore closed by the operculum these large nematocysts can be of little or no service, so they are shot and no new ones take their place. In the figures of the sections through the older medusæ (9, 10, 11) the reader will notice that none of these large nematocysts are to be seen. Where the operculum is not completely formed (fig. 8),
although the zooid has to all appearance changed into a medusa, one or two of these large nematocysts remain.

II. The Male Gonophores of Allopora and Distichopora.

1. Distichopora.—The male gonophores of Distichopora may be seen in clusters on the branches of the male stocks. They are small whitish bodies lying in the ampullae of the cœnosteum, and covered by a very thin semi-transparent wall of lime and cœnosarcal canals.

An examination of a series of sections through one of these branches shows that the male gonophores are found only in these superficial clusters (fig. 12). They are never found deeply seated in the cœnosteum, nor in other places than those indicated by external appearances.

One, two, or even three gonophores, in different stages of development, springing from a diverticulum of the cœnosarcal canal system, may occupy each ampulla.

A ripe male gonophore (fig. 14,) is a spherical, oval, or pear-shaped body, with an endodermal cell mass, representing the trophodisc on the side turned towards the axis, and a short conical or tubular seminal duct on the side turned towards the periphery. The sheath of the gonophore seems to be a simple layer of flattened ectoderm; but I am persuaded, after the examination of a great many sections and the study of the development, that two layers are represented, the inner or endodermal layer being extremely attenuated and devoid of nuclei.

When a very young bud is examined with a high power (figs. 13_a, 14_a, 15), the rudiment of the spermarium may be seen to be a homogeneous mass of protoplasm, containing a number of large spherical nuclei. It occupies a position apparently between the ectoderm and endoderm of the bud. As the spermarium increases in size the endoderm becomes cup-shaped in the bud, and the margins of the cup are produced into a very thin sheath between the ectoderm and the
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spermarium (fig. 16). At the peripheral pole of buds that are about half-way developed there is a thickening of the two sheaths of the gonophores, cell outlines are well marked, and the cells are nucleated (figs. 14 and 16). In this way the first rudiment of the seminal duct is formed. The two layers are from their first appearance quite distinct from one another, and there is never any indication that the two cell layers are formed by a splitting of the ectoderm. Just before the spermarium becomes mature the ectoderm, and subsequently the endoderm, are folded to form a conical cap, and this subsequently pushes through the superficial covering of the gonangium to form the seminal duct to the exterior (fig. 18).

Meanwhile, changes have taken place in the endoderm at the base, i.e. on the axial side of the bud. In the early stages of the bud there is a wide lumen in the endoderm, the cells are cubical in shape, and their outlines well marked; in the later stages the lumen becomes obliterated, the cells lose their distinct outline, and the endoderm degenerates into an irregular mass of tissue, with scattered nuclei (figs. 13, 14, 15, 16).

2. In Allopora (fig. 19) the male gonophores are scattered irregularly in the corallum, and lie at such a distance from the surface that there is no trace of their existence externally. I have been able to find them only in the old thick branches. I cannot say for certain whether Allopora is hermaphrodite or dioecious. The specimens at my disposal consisted of a number of fragments in a bottle, and I found on the smaller and younger branches numerous female gonophores, and on the thicker and older branches numerous male gonophores; but I have not found both sexes on the same branches. I have no information whether the older and younger branches in the bottle are fragments of the same colony. If Allopora is not dioecious, then it is probably protogynous, like Millepora, the female sexual cells being formed first in the younger parts of the colony, and the male sexual cells later in the older parts.

The male gonophores of Allopora resemble those of Dis-
tichopora in every detail of structure except one, and that is that the endoderm of the base is produced into the substance of the spermarium as a club-shaped spadix or manubrium (fig. 20, Spa.).

The spermarium is covered by a double sheath of very thin ectoderm and endoderm, and the seminal duct is produced in the same way that it is in Distichopora. When the spermarium is ripe the seminal duct perforates the superjacent structures, and serves as the duct for the spermatozoa to escape to the exterior. As the gonophores of Allopora are situated much more deeply than they are in Distichopora, the seminal ducts are considerably longer.

As a rule, only one gonophore is seen in each ampulla of Allopora, but occasionally two (fig. 19, gonophore 2), and very rarely three, in different stages of development may be seen.

Lastly, it must be observed that the fully developed male gonophores of Allopora are much larger than those of Distichopora.

From a large number of measurements I have obtained the following average measurements:

Longest diameter of male gonophores of Allopora . 0·38 mm.

" " " Distichopora 0·19 "

The male gonophores of a few species of Stylasteridæ have been described by Moseley (10).

In Sporadopora dichotoma the specimens were all males. "They are ovoid bodies with the long axes directed at right angles to the surface of the coral. Sometimes only one such body is present in an ampulla; sometimes two or three. The outer extremities of the gonophores are sometimes drawn out into a short tail-like prolongation." This structure probably corresponds with the seminal duct of Allopora and Distichopora. "There is a cylindrical spadix in the centre. The bases of the gonophores are continuous with large canals of the cœnosarcal meshwork, the endoderm of the spadix being continuous with that of these canals."
In Pliobothrus symmetricus the male gonophores are sacs containing a number of small ovoid bodies, which contain spermatozoa, or sperm-cells, in various stages of development. The exact structure of these smaller bodies and their relations to the endoderm were not determined.

