7. If, still imagining that the cone-vertices S and T are united in a point of the surface of $[H]$, we suppose the cone $[S]$ to be such that it touches the tangential plane in S to $[H]$, then r^4 gets a cusp in S and R coïncides with S and T, so that through r^4 pass but two quadratic cones; the plane RST remains determined, as the polar plane of H with respect to the cone $[R] = [S] = [T]$, and in this plane lies the tangent in the cusp R. The central projection now becomes a k^4 with three cusps, and the cuspidal tangent in R' is the line h. The double tangent through H remains determined as a trace of the plane of projection with the second tangential plane through O to $[H]$; however, as is easy to prove from the stereometric diagram, the points of contact must necessarily be imaginary.

As k^4 is situated harmonically with respect to h and H, the tangents in the cusps O_1, O_2 must intersect each other on h; however, h is the tangent in the cusp R': *so the three cuspidal tangents pass through one point.*

The point H forms with the cusps O_1, O_2, and the point of intersection of the line O_1O_2 with h a harmonic group; but now the same must hold for the two other sides of the $\Delta O_1O_2R'$ of the cusps; *the double tangent d is therefore the so-called harmonical line of the points of intersection of the three cuspidal tangents with respect to the triangle of the three cusps; and the points of contact of the double tangent are the nodes of the elliptic involution on d, of which the points of intersection of d with the sides of that triangle and with the cuspidal tangents in the opposite vertices are three pairs. With respect to each cuspidal tangent and the point of intersection of the opposite side of the triangle with it the curve lies harmonically with itself.*

Zoology. — "*On Ptilocodium repens a new Gymnoblastic Hydroid epizoic on a Pennatulid.*" By Miss WINIFRED E. COWARD B.Sc. Victoria University of Manchester. (Communicated by Prof. MAX WEBER).

(Communicated in the meeting of January 30, 1909.)

Order. Gymnoblastea — Anthomedusae.
Family. Ptilocodiidae. fam. nov.
Ptilocodium repens: gen. nov., sp. nov.
"Siboga" Expedition Stat. 289. 9° 0,3 S. 126° 24,5 E. 112 metres.

Among the Pennatulids sent to Professor HICKSON from the Siboga

Expedition were two specimens of Ptilosarcus sinuosus (Gray)., and growing over the tips of the leaves of them a small epizoic hydroid was discovered. To a description of this new hydroid, the present paper is devoted.

The occurrence of an epizoite on a Pennatulid is in itself an interesting fact as the Pennatulids have usually been regarded as being peculiarly free from any such growths. Only two specimens of Ptilosarcus were received from the Expedition and the hydroid occurs on both of them. The other Pennatulids of the collection have been carefully looked over, but on none of them has an extraneous growth of any kind been found.

Ptilosarcus belongs to the Pennatuleae, the section of Pennatulids which are distinctly bilaterally symmetrical and have the autozooids in rows, with their body walls fused to form leaves.

Along the free edges of the leaves of the given specimens of Ptilosarcus, the hydroid Ptilocodium grows (fig. 1). It is quite visible to the naked eye, though in a cursory glance over the leaves of the Pennatulid, it probably would not be noticed. The hydroid affects the free edges of all the leaves of the Pennatulid, even those at the free extremity. It is suggestive that it does not spread over the rachis of the Pennatulid nor even over the main surfaces of the leaves, but grows only over the oral ends of the autozooids.

The hydroid is devoid of any kind of skeleton and spreads over the distal parts of the autozooids composing the leaves of the Ptilosarcus (figs. 2, 3). The colony grows by means of spreading stolons. These stolons run singly over the spicular projections of the autozooids and along their tentacles; (figs. 2, 3, 4) but over the part immediately below this, they branch and closely anastomose forming a more or less continuous sheet of basal coenosarc.

The hydroid exhibits the phenomenon of dimorphism, the gasterozooids and dactylozooids being quite distinct. The zooids are sessile, arising directly from the stolon or basal coenosarc as the case may be.

The dactylozooids arise at very short intervals along the stolon and are far more numerous than the gasterozooids. Gonozooids occur at frequent intervals. They are much fewer in number than the

Note by Professor Hickson. The hydroid described in this paper was found on the only two specimens of Ptilosarcus in the Siboga collection. As they appeared to be of very great interest, and I could not part with the Pennatulids which are themselves under investigation, I considered it to be advisable, in the interests of science, that a description of them should be prepared in my laboratory without undue delay. I wish to express my hearty thanks to M. Billard, to whom the description of the Hydroidea of the Expedition has been entrusted for kindly giving his sanction to the publication of this paper independently of his memoir.

gasterozooids but in every case the gonozooid arises, not from the stolon but from the base of a gasterozooid (fig. 7) in close proximity to the stolon or basal coenosarc.

