On Parawrightia robusta gen. et sp. nov., a Hydroid from the Natal Coast; and also an Account of a Supposed Schizophyte occurring in the Gonophores.

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With Plates XXXIII and XXXIV.

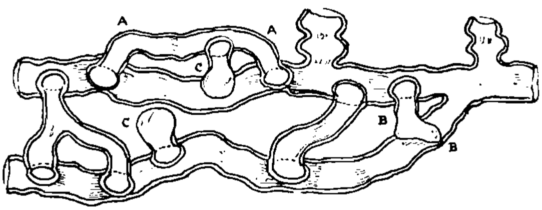
I.

This hydroid has been found at several places on the Natal coast. It was first collected at Park Rynie, and subsequently at Isipingo and Scottsburg. These places are situated thirty to forty miles south of Durban. The hydroid is not very common; it occurs attached to sea-weeds and sponges in the rock-pools near the low-water line.

(1) Trophosome.—It consists of a creeping stolon, about 0·25 mm. in diameter, forming an irregular reticulum on the surface of the foreign body to which it is attached (Pl. XXXIII, figs. 1, 2). From the reticulum there spring upright stems 5—12 mm. in height, which usually bear a single terminal polyp. Occasionally the stem may produce one or even two short lateral branches, each carrying a hydranth.

The growth of the stolon or reticulum is not by any means limited to apical growth. Almost any part of the stolon appears to have the power of sending out bud-like swellings. The ectoderm under the thick perisarc proliferates, forces its way through the perisarc, and is at first only covered by the thinnest cuticle-like layer (text-fig. 3, A, c.). An examination of a reticulum and its growing apices clearly shows that the lateral off-shoots are capable of fusing with neighbouring stolons, the perisarc ultimately disappearing at the place of contact, and the lumen of the lateral shoot becoming continuous with that of the stolon to which it has joined. In the annexed figure a piece of the stolon reticulum is shown. In the case of the shoot A, the outgrowth has bent round and fused with the parent stolon. In B, a cross-filament is flattening itself over a neighbouring stolon, preparatory to complete fusion and the disappearance of the intervening layer of perisarc. C and C are young buds

TEXT-FIG. 1.



AA. Branch uniting to parent stolon. C. Young buds covered by thin membrane. B. Young bud fastening itself to neighbouring stolon. × 20.

which have recently appeared. It is doubtful whether the substance of the perisarc is the same as that of the chitin of Arthropods; but in any case it is a peculiarly insoluble substance, and it might be of interest to endeavour to trace the mode of absorption of the perisarc in the formation of buds, and the fusion of lateral shoots, since it is clearly not merely a mechanical rupture. I have not, however, had an opportunity to investigate the matter with any thoroughness.

The stolons may be knarled in places, and the general contour tends to be somewhat irregular (Pl. XXXIII, fig. 2, *k*). The stems bearing the hydranths are irregularly ringed or spirally ridged to a variable extent. The ridging (*r.*) may extend throughout the whole length; but it is generally confined to the basal region, where the hydrocaulus springs from the stolon, and the greatest strain has to be borne. The older portions of the stolon tend to be dark brown, while the younger portions are pale brown or whitish. The whole surface of the perisarc is generally clothed with particles of mud and very fine sand (Pl. XXXIII, fig. 3, *ex. l.*, and XXXIV, fig. 6, *o. l.*).

The base of the hydranth is cup-shaped, and the perisarc extends over it forming a kind of calyx (Pl. XXXIII, fig. 3); but the crown of the hydranth is not perceptibly retractile into it, as in the case of Hinck's genus Atractylis. There are thirteen to eighteen tentacles which spring in a single whorl around the edge of the cup-shaped base. The tentacles are sometimes held alternately elevated and depressed (Pl. XXXIII, fig. 2, *p. el.*), as in the genera Perigonimus, Bimeria, etc. The hypostome can scarcely be described as conical, it is intermediate in shape between the conical hypostome of a Perigonimus and the widely expanded, trumpet-shaped hypostome of an Eudendrium.

The hydranth can be found in three conditions (Pl. XXXIII, fig. 2): (1) the ordinary contracted condition (*c. p.*) with tentacles placed more or less vertically, covering the hypostome; height about 0·90 mm.; (2) hypostome and cup elongated (*p. el.*) and tentacles alternately elevated and depressed; height about 1·10 mm.; (3) flattened condition (*ex. p.*) forming a star, where the hypostome and cup constitute the disc, about 0·90 mm. in diameter, and the tentacles form the rays. The thick perisarc of the cup must be highly elastic in order to allow such very complete lateral expansion.

The endoderm of the hydranth is red, the other parts of the hydroid are translucent and white.

The sexes are separate, and fixed gonophores are formed. Both male and female gonophores have only been found springing singly from the stems carrying the hydranths (Pl. XXXIII, fig. 2., *g*, *y.g.*), they have not been seen originating from the stolon.

(2) Histology.—Perisarc.—The perisarc of the stolon is

about 18·7 μ in thickness, and is obviously laminated in structure. The stem carrying the hydranth has a perisarc consisting of two layers: (1) An inner laminated layer continuous with the perisarc of the stolon (Pl. XXXIII, fig. 3, *ch.*[2]), and (2), an outer vertically striated layer (*ch.*[1]). This layer alone forms the cup of the hydranth, and its upper edge is inserted in the shallow perisarc-groove just below the verticil of tentacles. The outer layer gradually thins out towards the base of the hydranth-bearing stem, while the laminated layer thins out and disappears at the base of the hydranth. The thick perisarc around the gonophore consists of the laminated layer only (Pl. XXXIII, figs. 3 and 5, *ch.* 2; text-fig. 3, B, *ch.*[2]). The whole of the perisarc is apparently covered with a gelatinous or sticky substance, as there is normally a very conspicuous coating of small particles of mud and sand.