Only male specimens of Stylaster densicaulis were obtained. Each male ampulla contains two or three ovoid gonophores, which are attached to large offsets of the coenosarcal meshwork at one end of their longer axes. They have an internal spadix, and in finer structure seem to differ very little from the male gonophores of Sporadopora.

Moseley also describes the male gonophores of Allopora profunda, and remarks that they are very similar to those of Sporadopora. He does not figure the seminal duct of this genus.

Only one male specimen of Astylus subviridis was examined by Moseley. "The male gonophores appear as large rounded lobulated masses resting within the ampullar sacs, and springing from stout offsets of the coenosarcal meshwork, which pass into the sacs to reach them. . . . The sac as it enlarges becomes gradually pedicellate, and, when mature, is attached to the central mass by a narrow pedicle of some length. The walls of the pedicle are continuous with the ectodermal wall of the sac, which wall contains well-developed nuclei in its substance. Within the sac of the lobule a second sac, composed of a finer membrane, encloses the mature or developing generative elements. The wall of this inner sac is not prolonged into the cavity of the pedicle, but, passing across its commencement, shuts off the main cavity of the lobule from this latter. . . . No rounded spadix, such as that occurring in Allopora, is present in the interior of the lobules." These gonophores seem, from the figures and the description given, to be very similar to those of Distichopora.

It is not at all probable that Moseley overlooked the spadix, for in his figure there are represented no fewer than seven gonophores; and he remarks that his material was in a
good state of preservation. The "inner sac" of the gonophore that he mentions and figures is most probably the same as the inner endodermic lining that I have described in both Allopora and Distichopora. It would be certainly very remarkable if this membrane is not attached to the endoderm of the pedicle in Astylus, but this point can only be determined with accuracy by the examination of a continuous series of sections.

The male gonophores of Cryptohelia pudica seem to be similar to those of Astylus.

III. The Female Gonophores of Distichopora.

The position of the female gonophores of Distichopora can be readily seen on the female stocks by the prominent swellings on the surface of the corallum. They are usually situated on only one side of the thicker branches, but occasionally there may be found in addition a small cluster on the opposite side.

A section through one of these clusters shows the eggs and embryos in many stages of development, from the minute immature yolkless eggs in the cœnosarcal canals to well-advanced planulae (fig. 21).

The mature ova (fig. 23, ovum) are 0.3 to 0.4 mm. in diameter, and contain a large number of spherical yolk-globules. The large germinal vesicle is situated close to the peripheral border of the egg, and is surrounded by a number of yolk-globules much smaller in size than those of the other part of the egg. The eggs rest in the cup-shaped trophodisc (cf. Allopora, Hickson, 7), and is covered by a thin coat of ectoderm and endoderm. The trophodisc is similar to that of the female gonophores of Allopora, but not so complicated in its foldings. In transverse section it exhibits twelve pouches at its margin (fig. 24). In vertical section it is simple (fig. 23); the inner and outer pliets that I have described in Allopora are not found in this genus.

When fertilisation has taken place the germinal vesicle loses
its sharp outline, and remarkable changes occur in the shape and arrangement of the yolk-globules. My observations are not yet complete of the early stages of the development, but I hope to be able to publish shortly a separate memoir, giving a full account of the development of this form up to the stage when the larva escapes from the ampulla.

During the early stages of development the trophodisc rapidly atrophies, and by the time a layer of columnar epiblast-cells has formed round the embryo no recognisable trace of it can be seen (figs. 22 and 25).

In the meantime young eggs are migrating from the subjacent canals to the base of the ampulla, and in many cases before the larva has escaped a new egg, borne by a new trophodisc, occupies a considerable space in the same ampulla (fig. 25).

The young eggs (fig. 22, ov.) are frequently seen quite deeply situated in the canal system; those that are nearer to the ampullæ are larger in size and amoeboid in shape. As soon as they reach the ampulla they show very minute yolk-granules, which increase in size with the growth of the egg and the development of the trophodisc.

The female gonophores of a few species of Stylasteridæ have already been figured and described by Moseley (10).

In Pliobothrus symmetricus "the gonophores are contained in ampullæ which are often sunk deep in the cænosteum. . . . The ova are solitary, one only being developed in each growing ampulla. Each ovum is developed within the cup of a cup-shaped spadix," i.e. trophodisc. "As the ovum advances in development and increases in size the spadix enlarges with it. Subsequently, however, in later stages, the spadix appears not to increase further, and when in relation with a nearly fully developed planula appears proportionately small."

In Errina labiata "the female gonophores are closely similar in structure to those of Pliobothrus symmetricus; but there is this great difference, that whilst in Pliobothrus the ampullæ and their contained ova and planulae remain until maturity immersed in the cænosteum beneath its surface,
in Errina the ampullæ project more and more above the surface as development proceeds.

"The spadix in Errina labiata is at first cup-shaped, the walls of the cup being composed of a very thick layer of endoderm. The cavity of the cup is directed towards the surface of the coral, and within it rests the single large ovum with its distinct germinal vesicle and spot. Each ampulla contains invariably only one spadix and ovum."