Stolon.

The stolons are tubular in structure (fig. 3). Their walls consist of superficial ectoderm and a lining of endoderm separated by a structureless lamella, the mesogloea. The ectoderm exhibits no traces of a perisarc. It possesses a few scattered nematocysts of the smaller kind .008 mm. × .005 mm. (vide infra).

Basal Coenosarc.

The basal coenosarc is formed by the anastomosing of stolons running over the parts of the autozooids immediately behind the tentacles. When two stolons run together or cross, the ectoderm of the dividing walls disappears so that the upper ectoderm of one stolon becomes continuous with the upper ectoderm of the other and the lower ectoderm of the one becomes continuous with the lower ectoderm of the other. Thus the basal coenosarc of the hydroid consists of superficial ectoderm and lower ectoderm separated by endodermal tubes (fig. 5). The structure arrived at is thus the same as in the coenosarc of Hydractinia except that Ptilocodium has no chitinous skeleton.

Nematocysts.

The hydroid possesses two sets of nematocysts. The larger kind is found in the dactylozooids. Here the nematocysts are oval in shape and measure .017 mm. × .008 mm. The smaller kind occurs in the ectoderm of the basal coenosarc and of the gonozooid, the size of these nematocysts being .008 mm. × .005 mm.

Gasterozooids.

Gasterozooids occur at frequent intervals on the basal coenosarc and are sessile (fig. 7). They vary in size from .213 mm. high and .106 mm. broad, to .373 mm. high and .026 mm. broad. They are much reduced in structure. There are no traces of tentacles. The zooid is simple and sac-like; the mouth is a simple pore leading from the exterior into the cavity of the zooid. The gasterozooids show no nematocysts. The endoderm cells near the mouth of the gasterozooids are comparatively short whilst those lining the remainder of the gastral cavity are long and narrow. The material is not sufficiently well preserved to make out clearly the histological structure of the cells but it seems probable that the digestive functions are preformed by the long, narrow cells of the basal half of the gasterozooids.

Dactylozooids.

The dactylozooids are very numerous compared with the gasterozooids. They occur at irregular intervals; there seems to be no definite relation, as regards arrangement on the basal coenosarc, between the dactylozooids and gasterozooids such as we find in Millepora or Stylaster.

The dactylozooids are short and broad and each bears four capitate tentacles crowded with large nematocysts (fig. 6). The zooids do not vary much in size, the average size being .186 mm. × .106 mm. The smallest zooids measure .106 mm. × .053 mm. The capitate tentacles are .038 mm. in length and .033 mm. broad. The nematocysts of the tentacles are of the larger of the two kinds possessed by the hydroid and measure .017 mm. × .008 mm. The ectoderm of the remainder of the zooids shews no nematocysts. The endoderm of the dactylozooids and tentacles is solid and scalariform, there being no trace of a cavity or oral opening. (fig. 6). Judging from the preserved specimens the dactylozooids seem little, if at all, contractile.

Gonozooids.

The gonophores which are adelocodonic, arise in each case, as before described, from the base of a gasterozooid. Thus the base of a gasterozooid functions as a blastostyle (fig. 7).

The gonozooids vary little in size, the average being .373 mm. × .186 mm. They are considerably reduced in structure, having the form of closed sporosacs. All the gonophores on the two specimens received are female. The ova are borne between the ectoderm and endoderm of the manubrium and have a diameter of .017 mm. They are practically all of the same size but it cannot be said whether or not they are ripe.

The superficial ectoderm of the gonozooid and the ectoderm lining the cavity corresponding to the sub-umbrella cavity of a medusa, are separated by an endoderm lamella, which shows traces of radial canals (figs. 7 and 8). There is no velum and there are no sense organs and only traces of four rudimentary tentacles. Nematocysts of the smaller kind occur in the superficial ectoderm of the gonozooids.

The Relation between the Hydroid and Ptilosarcus.

The specimens of Ptilosarcus sinuosus on which the hydroid is growing seem practically unaffected by it. The autozooids are well developed, showing no signs of degeneration.

The hydroid spreads only over the oral ends of the autozooids, that is, it keeps near the tentacles of the same, and does not run far over the leaves of the Pennatulid. Correlated with this is the

fact that the gasterozooids of the hydroid are devoid of organs for catching food. These facts at once suggest that the Ptilosarcus benefits the hydroid by helping it to secure food.