In the developing hydranth the whole of the ectoderm of the cup-like base appears to take part in the secretion of perisarc. The perisarc-groove, where the perisarc terminates, is a more obvious structure than in the mature hydranth (text-fig. 2, B, *p. g*). It would appear that the outer vertically striated layer (*ch.*[1]) is only secreted by the hydranth, and that as the hydranth elongates and forms a stalk, this layer of perisarc is, so to speak, left behind, and is then strengthened by the secretion of the inner laminated layer by the general ectoderm of the stem. It may be noticed that in the majority of the gymnoblastic hydroids the groove or "collar" occurs at the top of the stem bearing the polyp, where the perisarc terminates; while in the present species it occurs just below the verticil of tentacles of the hydranth.

Ectoderm.—The histology of the ectoderm is typical. The nematocysts are of one kind only in the hydranth, and are somewhat small, measuring about 5·0 μ in length and 2·9 μ in breadth. I have not found them occurring in the endoderm. They are scattered somewhat sparsely throughout the ectoderm of the tentacles and general cœnosarc. In the gonophores, nematocysts are abundant, and they tend to be somewhat larger than those on the tentacles (5·6 μ in length);

they occur in the thickening of the umbrella ectoderm around the opening of the umbrella (Pl. XXXIII, figs. 3 and 5, *n*; text-fig. 6, *n*.). They also occur plentifully in the midst of the spermatic mass (Pl. XXXIV, fig. 6, *n*).

It seems fairly clear that nematocysts can have no function imbedded in the spermatic mass, or even in the general cœnosarc, since they are shut off from the exterior by a thick perisarc. It would appear that the ectoderm, being endowed with the power of forming nematocysts, produces these structures whether or not they can become functionally active. It is conceivable that the presence of nematocysts throughout the entire substance of the ectoderm would render the hydroid distasteful to be eaten as a whole; but I do not consider that this is the correct view. The abundance of nematocysts around what would be the margin of the umbrella is an interesting case of the persistence of a structure after the loss of its function. The fact that the nematocysts are somewhat larger in the gonophore than in the hydranth is also of some interest.

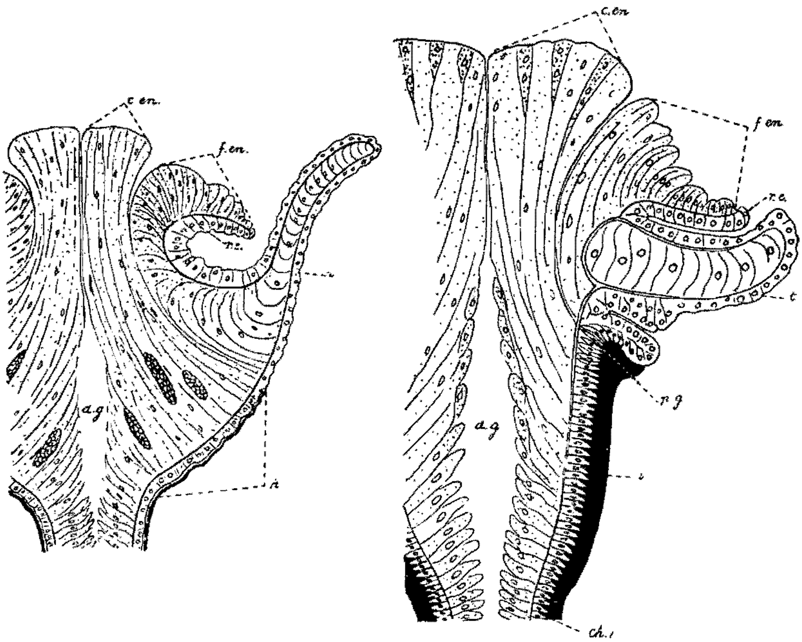
Endoderm.—The endoderm of the hypostome consists of narrow columnar cells, with small deeply-staining nuclei (Pl. XXXIII, fig. 4, *en. h.*). The small vacuolated cells, which stain intensely, and are frequently seen in the endoderm of the hypostome of various hydroids, do not appear to occur in this species. In transverse section the endoderm of the hypostome is seen to be raised into six to eight prominent ridges.

At the base of the hypostome the endoderm abruptly changes its character, and the cells are large, vacuolated, and richly granular. These endoderm cells frequently contain globules of yolk (Pl. XXXIII, fig. 3, *y. gl.*), more especially towards the base of the polyp. Special glandular cells (*gl. c.*) with large granules occur in the upper portion of the digestive cavity of the hydranth, and they are also found irregularly scattered in the endoderm of the stem and stolon.

(3) The development of the hydranth.—A lateral branch of the stolon, a hydranth, or a gonophore, originate

from the parent cœnosarc in a closely similar manner. A bud is formed by an outgrowth of the cœnosarc, which pushes its way through the perisarc, partly by mechanical pressure, and partly, I think, by absorption (text-fig. 3, A). The bud is at first covered merely by a very thin membrane (*c.*). In

TEXT-FIG. 2.



A. B.

A. Adult hydranth of Eudendrium sp. B. Developing hydranth of Parawrightia robusta.

c.en. Central endoderm. *f.en.* Fan-shaped endoderm. *r.e.* Reflexed ectoderm. *t.* Tentacle. *p.* Perisarc, consisting of the vertically striated layer chiefly. *p.g.* Perisarc groove. *d.g.* Digestive cavity. × 140.

the case of a lateral branch of the stolon the bud can readily mould itself so as to fit into any irregularities of surface of the foreign body which supports the hydroid. In this way the colony becomes very firmly attached (Pl. XXXIII, fig. 2, *cl. r.*).

The developing hydranth shows a very marked resemblance to the adult structure of an undescribed Eudendrium-like species, which was dredged off Bird Island last year by the museum collector.

In the annexed illustration are shown, side by side, vertical sections of the adult polyp of the Eudendrium (A) and of the developing polyp of Parawrightia (B).