Moseley gives a detailed account of the female gonophore of Cryptohelia pudica. In a late stage the trophodisc is "complicated at its margin by subdivision of its lobes, which form a network over one half of the surface of the ovum, terminating in a fringe of numerous tentacula-like lobes."

From these descriptions of Moseley and my own it seems probable that the female gonophores of the various genera of Stylasteridae are very similar in general structure to one another. Moseley does not describe nor figure an inner endodermal membrane covering the egg, but in other respects his descriptions of the female gonophores of the three genera, Errina, Pliobothrus, and Cryptohelia, agree with mine of Allopora and Distichopora. The chief point of variation among the different genera is probably the lobulation or branching of the margins of the cup-shaped trophodisc.

I prefer to retain the word trophodisc that I introduced in a former paper to the word spadix used by Moseley for the cup-shaped receptacle of the ovum. This structure cannot be considered to be strictly homologous with the spadix or manubrium of the adelocodonic gonophore of the Hydromedusae. It seems to me to be more probable that it is homologous with the umbrella.

IV. THE GONOPHORES OF THE HYDROCORALLINÆ AND HYDROMEDUSÆ COMPARED.

In the absence of a knowledge of the minute anatomy of the gonophores of the Hydrocorallinæ, the true position of this group in the classification of the Hydrozoa has not yet been very satisfactorily made out.
The peculiar characteristics of the group, namely, the
dimorphism of the polyps and the extensive skeleton of carbon-
ate of lime, have not been considered by naturalists to be of
sufficient importance by themselves to justify the separation of
the Hydrocorallinæ from the Hydromedusæ.

Lankester (9) places them in a separate order of the sub-
class Hydromedusæ.

In the classification used at Cambridge Balfour placed Mille-
pora and the Stylasteridæ in the sub-order Hydroidea of the
order Hydromedusæ.

Claus, in his 'Grundzuge der Zoologie,' makes the Hydro-
corallinæ the first sub-order of the order Hydromedusæ.

In Jackson's edition of Rolleston's 'Forms of Animal Life'
(8) the order Hydroidea is divided into the three sub-orders
(1) Tubulariæ, (2) Hydrocorallinæ, and (3) Campanulariæ.

The opinion I have come to, based upon Moseley's researches
and my own, is that the Hydrocorallinæ should be placed in
an order apart from the Tubulariæ and Campanulariæ (i.e.
Hydroidea of Balfour and Jackson).

The classification of the Hydrocorallinæ with the Hydroidea
was perfectly justified by the state of knowledge at the time.
Both dimorphism and skeletal structures are, comparatively
speaking, uncertain features for the purposes of classification,
and the character and structure of the polyps and their con-
ecting canal systems show undoubted affinities with many
forms of Tubulariæ.

Unless, then, the organs that bear the sexual products can
be shown to differ very widely from those of the Hydroidea,
and present characteristics peculiarly their own, the Hydro-
corallinæ must remain in the position that is assigned to them
by some authorities in the order Hydroidea.

These considerations demand a careful and exhaustive com-
parison of the typical gonophores of the Tubulariæ, and of those
Hydrocorallines that are at present known to us.

To aid in the discussion of the homologies I have given on
p. 390 diagrammatic figures representing the structure of
(Woodcut 2) a phanerocodonic medusa, (3) a medusa of Mille-
pora, (4) an adelocodonic medusa, (5) the male gonophore of Allopora, (6) the male gonophore of Distichopora, (7) the female gonophore of Distichopora.

Figs. 2 and 4 are copied from Allman with this modification, that both endodermal tissue and endodermal cavity are represented in black. The diagrams are modified in this way, because no important morphological distinctions can be drawn between endodermal structures possessing a cavity and those that do not. For example, no one would think of drawing a
fine morphological distinction between the dactylozooids of Millepora and those of Allopora because in the case of the former there is a lumen and in the case of the latter the endoderm is solid.

In comparing the structure of the phanerocodonic medusa and the medusa of Millepora a very general similarity may be observed.

In both there is a centrally placed manubrium (A).
In both the generative elements (a) are developed between the ectoderm and endoderm of the manubrium.

In both there is a contractile bell umbrella, from the centre of whose concavity the manubrium is suspended; in both this umbrella is composed of a centrally placed sheath of endoderm covered by a sheath of ectoderm on both sides; and in both the gonophore lies in a gonangial cavity of ectoderm, which, before the medusa is set free, is continuous with the ectoderm of the outer wall of the umbrella.

The principal points in which these two forms differ from one another are these:

The manubrium of 2 possesses a mouth.
The manubrium of 3 does not.
There is a system of canals (longitudinal and ring) in the umbrella of 2.
There are no canals in the umbrella of 3.
There are tentacles and sensory epithelium at the margin of the umbrella in 2.
There are no tentacles or sensory epithelium at the margin of the umbrella of 3.
There is a velum in 2.
There is no velum in 3.

Too much stress should not be laid upon any of these points of difference, for it is quite possible that tentacles, eyes, or auditory organs, a velum and a system of gastro-vascular canals, may be subsequently developed in the medusa of Millepora after it is set free.