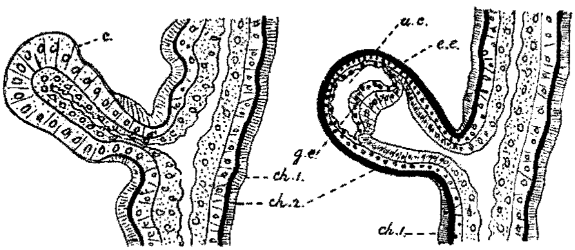
The striking similarity in structure in the two cases is remarkable. At this stage in the development there is no hypostome, and the elongated endoderm is spread out in a fan-shaped manner so as to be widely exposed to the exterior. The reflexed ectoderm (*r. e.*), the arrangement of the endoderm over it (*f. en.*), and the origin of the tentacles (*t.*) may be directly compared with the condition seen in the adult polyp of the supposed Eudendrium. The central portion of endoderm (*c. en.*), consisting of very elongated cells, is essentially alike in the two cases. The digestive cavities (*d. g.*) are both exceptionally narrow. In the Eudendrium the perisarc is less strongly developed; but it does extend over the base of the polyp (*p.*) to form a kind of calyx, as in Parawrightia.

It is, of course, debatable how far such a resemblance is to be regarded as arising through genetic relationships; but the similarity of structure in the two cases is so close that the matter appeared worthy of record; and it is not unreasonable to assume the possibility that the mode of development of the hydranth may give some hints of phylogenetic significance.

(4) Gonosome.—The sexes are separate, male and female gonophores being formed on different colonies. The gonophores, whether male or female, arise on the stems carrying the hydranths. As a rule only one gonophore is produced on a stem, and it is generally situated not far from the polyp. The gonophore, like a lateral polyp, arises by proliferation of a patch of ectoderm and endoderm, which grows through the perisarc in the form of a swelling, and is at first only covered by a very thin membrane.

Ultimately the gonophore becomes surrounded by a uniform layer of perisarc continuous with the inner laminated layer of the stem (text-fig. 3, B). An umbrella-cavity (*u. c.*) appears at an early stage with ectoderm on ectotheca (*e. e.*) and endotheca (*g. e.*) Later on the umbrella-cavity becomes relatively small and is mostly confined to the apical region of the gonophore (text-fig. 4, A and B). Below the apically-situated cavity the endotheca, consisting of the generative epithelium, is continuous with the ectotheca; but there are gradually developed four canals (Pl. XXXIII, fig. 4, *sp.*, and text-fig. 4, *sp.*) which are continuous with the umbrella-cavity in the apical region, and are situated in such a manner

TEXT-FIG. 3.



A. Polyp-bud. × 100. B. Young gonophore. × 70.

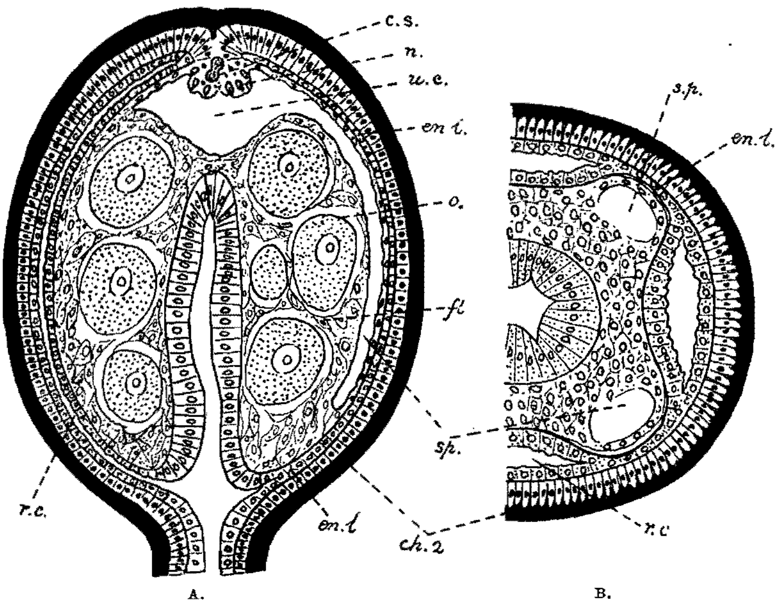
c. Thin membrane covering bud. *ch*¹. Outer striated layer of perisarc. *ch*². Inner laminated layer of perisarc. *g.e.* Germinal epithelium. *u.c.* Umbrella cavity. *e.c.* Ectoderm of Ectotheca.

as to alternate with the endodermal radial canals (*r. c.*) An endodermal lamella (*en. l.*) is present, connecting together the radial canals.

The male and female gonophores differ in shape. The male is a somewhat elongated ovoid, about 1·20 mm. in length, and 0·70 mm. in breadth, and is so placed that it lies almost parallel to the parent stem. The female gonophore is more nearly spherical, about 1·10 mm. in length, and 0·99 mm. in breadth, and it tends to stand out nearly at right angles to the stem (Pl. XXXIII, figs. 3 and 5).

The umbrella-cavity (*u. c.*) of the mature female gonophore has an apical opening (*o. u.*) surrounded by nematocysts (*n.*); but it does not communicate with the exterior on account of the presence of the thick perisarc (about 25 μ thick). In the case of the male gonophore I have not actually seen such an opening developed, but its position is clearly indicated by the dipping in of the ectoderm and the cluster of nematocysts (Pl. XXXIII, fig. 5; text-fig. 4, A.) The ectodermal epithelium of the ectotheca lining the umbrella-cavity is seen in

TEXT-FIG. 4.



A. Female gonophore, longitudinal section. B. Male gonophore, transverse section.

c.s. Capsule of Schizophyte. *n.* Nematocysts. *u.c.* Umbrella-cavity. *en.l.* Endodermal lamella. *o.* Ovum. *fl.* Follicle cells. *r.c.* Radial canal. *ch*[2]. Laminated perisarc. *sp.* Canals opening into umbrella-cavity. × 140.

Pl. XXXIV, fig. 6, *n. o. e.*, and of the endotheca, as distinct from the spermatic tissue, at *e. c.* The space marked *u. s.* is one of the channels which opens into the umbrella-cavity at the apical region of the gonophore. The spaces marked *ch.* occur irregularly through the spermatic mass. A distinct circular canal is not formed.