It is of importance to note, however, that these organs are not developed while the medusa is still attached to the parent
stock, as they are in the typical phanerocodonic medusa of the Tubulariae.

Comparing the medusa of Millepora with the adelocodonic gonophore (fig. 4) of Hydromedusae, the following points of difference may be observed:

There is a codonostome in the former, there is none in the latter.

In the former the endoderm extends almost to the margin of the umbrella, in the latter the endoderm is reduced to a shallow cup surrounding the base of the manubrium.

In other respects the two gonophores are practically similar.

Comparing the adelocodonic gonophore (fig. 4) with the male gonophore of Allopora (fig. 5), two points of difference may be observed. In the first place the endoderm completely surrounds the gonad in the latter, excepting at a small aperture at the distal pole, where it forms the inner wall of a narrow seminal duct. Secondly, there is no layer of ectoderm between this endoderm and the gonad in Distichopora. In the adelocodonic gonophore there are two layers of ectoderm between the gonad and the wall of the gonangium.

The male gonophore of Distichopora (fig. 6) resembles that of Allopora (fig. 5) in all respects except one, namely, that in the former there is no manubrium.

The female gonophores of the two genera of Stylasteridae resemble the male gonophores in most respects, but in the former there is a more complicated pleting of the base to form a nourishing disc (trophodisc), and no structure corresponding to a manubrium can be observed.

Do these gonophores of the Hydrocorallinae represent stages in the degeneration, or do they represent stages in the evolution of the free medusiform gonophore?

It would be more satisfactory, perhaps, to leave these questions to be answered at a time when we are better acquainted with the minute anatomy of the gonophores of other species of Millepora and the other genera of the Stylasteridae.

The very convincing proofs that have been brought forward by Balfour, Weismann, and others, showing that the gonophores
of the Hydroidea, however simple in structure, represent stages in the degeneration of medusæ, may lead to the conclusion that these gonophores of the Hydrocorallines are also degenerate medusæ; and it is necessary to issue a warning that this is probably not the case.

That the medusa of Millepora is not degenerate but primitive in its simplicity must be apparent.

In the course of its development there is no abbreviation nor any trace of organs that were at one time functional and have since become rudimentary. Moreover, it cannot be considered at all probable that a free-swimming medusa, bearing immature spermatozoæ, would have lost its mouth, tentacles, sensory organs, endoderm canals, and velum; or, if it is a degenerate medusa, that the development of these organs would be postponed until after its escape.

The only view that seems to me to be at all tenable is the one that considers the medusa of Millepora to be primitive in its simplicity.

As regards the male gonophores of Allopora and Distichopora, there is without doubt a close similarity in appearance between certain stages in the development of the male gonophores of both these genera and the younger stages of the medusæ of such forms as Pennaria and other Tubularians (cf. this paper, Pl. XXX, and Weismann (12), pl. xvii, fig. 3); and the manubrium of Allopora is undoubtedly closely similar in general appearance to the manubrium of the adelocodonic gonophore of many of the Tubulariæ. In fact, the gonophores of some of the Hydroidea, such as Clava (Allman) and Corydendrium (Weismann), are much less like adelocodonic medusæ, even when they reach their full development, than are these gonophores of Allopora and Distichopora.

If it could be shown that the inner membrane covering the spermarium is derived from the ectoderm and is not endodermic as I have described it, and that structures corresponding to the "glockenkern" do occur in the development of these gonophores, then my principal objections to the view that they are degenerate medusæ fall to the ground. A very
careful examination of my sections of gonophores in all stages of development convinces me that there is in these forms no true "glockenkern," and that the two membranes covering the gonad are truly homologous with the two membranes covering the ova, namely, an outer ectodermic membrane and an inner endodermic membrane.

The manubrium of the gonophore of Allopora is, I believe, strictly homologous with the manubrium of the medusa of Millepora; that is to say, it is a subsequent endodermal ingrowth into the spermarium developed for the purpose of affording increased nourishment to the rapidly increasing spermoblasts.

These gonophores, then, do not represent, in my opinion, stages in the degeneration of medusæ. The Stylasteridae never possessed free-swimming medusæ, I believe, although their gonophores may indicate to us some of the stages that the medusæ of Hydroidea passed through in the course of their phylogeny.

Before entering into a discussion of the meaning of the gonophores of the Hydrocorallines, it is necessary to consider briefly the principal views that have been put forward concerning the primitive or ancestral form of the Hydrozoan. Is it probable from the evidence at our command that the ancestral form was a fixed colonial hydroid, or was it like a scyphistoma larva (Hydra tuba); or, lastly, was it a floating Hydra or actinula?

Balfour says, "A condition like that of Hydra, in which the ovum directly gives rise to a form like its parent, is no doubt the primitive one, though it is not so certain that Hydra itself is a primitive form. The relation of Hydra to the Tubulariæ and Campanulariæ may best be conceived by supposing that in Hydra most ordinary buds did not become detached, so that a compound Hydra became formed; but that at certain periods particular buds retained their primitive capacity of becoming detached, and subsequently developed generative organs, while the ordinary buds lost their generative function."
Weismann's view is similar to that of Balfour. He says, "Die niedrigste d. h. einfachste Form der heute lebenden Hydroiden ist wohl Hydra; es scheint mir wenigstens für jetzt kein Grund vorzuliegen, sie für eine rückgebildete Form, wohl aber manche Gründe sie für eine sehr alte Form zu halten, wie oben schon genauer begründet wurde, und wie es auch so von den meisten Forschern angenommen wird" (12).

Both of these authors considered that the primitive type of Hydrozoan was a simple sessile form more or less similar to our modern Hydra, and that the medusa originated by the modification of individuals bearing the sexual cells that were budded from, and set free from, the primitive simple sessile Hydra.

Lankester says, "The particular form which the proximate ancestor of the Hydrozoa took is most nearly exhibited at the present day in Lucernaria, and in the scyphistoma larva (Hydra tuba) of Discomedusæ. It was a hemispherical cup-like polype with tentacles in multiples of four, with four lobes to the wide enteric chamber. This polype, after passing a portion of its life fixed by the aboral pole, loosened itself and swam freely by the contractions of the circular muscular fibres of the hypostome (sub-umbrella), and developed its ovaria and spermaria on the inner walls of the enteric chamber. This ancestor possessed, like its descendants, a very marked power of multiplication, either by buds or by detached fragments of its body. Accordingly it acquired definitely the character of multiplying by bud formation during the earlier period of its life; each of the buds so formed completed in the course of time its growth into a free-swimming person. We must suppose that the peculiarities of the two phases of development became more and more distinctly developed, the earlier budding phase exhibiting a more elongated form and simple enteric cavity (Hydra form), which subsequently became changed in the course of ontogeny into the umbrella or disc-like form, with the coalesced enteric walls and radial and circular surviving spaces (medusa form). And now the ancestry took two distinct lines, which have given rise respectively to
the two great groups into which the Hydrozoa are divided—
the Scyphomedusæ and the Hydromedusæ."

Another view has been put forward by Brooks (3), who,
from a consideration of the developments of the Trachome-
dusæ and Narcomedusæ, comes to the conclusion that the
ancestral form was a simple solitary floating or swimming
Hydra.

It does not seem to me to be at all clear that Claus pre-
viously expressed the same view in the 'Grundzüge der Zoologie,'
for although he says that Hydra is certainly not a primitive
form, that the medusa is a higher form than the polype, and
that intermediate forms between the medusa and polype are
represented by the actinula of Tubularia and Tetraápteron
volitans, he does not commit himself to the view that the
ancestral Hydrozoan was a free-swimming Hydra-like larva.

Böhm (2), on the other hand, expresses his views very clearly:
"Eine der nächsten Nachkommen der uralten Gastraea muss
als die Stammform der Zoophyten, eine nicht weit von ihr
entfernte als die der Hydromedusen angesehen werden. Bei
der hypothetischen Construction der letzteren hat man zwischen
drei Möglichkeiten zu wählen.

"Entweder war diese schon entschieden polypoid ihre
nächsten Nachkommen waren Polypen, und die Medusen
haben sich erst später aus diesen entwickelt.

"Oder sie war ganz medusoid, die Medusen die primären die
Polypen die secundären Nachkommen.

"Oder schliesslich es war eine intermediäre zwischen Poly-
pen und Medusen stehende Form, und Polypen wie Medusen
haben sich von ihr aus nach zwei verschiedenen Richtungen hin
entwickelt.

"Die letztere Annahme schient mir manche Gründe für sich
zu haben. Denn der lange Weg vom wenig differentzerten
festsitzenden Polypen bis zur hochausgebildeten freischwimm-
enden Meduse wird wesentlich abgekürzt durch die Annahme
einer Mettelform."

Notwithstanding the arguments of these authors, it is not
easy to believe that the free-swimming actinula represents an
The ancestral type of Hydromedusan. The parasitic or semi-parasitic habits of the actinula of most of the Narcomedusae suggest that it is an extremely modified form, and it seems to me to be extremely hazardous on the part of Brooks to base his phylogenetic considerations upon such a weak and slender foundation. The views of the earlier writers that the sessile form is the more primitive, that in those cases in which the medusa develops directly from the egg the trophosome has disappeared from the developmental cycle, seem to be more probable.

It is not necessary to enter further into the discussion of these extreme speculative questions.

I have referred to them not in the hope of adding anything new, nor of throwing light upon them, but in order that I may place clearly before the reader the position I take with regard to them.

It seems to me to be more satisfactory to regard the sessile trophosome rather than the free-swimming actinula as the primitive type, and the medusa as a structure produced originally by a polypoid colony for the nourishment and distribution of the gonads.

Having thus stated my opinion as to the original form of Hydroid, it is necessary to go further and express an opinion as to the mode in which medusae originated.

The views of Weismann and Balfour on this question are as nearly as possible identical. They supposed that the medusa originated by certain buds bearing the primitive sexual cells, retaining their primitive capacity of being detached from the parent, and that such buds became modified for a free-swimming existence. According to these views the medusa is homologous with a polype, it is simply a modified trophosome, or that trophosomes and gonophores are both modifications of some common type.

Huxley's original view that the gonophore is a peculiar sexual organ has in recent years been subject to a storm of criticism, and there are very few naturalists of the present day who would defend the position he took. "A medusoid, though
it feeds and maintains itself, is in a morphological sense simply
the detached generative organ of the hydrosoma on which it is
developed.""