It is far from clear how fertilisation takes place, since the gonophore is surrounded by a thick perisarc, and the eggs, after they have become charged with yolk-globules, segment and ultimately form planulæ while still inside the parent gonophore (Pl. XXXIII, fig. 3, *Pl.*). The planulæ are solid, and consist of an outer columnar epithelium, within which is a granular mass densely crowded with yolk. During maturation the eggs are surrounded by follicle cells (Pl. XXXIII, fig. 4, *fl.*; and text-fig. 4, A, *fl.*). On the formation of the planulæ the follicle cells disappear, but a layer of ectoderm cells persists on the ectotheca and also covering the spadix (Pl. XXXIII, fig. 3, *ect.*).

(5) Systematic position.—As it has been seen, the reproductive bodies are fixed gonophores, and consequently the present species is at once marked off from Perigonimus, where free medusæ are produced. It agrees with Bimeria and Garveia in having fixed gonophores. It differs, however, from Bimeria in habit, in not having the perisarc continued over the base of the hypostome and tentacles, and in having the spadix unbranched. It also differs from Garveia in habit and in the structure of the gonophore.

In the gonosome the species agrees with Hinck's definition of Atractylis arenosa (Allman's Wrightia arenosa), in which a special point is made that although closely allied to Perigonimus it differs in having fixed gonophores.

The polyp of this species is, however, very little like that of Wrightia arenosa. The average number of tentacles is about fifteen instead of about nine; the tentacles are not muricated, and the polyp is scarcely at all retractile into the upper cup-like portion of the stem. Also, the extrusion of the eggs from the gonophore into a gelatinous sac, which Hinck's describes in Atractylis, has not been observed in the present species; and in fact it probably does not occur, since fully-developed planulæ are found in the unruptured gonophore. The mode of fertilisation is problematical.

The general appearance of a colony is like that of Perigonimus; the endoderm of the hydranth is red, as in several species of Perigonimus, while in Wrightia it is white. On the whole it appears advisable to separate it from Wrightia; and the name Parawrightia robusta is proposed to indicate the relationship.

II.

The structures about to be described, and shown *in situ* in Pl. XXXIII, fig. 3, *p.b.*, Pl. XXXIV, fig. 6, *y.s.*, have only been found in the male and female gonophores. I have searched carefully in the substance of the general tissues of the hydroid, both in the ectoderm and endoderm of the polyp, stem, and stolon. Also, they have not been seen in any cavities, such as the digestive cavities of the polyp or cœnosarc, or in the irregular cavities between the cœnosarc and the perisarc. The structures occur in the umbrella-cavity, in the generative epithelium, and in one case embedded in the ectoderm filling up the opening of the umbrella-cavity. They have not been seen in the endodermal radial canals of the gonophore. It will be noticed that the structures develop in temporary spaces, and that they must ultimately pass out to the exterior by the dehiscence of the gonophore.

In no sense do the bodies appear to exercise a malignant effect on the host; they may increase in numbers in the gonophore to a considerable extent, but the development of the planulæ and sperm continues, to all appearance, in a perfectly normal manner.

From the amount of material available it is difficult to obtain much idea of their frequency of occurrence. I have collected six colonies; three of these possessed no gonophores; of the remaining three, two from one locality (Park Rynie) were female, and one from another locality (Isipingo) was male. About fifteen male and female gonophores in various stages of development were present on these three colonies, and the structures were present in ten. They occurred in all three colonies, but not in every gonophore. The evidence, as far as it goes, indicates a general occurrence of the structures in the gonophores. The organisms have not been found outside the hydroid, either adhering to the surface of the perisarc, or to the sea weed or other foreign body to which it is attached. The structures occur especially in the four canals of the umbrella cavity left between the ectotheca and endotheca, and alternating in position with the radial endodermal canals (text-fig. 4, A and B). They may also be found in cavities that occur in the spermatic mass (Pl. XXXIV, fig. 6, *ch.*), and between the ova or developing planulæ of a female gonophore.

The youngest stage observed is seen in Pl. XXXIV, fig. 7 (*1*). It is a rounded body, about 2·2 μ in diameter, and staining with hæmatoxylin or aniline dyes with great difficulty. The body is refringent, and appears homogeneous with Zeiss's DD objective, but with Zeiss's apochromatic $\frac{1}{18}$ it is seen to be slightly granular with one or two minute globules. In this stage it is capable of division. I have found such bodies embedded in the spermatic tissue, and in one case in the ectoderm of the ectotheca. The bodies apparently work their way out into any spaces, such as the umbrella-cavity and channels, and any cavities in the spermatic mass (Pl. XXXIV, fig. 6, *b*) or between the ova. No distinct, separable cell-wall can be observed.

When in a cavity the body soon secretes a transparent and refringent envelope of one or two layers (fig. 7 (*2*, *3*, *4*, and *5*)). This envelope, especially the outermost and older layer, is capable of staining deeply with hæmatoxylin (Pl. XXXIV, fig. 8 (*4*), *o.en.*).

In this condition (fig. 7 (*4*)) it is capable of fission, both the central body (*c. b.*) and the envelope dividing.

The envelope, forming a definite capsule, increases in size and in the number of laminations, and the central body becomes smaller and more refringent. The central body, which in the young stage is rounded and about 2·2 μ in diameter, varies in size in the fully-grown capsule from about 1·10 μ to 0·48 μ (figs. 9 and 10, *c.b.* and *d.b.*). The central body can divide by fission (*d.b.*) inside the capsule. Previous to fission the body becomes rod-shaped, and is about 1·10 μ. in length, and 0·50 μ in width (fig. 10, *c.b.*) On the division of the central body, one of three events may take place:

(1) The envelope divides, and fission or budding takes place as mentioned above. This may continue a number of times until a cluster of individuals is produced (fig. 8 (*2, 4, 5*)). Such occurs only when the capsules are small and consist of but few layers.

(2) The division products of the central body may each form a centre from which fresh laminated layers originate. In this way a number of separate centres of lamination may be formed inside the original system (fig. 8 (*7*) and fig. 11).

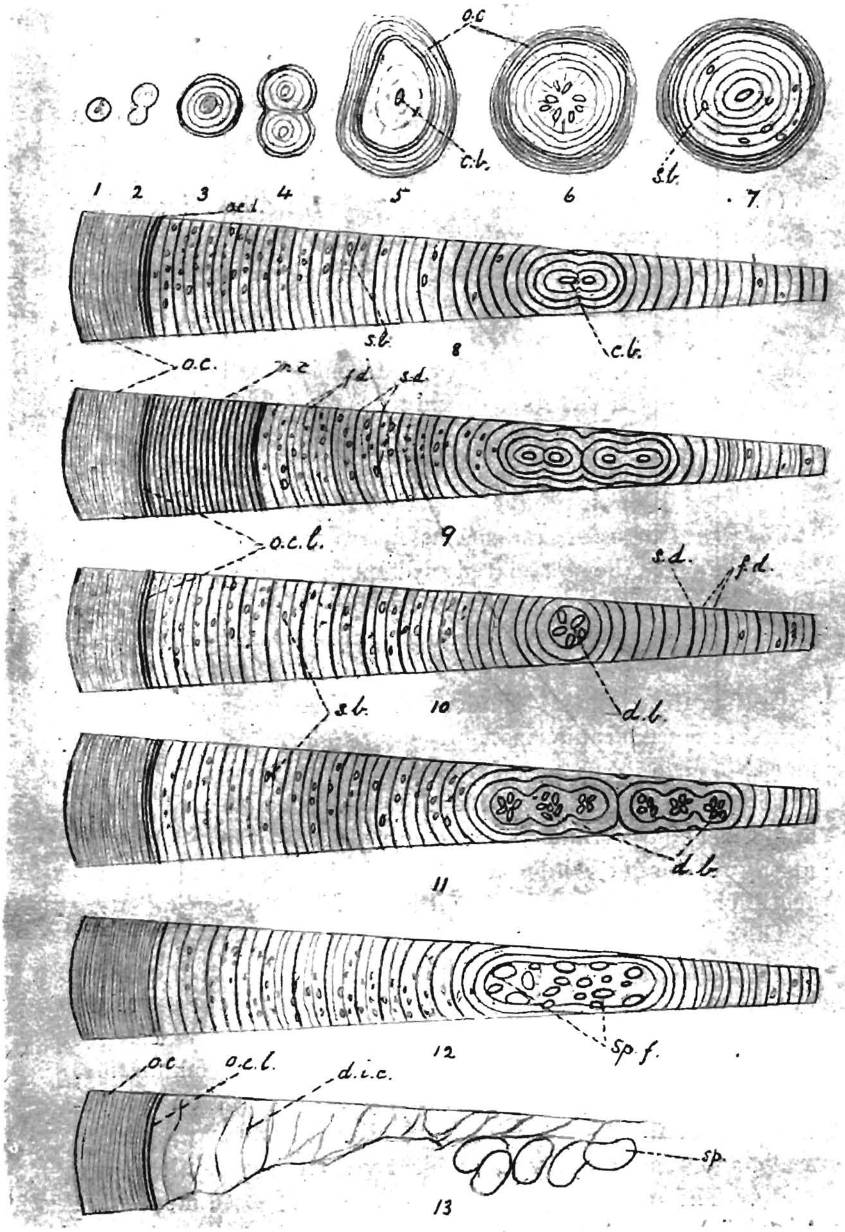
(3) The division-products of the central bodies may not start fresh centres of lamination, but may remain stranded, so to speak, in the laminated system of the parent body (figs. 9, 10, 11, *s.b.*, and text-fig. 5 (*7*) *s.b.*). In an old capsule such bodies are seen irregularly scattered through the laminations.

In the case of the female gonophore the capsules may grow to a very considerable size, and may reach a length of 70 μ or more. The appearance of these structures varies according to the number of centres of lamination. The central bodies, and the bodies stranded in the substance of the capsule, are highly refringent, while the substance of the capsule is perfectly clear like spun glass, and is considerably refringent.

The structures may be spherical with a single central body, or they may be elongated with a row of central bodies along the long axis (Pl. XXXIV, fig 10), or they may be lobed with various centres of lamination (fig. 11). In the case of fig. 9 the structure was bilobed with two centres of lamination.

In the accompanying illustration (text-fig. 5), the arrangement of the laminations and the bodies is shown on a large scale, and consequently more clearly than is possible in the plate. The cone-shaped figures are wedges taken from various capsules; the centre of the capsule being situated towards the right hand side of the page.

Figures 1 to 5 and 7 show the early stages of development, TEXT-FIG. 5.



c.b. Central body or supposed Schizophyte. *d.b.* Dividing body. *d.i.c.* Disintegrating inner capsule. *f.d.* Faintly defined layer of capsule. *o.c.* Outer capsule. *o.c.l.* Outer layer of inner capsule. *s.b.* Stranded body. *s.d.* Sharply defined layer. *sp.* Spore. *sp.f.* Spore formation. × 2000.

and have already been sufficiently explained. Fig. 6, and Plate XXXIV, fig. 8 (*8, 9, 10*), represent capsules which frequently occur in the male gonophore, and they will be mentioned below.

In text-fig. 5 (*8*) are seen two central bodies, 1·3 μ and 0·6 μ in length, which have clearly been formed by fission. The outermost layer (*o. c.*) of the capsule is about 3·9 μ in thickness, it is apparently very compact and dense, and the lamination, if visible at all, is very close. On the inner side of this dense envelope are two thin layers separated by a narrow clear space (*o. c. l.*). The outer capsule and these two thin layers stain more intensely than any other part of the capsule. Passing inwards we find concentric layers arranged with great regularity, often there are alternating layers of sharply and less sharply defined strata. In these layers and between them can be seen refringent bodies irregularly placed. They may be clustered on one side of the capsule only (Pl. XXXIV, figs. 9, 10, 11, *s. b.*). They vary in size from about 1·1 μ to about 0·4 μ, and were presumably formed by the division of the central body. The layers of capsule immediately surrounding the central body or bodies are less pellucid than the others (Pl. XXXIV, figs. 10 and 11, *i. l.*).