The gonophores of the Hydrocorallinæ do not seem at first
sight to throw much light upon these questions. If we
arbitrarily assume that they are degenerate medusæ comparable
to the adelocodonid gonophores of the Tubulariæ and Cam-
panulariæ, we cannot expect to find in them any evidence to
support either the one view or the other. But there is no
reason to suppose that they are degenerate medusiform gono-
phores. Neither in Millepora, nor in Allopora and Distichop-
pora, are there any features in development that suggest rudi-
mentary structures of medusæ.

If they are not degenerate structures, then, but gonophores
of a primitive type, how can we reconcile the medusa of Mille-
pora, which is a metamorphosed polype, with the gonophores
of Allopora and Distichopora, which show no trace of polypoid
or medusoid structure?

The explanation I would suggest is briefly as follows:
When the ova or sperm-mother cells reach a certain size and
are too large to move freely in the canal system, they set up a
local stimulus or irritation, which causes a cup-shaped folding
of the adjacent canal or polype wall. This cup-shaped fold
being of advantage to the sexual cells during their maturation,
by affording increased facilities for nourishment and by in-
creasing the size of the cavity by solution of its walls, has been
modified into a definite form in each species by natural selec-
tion. When the sexual cells arrive at their maturity the
nourishment afforded by these cells is no longer necessary,
and consequently the stalk of connection with the canals be-
comes constricted until the gonophore is set free in the cavity
of the ampulla. In the ancestral form of the Millepora a
ready access to the exterior was open to the separated gono-
phore by way of the dactylopore, and thus the detached gonophore was able to escape and lead a free-swimming existence.

It is reasonable to suppose that all the cells of the colony of
a Millepora are capable of a certain amount of contractility,
and that the slight power of contractile movement that the original free gonophore possessed being of advantage to the species—by enabling the gonophore to keep afloat longer and thus spread the sexual products farther—was increased by natural selection. Similarly the rim of the gonophore cup was produced until it assumed the size and shape of a medusa.

The whole of this hypothesis of the origin of the medusæ rests upon the supposition that the sexual cells when they reach a certain size set up a local irritation or stimulus, causing a cup-shaped growth of the cænosarc in its immediate neighbourhood.

Is it reasonable to suppose, in the first place, that the gonads when they reach a certain size do produce a local stimulus or irritation? In young immature stocks there is no trace of ampullæ or other receptacles in the cænosteum of sufficient capacity for the mature gonads. Nor are there found in stocks that are bearing but few sexual organs any empty cavities in the cænosteum. It is almost certain, then, that the gonads, when they reach a certain size, cause a stimulus to certain cells to secrete an acid (?) which dissolves the lime of the cænosteum and causes an ampulla to be formed. There can be no doubt, then, that the sexual cells do cause one kind of stimulus to the tissues.

But is a local irritation or stimulus likely to cause any such modification as circumferential folding of the canals in its neighbourhood?

The only direction in which we can look for an answer to this question is to the effects caused by the irritation of foreign substances and parasites. The Hydrocorallines, like most of the corals, are subject to the attacks of many kinds of parasites. Worms, molluscs, barnacles, and other forms may be seen in every specimen that is examined.

When the colony is attacked by such a form as Tetraclita, for example, the cænosarc at the immediate spot on which the parasite settles is killed, but this does not cause an atrophy of the surrounding canal system. On the contrary, a pronounced hypertrophy of the canal system immediately surrounding the
parasite takes place, and in time it grows round and over the parasite until it is almost buried in its substance. An examination of other forms of coral will show similar examples of parasites and other foreign bodies covered by an hypertrophied growth of the cænosarc.

The formation of the corbula of Aglaophenia may be accounted for by a similar explanation. The stimulus of the growing blastostyles causes, not only an increased activity in the growth of the lateral branchlets, but a growth in such a manner as to enclose the blastostyles in a cup.

Similarly the various kinds of animal galls found in Hydroids and Aleyonarians are probably caused by a circumferential hypertrophy of the tissues surrounding the parasitic pycnogonid, crab, or mollusc.

From this evidence, then, it does seem probable that a local stimulus or local irritation of the cænosarc of these forms causes a growth of the tissues which gradually folds over the seat of the irritation.

If this is the case, then, the production of a very rudimentary and imperfect umbrella-shaped structure is a physiological result of the stimulus caused by the growth of the sexual cells, and the medusa is simply a modification, produced by natural selection, of such a structure.

If this view is a reasonable one, we get over the principal difficulty in accepting the view that the ancestral Hydrozoan was a colonial Hydra form.

One of the chief features of the higher Protozoa and of the Cælenterata is the power they possess of forming large colonial organizations by asexual reproduction. And it is reasonable to suppose that when the primitive Hydrozoan became differentiated off from its colonial Protozoan ancestry it retained the power of forming colonies by fission or gemmation.

It has seemed to me improbable that Hydra can be closely related to the ancestral type, because it does not possess this power.

If this view of the origin of medusæ is correct, there is
no difficulty in believing that the ancestral form was a colonial trophosome, and that medusæ of different kinds may have originated quite independently of one another from the Hydroid stocks.