In fig. *9* there are four central bodies, obviously formed by the division of two. The capsule shows the usual outer compact layer with little trace of lamination, then the sharply defined double line. Within this there are twelve or thirteen closely applied layers (*m. c.*), following which are two sharply defined layers, and then a considerable number of thick layers (*s. d.*), each consisting of two or three faintly defined layers (*f. d.*).

In fig. *10* the central body has broken up into a cluster of smaller bodies, and it is supposed that it is in such a way that the bodies (*s. b.*) scattered through the substance of the capsule originate. Most of the bodies of the cluster appear to become included in the new laminations, while one or more remain as central bodies producing fresh laminations.

In fig. *11* the central bodies, of which there were clearly six, have each broken up into clusters of small bodies.

When the life of the gonophore is drawing to a close, and the generative products are nearly ripe, a change takes place in the central bodies. These divide rapidly and form an irregular collection in the central region of the laminated system; at the same time the innermost layers of lamination become indistinct, and then disappear. The bodies, derived from the splitting up of the central bodies, increase considerably in size; they are rounded in shape, and some of them become conspicuously large (Pl. XXXIV, figs. 11 and 12, *d. b.*; and text-fig. 5 (*12*), *sp. f.*).

Ultimately the whole of the laminated layers of the capsule, except the outer dense layer, and the double sharply defined layer immediately on the inside, disintegrate, and more or less completely disappear (text-fig. 5 (*13*), *d. i. c.*). Most of the bodies derived from the splitting up of the central body or bodies also disappear; but a few persist, ten to twelve for a good-sized capsule, having grown into oval bodies of very fairly constant size and shape. The average size is 3·4 μ in length and 2·5 μ in breadth. These bodies may probably be regarded as "spores;" they are characterised by readily becoming intensely stained with hæmatoxylin, while the ordinary central bodies of the capsules do not stain very readily. The "spore" is surrounded by a membrane which appears to be firm, since a constant shape is maintained.

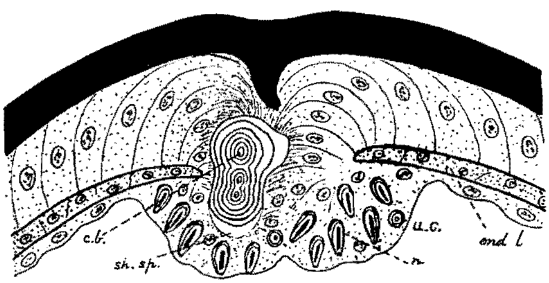
In Pl. XXXIV, fig. 12, the process of "spore-formation" is in progress, and the inner layers are shrinking (see also text-fig. 5 (*13*)). Ultimately the capsules become hollow, and include nothing but a few oval "spores" and perhaps the shrunken residue of some of the inner layers (Pl. XXXIV, figs. 13 and 14).

Under the highest magnification I could detect no obvious structure in the "spore" except an outer membrane and a very finely granular interior.

It may be noticed that in Pl. XXXIV, fig. 11, a number of different systems are enclosed in the compact outer envelope. In two of these spore-formation is beginning (*d. b.*), while in the other two centres vegetative growth is still continuing.

In the case of the male gonophores, I have never found such large capsules as occur in the female gonophores. Their final growth appears to be much reduced, and they do not as a rule exceed 10 to 12 μ in diameter. In some of these smaller forms the concentric lamination, especially towards the centre, is replaced by a radial striation (Pl. XXXIV, fig. 8 (*8, 9, 10*), and text-fig. 5 (*6*)). In figs. *9* and *10* of the plate the central body has split up (*d. b.*) preparatory to the formation of spore-like bodies. In correlation with the small size of the capsules in the male gonophore it may be noticed that there is but little space for development, as the umbrella-

TEXT-FIG. 6.



u.c. Umbrella-cavity. *c.b.* Central body, supposed Schizophyte. *end.l.* Endodermal lamella. *n.* Nematocysts. *sh.sp.* Shrinkage space between capsule and hydroid. × 750.

cavity is very restricted. It is interesting to note this adaptation to the environment.

In one female gonophore a capsule was found embedded in the ectoderm at the future opening of the umbrella-cavity. It differed from the capsules growing free in the umbrella-cavity in the almost complete absence of the outer compact layer, and in the layers of the capsule being apparently more separable from one another.

The real nature of the central bodies and capsules is problematical. The central bodies are, as we have seen, highly refringent, and stain in section only with difficulty. The structures in a young condition can be embedded and cut with a microtome fairly well, but in an older condition, when the capsule is fully formed, it has not been found possible to cut satisfactory sections. The circumstance is, however, of less importance as the capsules are exceedingly transparent. It is probable that the difficulty in cutting is due to the impermeability of the capsule to the paraffin-wax.

The capsule itself is refringent, but it stains readily with Delafield's hæmatoxylin.

I have treated some fragmentary sections with a series of reagents in order to endeavour to test the nature of the capsule. I have had no opportunity of testing fresh material[1] in a similar manner.

Cellulose tests.—It is coloured faintly yellow by liquor iodi; it is slightly disorganised by concentrated sulphuric acid; it is not coloured blue with iodine and sulphuric acid; it is not appreciably swollen or dissolved by an ammoniacal solution of cupric hydrate.

The capsule accordingly does not give a characteristic cellulose reaction.

Proteid tests.—Concentrated nitric acid causes a faint yellow tinge both in the capsule (especially in the outermost layer) and in the perisarc and mesoglea of the hydroid. On the addition of 50 per cent. caustic potash or ammonia the yellow tinge becomes somewhat intensified. There would thus appear from this test, the xanthoproteic reaction, that there is some proteid matter both in the capsule and in the perisarc.

Neither 50 per cent. caustic potash nor concentrated ammonia have any appreciable swelling action on the capsule.

Concentrated hydrochloric acid and aqua regia do not obviously affect the capsule.

Picric acid has no marked staining effect.

Delafield's hæmatoxylin stains the capsule and the mesoglea intensely, while the perisarc is somewhat less strongly acted upon.

Methyl blue stains the capsule deep blue.

Methylene blue is an excellent stain for the capsule and

[1] The hydroid had been fixed with a half-saturated solution of corrosive sublimate in 30 per cent. spirit with 1½ per cent. acetic acid.

also for the central bodies. By means of this stain the outer envelope of the capsule, which generally appears homogeneous, is shown to be finely laminated.

Methyl eosin does not stain the capsule or the perisarc of the hydroid to any extent.

Congo red tends to stain the inner envelopes of the capsule more than the outer sheath. All the tissues of the hydroid, including the perisarc, are stained. On faintly acidulating the preparation the perisarc becomes blue, while the capsules, the mesoglea, and the rest of the tissues of the hydroid remain red.

Mr. Arnold Cooper has kindly tested for me the effect of the capsules on polarised light. He finds that they sometimes possess slight depolarising power. The innermost layer of the capsule immediately surrounding the central bodies appears generally to possess this power to the greatest extent. The central bodies themselves remain dark. In some capsules areas of light of different sizes appear in various parts of the laminations. Perhaps this is due to stresses and strains set up in the substance of the capsule during its growth. The perisarc, especially the innermost layer, and also the mesoglea may at times possess a certain amount of depolarising power.

In all the tests that have been applied, the capsules, the mesoglea, and the perisarc react very similarly, and it is possible that they may all consist of somewhat analogous substances; but the capsules are certainly harder and more brittle than either the mesoglea or the perisarc.

It would appear probable that the organism gains entrance into the gonophore when the latter is in the form of a bud, for at this stage the young gonophore is practically naked, as the covering membrane is excessively thin.

The central body is possibly a Schizophyte, and the laminated capsules recall Leuconostc; but in the present case the capsules are hard and not gelatinous.

The formation of a limited number of somewhat large spore-like bodies, with the disappearance of the middle portion of the capsule and the greater number of the cocci, are also somewhat analogous to the phenomena which occur in Leuconostc.

The central bodies are too small, and apparently structureless to be regarded as unicellular algæ of the nature of Gleocapsa, and besides the character of the capsule is not the same.

Certain bacteria form capsules, and perhaps in the present case in extracting their nourishment from the fluids of the hydroid the central bodies form the capsules as a by-product, which is not very dissimilar in nature from the mesoglea.

On the other hand, it should be noticed that in the formation of the so-called spores the whole of the inside of the capsule is dissolved, and only the outer compact envelopes remain. It would, therefore, be more reasonable to regard the inner substance of the capsule as reserve food-material which is utilised in the reproductive stage when the spores are formed. It is scarcely conceivable that the relatively huge capsule should be formed merely in connection with the vegetative growth of the minute central bodies. This hypothesis is rendered somewhat more probable in that the reproductive processes take place when the gonophores are dehiscing and losing their vital activity.

EXPLANATION OF PLATES XXXIII AND XXXIV,

Illustrating Dr. Ernest Warren's paper "On Parawrightia robusta gen. et sp. nov., a Hydroid from the Natal Coast; and also an Account of a supposed Schizophyte occurring in the Gonophores."

FIG. 1.—Natural size. Colony growing over sponge and sea-weed.

FIG. 2.—× 15 diameters. A small piece of a female colony attached to sea-weed. The hydranths are shown in different conditions of expansion and contraction (*ex. p.*; *p. el.*; *c. p.*). The attachment of the stolon to its support is assisted by clinging branches (*cl. r.*). The planulæ have escaped from the empty gonophore (*em. g.*).

FIG. 3.—× 60. Longitudinal section through hydranth and female

gonophore. The umbrella cavity (*u. c.*) of the gonophore has an opening (*o. u.*). Two planulæ nearly ready to escape are shown (*Pl.*). *ect.* Ectodermal epithelium lining spadix and ectotheca.

FIG. 4.—× 60. Transverse section of a young female gonophore. Alternating with the endodermal canals are seen four spaces (*sp.*), which are ectodermal canals opening into umbrella-cavity.

FIG. 5.—× 60. Longitudinal section through a male gonophore. The umbrella-cavity (*u. c.*) is closed, although the position of an opening is indicated at *n.* *e. ep.* is the ectodermal epithelium lining spadix and ectotheca.

FIG. 6.—× 750 diameters. Small piece of transverse section of male gonophore with capsuled Schizophyte in ectodermal canal and in channels (*ch.*) in the generative epithelium.

FIG. 7.—× 1300 diameters. (*1*) Youngest stage; (*2*) and (*3*) show the beginning of the formation of a capsule; (*4*) shows the fission of central body and of capsule.

FIG. 8.—× 1300 diameters. Older stages. (*2*) (*4*) and (*5*) are examples of budding; (*6*) central body (*d. b.*) dividing; (*7*) several central bodies are present, and dense outer capsular layer; in (*8*) (*9*) (*10*) the laminated structure is replaced by a radiating structure, except for the outer layer (*o. en.*). Specimens were taken from a male gonophore. In (*9*) and (*10*) the central body has divided considerably (*d. b.*).

FIG. 9.—× 1000 diameters. Specimen taken from a female gonophore, showing central bodies (*c. b.*); capsule with outer compact envelope, and bodies (*s. b.*) embedded in the substance of the capsule.

FIG. 10.—× 1000. Specimen from female gonophore with central bodies (*c. b.*), and dividing bodies (*d. b.*). Two outer envelopes or sheaths to the capsule are seen. The innermost layer (*i. l.*) is less pellucid than the other layers of the capsule.

FIG. 11.—× 1000 diameters. Lobed specimen with several centres of lamination. At *d. b.* the central bodies are splitting up preparatory to the formation of spores.

FIG. 12.—× 1000. Older stage with dividing bodies (*d. b.*) and the contracting inner capsule (*I. sh.*) with cavity (*e. cy.*). The two outer envelopes, en_1. and en_2. are shown.