The original position of the gonads was the centre of the concavity of the umbrella. As they became larger and larger in phylogeny a conical growth of the endoderm, with respiratory and nutritive functions, penetrated them, and became the manubrium. All of these stages may be seen repeated in the ontogeny of the medusa of Millepora. When a mouth was formed at the end of the manubrium the gonads were in some forms (anthomedusæ) restricted to the sides of that organ; but in other forms (leptomedusæ) they were shifted to a more convenient place in the radial canals. According to my view, then, the manubrium of the male gonophore of Allopora does not prove that it is a degenerate medusa, but, rather, that it is one stage further than Distichopora on the road that all medusæ have travelled in the early history of their phylogeny; that is to say, a stage with a larger spermarium, and a special process of endoderm for its more perfect nourishment and respiration.

Another question arises in connection with the gonophores of the Hydrocorallinæ that at one time would have been considered one of vital importance.

In the description given above of the development of the medusa of Millepora, I have shown that it is formed by a metamorphosis of a dactylozooid. This would support the view, then, that the medusa is a modified trophosome.

In the description of the development of the gonophores of Allopora and Distichopora I do not mention the zooids at all. The gonophores are not developed in these genera (figs. 12, 19) in connection with either the gastrozooids or dactylozooids, they arise quite independently from the conosarcal canals. They have no particular relation to the systems in which the zooids are arranged, and there is every reason to suppose that they are quite independent of them. Further, these gonophores are not, according to my view, degenerate
medusae. They must, therefore, be special organs of the colony bearing the gonads.

To those naturalists who believe that there is a sharp distinction to be drawn between the idea of the "individual" and the "organ" in the animal kingdom, these apparently contradictory cases must be very puzzling. In the one case they would say the gonophore is an "individual;" in the other, it is an "organ."

I am not inclined, however, to believe that it is possible to draw a sharp distinction between these two ideas. They are relative ideas, as Claus (5) maintains, just as "cell" and "tissue," "individual" and "colony," must be.

The stimulus of the sexual cells of a certain size would produce the same effect if they were formed in the coenosarcal canals or the zooids; but natural selection has stepped in in the case of the Hydrocorallines, so that in the case of Millepora the gonads do not produce this effect until they reach the zooids, and, in the case of the Stylasteridae, not until they reach certain parts of the canal system.

The two kinds of gonophores are, then, to my ideas really homologous, although in the one case they have reached such a stage of development as to justify us in considering them "individuals," while in the other case they cannot be considered more than sexual "organs."

General Conclusions.

1. In Millepora murrayi (sp. ?) the male gonads are borne by medusae which escape from the ampullae in which they are developed before the spermatozoa are matured.

2. The ova of this species are, like the ova of Millepora plicata, extremely small and alecithal. They move in an amoeboid manner in the coenosarcal canals, and do not ultimately rest in gonophores, nor in any specialized portion of the system.

3. The medusae of Millepora murrayi have no radial nor ring canals in the endoderm of the umbrella, no velum, no sensory organs, and no mouth.
4. The medusae are formed by a metamorphosis of an ordinary zooid; in the majority of cases dactylozooids, but in others gastrozooids.

5. The sperm-cells originate in the ectoderm of the coenosarc and wander into the ectoderm of the zooids, where they fuse into aggregations to form a spermarium.

6. The young spermarium is formed at the distal extremity of the dactylozooid, and when it has reached a certain size it causes a retrograde metamorphosis of the tissues. The tentacles flatten out and disappear, and the zooid loses all its characteristic features.

7. A cup-shaped outgrowth next appears which forms the umbrella of the medusa, and subsequently a conical growth of the endoderm penetrates into the substance of the spermarium and forms the manubrium.

8. The male gonophores of Distichopora occur in groups of two or three in each ampulla in different stages of development. The gonad is supported by a small cup-shaped trophodisc, and enclosed in a double sac of ectoderm and endoderm. At the distal pole of the ripe gonophore there is a short seminal duct.

9. The male gonophore of Allopora differs from that of Distichopora, in the fact that it is provided with a club-shaped endodermal manubrium or spadix.

10. The female gonophore of Distichopora resembles that of Allopora described in a previous paper; but the folds of the trophodisc are not so complicated.

11. The gonophores of the Hydrocorallinae are not degenerate medusae.
BIBLIOGRAPHY.

1. F. M. BALFOUR.—‘Comparative Embryology,’ 1880.
DESCRIPTION OF PLATES XXIX & XXX,

Illustrating Mr. Sydney J. Hickson's paper "The Medusæ of Millepora murrayi and the Gonophores of Allopora and Distichopora."


PLATE XXIX.

Millepora murrayi.

Fig. 1.—Section through a retracted dactylozooid of Millepora murrayi, showing a number of spermospheres (Sperm. S₂) in the ectoderm of the cænosarco, and in the ectoderm (Sperm. S₁) at the base of the dactylozooid.

Fig. 2.—Section through a retracted dactylozooid, showing a single small aggregation of spermospheres (Sperm. S₁) in the ectoderm at the base of the dactylozooid.