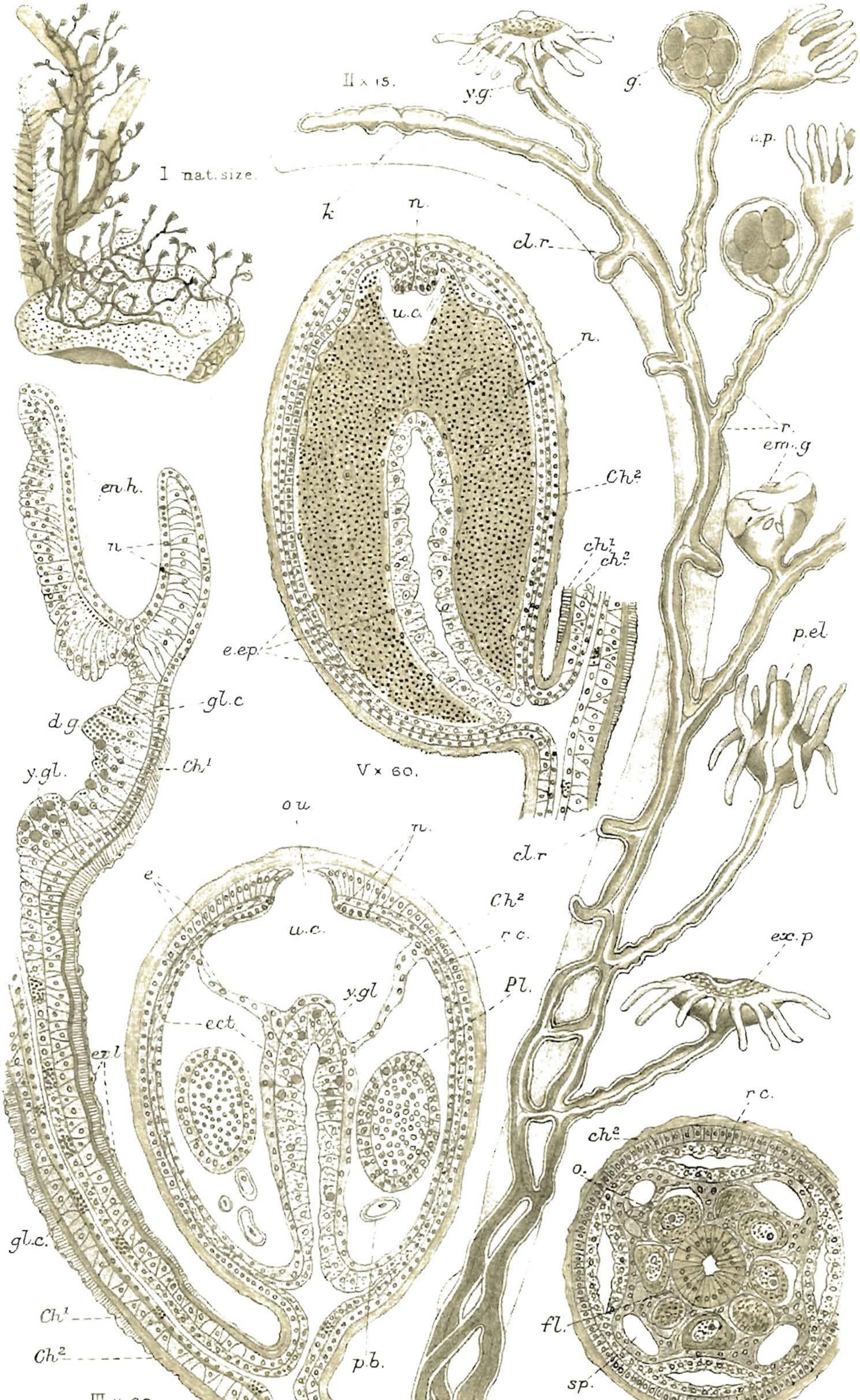
FIG. 13.—× 600 Capsule showing spores (*spo.*) and cavity (*e. cy.*).

FIG. 14.—× 1500. Specimen with disintegrating inner capsule (*In. sh.*) and spores (*spo.*).

FIG. 15.—× 2000 Spores.

EXPLANATORY REFERENCES.

b. Youngest stage of Schizophyte. *c. b.* Central body. *c. p.* Contracted polyp. ch_1. Outer vertically striated layer of perisarc. ch_2. Inner laminated layer of perisarc. *ch.* Channel in spermatic tissue. *cl. r.* Clasping branch of stolon. *d. b.* Dividing body. *d. g.* Digestive cavity. *e.* Ectoderm of umbrella. *ect.* Ectoderm lining spadix and ectotheca. *e. cy.* Empty cavity of capsule. *e. c.* Ectodermal nuclei in generative epithelium. *e. l.* Endodermal lamella. *e. ep.* Ectodermal epithelium of umbrella cavity. en_1. Outer envelope of capsule. en_2. Outermost envelope of inner capsule. *en. h.* Endoderm of hypostome. *em g.* Empty gonophore. *ex. l.* Outer layer of perisarc with adhering débris. *ex. p.* Expanded polyp. *fl.* Follicle cells. *g.* Female gonophore. *gl. c.* Glandular cell of endoderm. *i. l.* Innermost layer of capsule, less pellucid than the other layers. *I. sh.* and *In. sh.* Inner sheath or capsule. *k.* Knarled stolon. *l. s.* Laminated structure. *n.* Nematocyst. *n. o. e.* Nuclei of ectodermal epithelium of ectotheca lining umbrella cavity. *o.* Ovum. *o. l.* Outer coating of mud and sand. *o. en.* Outer envelope of capsule. *o. u.* Opening of umbrella cavity. *Pl.* Planula. *p. b.* Capsules of supposed Schizophyte. *p. el.* Polyp elongated, with tentacles alternately elevated and depressed. *r.* Ringed portion of stem. *r. c.* Radial endodermal canal. *s. b.* Stranded bodies in the substance of the capsule. *s. l.* Laminated perisarc layer. *s. p.* Ectodermal canals continuous with umbrella cavity. *spo.* Spore. *u. c.* Umbrella-cavity. *u. s.* Umbrella space. *y. g.* Young gonophore appearing as a bud on the stem. *y. s.* Young stages of Schizophyte. *y. gl.* Yolk-globules.



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