Fig. 3.—Section through a retracted gastrozooid, showing an aggregation of spermospheres in the ectoderm. The gastrozooids may be readily distinguished from the dactylozooids by the presence of a mouth and by the large endoderm cells, the peripheral portions of which are filled with mucus. Just below the gastrozooids may be seen a plate of vacuolated ectoderm cells in section, which forms the last tabula of the gastropore.

Fig. 4.—Section through a dactylozooid, showing a large aggregation of spermospheres on its side in a condition very similar to that I have described in Millepora plicata (6). The spermospheres have caused a very considerable depression in the dactylozooid, and are partially covered by the surrounding parts.

Fig. 5.—An aggregation of spermospheres at the peripheral extremity of a dactylozooid. The tentacles (tent.) are visible.

Fig. 6.—An aggregation of spermospheres (Sperm. S₁) at the peripheral
extremity of a dactylozooid, sunk in a cup-shaped receptacle. At *Umb.* may be seen the first trace of the formation of the umbrella by the growth of the endoderm. The position of the tentacles is still indicated by the rows of small nematocysts.

FIG. 7.—Section through another dactylozooid, showing a still further growth of the folds forming the umbrella. All trace of the tentacles has disappeared.

FIG. 8.—Section through a young medusa of *Millepora*. The form of the dactylozooid is completely lost. The endoderm of the umbrella is solid, and much thicker than it is in later stages. The opening of the dactylopore can still be traced, although it is blocked with the thickened ectoderm cells. The pore is guarded by nematocysts (*Nemat.*).

FIG. 9.—Section through another medusa. The umbrella is not completely developed, but the endoderm is much thinner than it is in Fig. 8. The spermarium is much larger, but there is no trace of a manubrium. The dactylopore is completely closed by an operculum (*op.*) formed by flattened strap-shaped ectoderm cells.

FIG. 10.—Section through another medusa, with a well-developed manubrium (*man.*), containing a cavity continuous with a large canal. The umbrella walls are much thinner than they are in the specimens drawn in Figs. 8 and 9, except at the margin.

FIG. 11.—Section through a medusa that lies freely in the gonangium. It is not connected organically with the colony at any point. It is probably ready to escape. The umbrella (*Umb.*) is extremely thin, except at the margin. There is a small cavity in the endoderm, but there is no mouth. There are no tentacles, velum, nor sensory bodies on the margin of the umbrella. Between the codonostome and the superficial ectoderm there is a layer of mucus.

PLATE XXX.

FIG. 12.—Transverse section through a decalcified branch of *Distichopora*, showing the male gonophores lying in the ampullae. One, two, or three gonophores occur in each ampulla. At the edges of the branch are situated the rows of dactylozooids (*Dact. Z.*) and gastrozooids (*Gast. Z.*).

FIG. 13.—Section through an ampulla of *Distichopora*, containing two young male gonophores. Each of these is supported by its own trophodisc containing a large lumen.

FIG. 14.—Section through an ampulla of *Distichopora*, containing three male gonophores in different stages of development. The largest of these (1) contains ripe spermatozoa, and shows on its distal pole a conical cap of
cells, the undeveloped seminal duct. The trophodisc (troph.) is reduced to an irregular mass of endoderm cells.

FIG. 15.—Section through a very young male gonophore of Distichopora. The young spermarium (sperm.) lies apparently between the ectoderm and endoderm of the bud, but the endoderm is cup-shaped, and the margins of the cup project between the ectoderm and the proximal hemisphere of the spermarium.

FIG. 16.—Section through an older male gonophore of Distichopora, showing the spermarium covered by the two membranes, a thin nucleated ectoderm and a thinner non-nucleated endoderm, which is continuous with the endoderm of the trophodisc.

FIG. 17.—Section through the earliest stage I have found of the formation of the seminal duct. The ectodermic and endodermic elements are from the very first quite distinct from one another.

FIG. 18.—Section through a seminal duct of a ripe male gonophore, open to the exterior.

FIG. 19.—Section through a portion of a decalcified branch of Allopora, showing three male gonophores lying in their ampullae. As a rule, only one gonophore is found in each ampulla; but one case is figured (gonophore 2) in which a large gonophore and a very young bud occur in the same ampulla.

FIG. 20.—Section through a nearly ripe male gonophore of Allopora, showing the club-shaped endodermal spadix, and the two membranes (Ect. and End.) surrounding the spermarium.

FIG. 21.—Section through a portion of a decalcified branch of a female stock of Distichopora, showing a number of ova and planulae in various stages of development lying in their ampullae.

FIG. 22.—A portion of the same as Fig. 21, more highly magnified. The ampullae are occupied by planulae. Below the ampullae there may be seen in the endoderm of the canals some very young eggs, containing no yolk-granules and showing blunt amœboid processes.

FIG. 23.—An ovum of Distichopora that is nearly mature, as seen in section. The germinal vesicle (Germ. Ves.) lies near the superficial side of the egg, and is surrounded by small yolk-granules. The trophodisc is simple, in vertical section, and contains a pronounced lumen.

FIG. 24.—Transverse section through an ovum and trophodisc of Distichopora in the plane represented by the line $x \cdot x'$ in Fig. 23, showing the twelve pouches of its margin.

FIG. 25.—Section through an ampulla of Distichopora, containing a planula, and below it a young ovum in a young trophodisc.