On the other hand, on looking at a preparation of the hydroid, one is struck by the great number of dactylozooids which are so well provided with large nematocysts. Such a protection as these are capable of affording is probably more than is required by the small hydroid. The large projecting spicules of the autozooids of the Pennatulid also, would protect the hydroid. Therefore I would suggest that the Ptilocodium is of use to the Pennatulid in the warding off of enemies and in stinging prey by means of its batteries of large nematocysts and that the Ptilosarcus by means of its projecting spicules, protects the Hydroid. Thus the Ptilosarcus and Ptilocodium are mutually benefited.

Systematic position.

Ptilocodium seems to have some affinities with Hydractinia, Podocoryne and Millepora, as shewn by the sheet-like, encrusting basal coenosarc from which the zooids arise independently; but even in this character Ptilocodium stands alone in having no chitinous or calcareous skeleton to protect it.

In other respects Ptilocodium is unique. The dimorphism of Ptilocodium is quite distinct from that of Hydractinia and Millepora, and probably originated independently. In the first place, the gasterozooids of Ptilocodium are extremely unlike those of Hydractinia and Millepora. They are short, sessile, sac-like structures, without tentacles. Those of Hydractinia are long, filiform structures, provided with a crown of tentacles. The gasterozooids of Millepora are also much longer than broad, not at all sac-like in form, and are provided with knob-like tentacles.

The dactylozooids, also, are very different in structure, in the three genera. Those of Ptilocodium are short and broad, and are furnished with four characteristic capitate tentacles. The endoderm of the body of the zooid and of the tentacles is solid and scalariform, giving the dactylozooids a marked appearance. The dactylozooids of Hydractinia are long and slender and very muscular so that they are capable of coiling and uncoiling themselves. They have also a central cavity and according to Miss Colcutt [1]) are provided with a terminal mouth. The dactylozooids of Millepora are very similar to those of Hydractinia. In possessing a solid scalariform endoderm, Ptilocodium resembles the Stylasterina. All the genera,except one, of this group, have the endoderm of the dactylozooids solid.

[1]) Quart. Journ. Micro. Sci. No. 157, 1897.

In all other points except the dimorphism, however, Ptilocodium differs from the Stylasterina, and on the importance of dimorphism as indicating close relationship too much stress should not be laid. The old group Hydrocorallinae affords an illustration of the result of laying too much stress on this factor In this group, the Milleporina and the Stylasterina were formerly united, but it has since been pointed out that differences of more importance necessitate their being classed as separate orders.

The next point to consider in discussing the relationship between Ptilocodium, Hydractinia and Millepora, is that of the gonophores. Ptilocodium resembles Hydractinia in having adelocodonic gonophores but differs from it in having the gonophores arising from the base of the ordinary gasterozooid and not from a specialised individual or blastostyle. In Millepora there is no blastostyle and the medusae arise independently of the gasterozooids, from the surface of the colony.

In Perigonimus, which, in the important respect of the structure of the basal coenosarc does not closely resemble Ptilocodium or Hydractinia, the gonophores arise from the hydrocaulus bearing the gasterozooid or from the hydrorhiza. This case may therefore be taken as an indication that too much stress must not be placed on the position of origin of the gonophore in the colony.

Ptilocodium stands quite apart from other genera of Hydroids with epizoic habits.

The epizoic Hydroid Stylactis minoi described by ALCOCK [1]) was found on the fish Minous inermis, but differs considerably from Ptilocodium. It has hydranths crowned with numerous tentacles rising from the hydrorhiza. It is not provided with dactylozooids of any kind and its gonophores are in the form of sporosacs arising from specialised individuals which bear tentacles.

Ptilocodium also differs considerably from Hydrichthys mirus, a Hydroid described by FEWKES [2]) as epizoic on the fish Seriola zonata. This hydroid exhibits structures of two kinds arising from the basal plate. In the first place there are long, filiform hydranths, which are looked upon as degenerate gasterozooids and secondly clusters of botryoidal gonosomes. Dactylozooids do not occur.

Ptilocodium has obviously no affinities with the hydroid Nudiclava described by LLOYD [3]), nor with Moerisia lyonsi, a Hydromedusan from Lake Qurun, described by C. L BOULENGER [4]).

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[1]) ALCOCK A. Ann. & Mag. Nat. Hist. 1892 vol. X p. 207.

[2]) FEWKES. Bull. Mus. Comp. Zoöl. vol. XIII p. 224.

[3]) LLOYD R. E. Records of Indian Museum. Vol. I. Part IV.

[4]) BOULENGER C. L. Quart. Journ. Micros. Sci. Vol. lii Jan. 1908.

In consequence of these considerations the only course to adopt is to regard Ptilocodium as the representative of a new family.

The above piece of work was undertaken at the suggestion of Professor HICKSON, to whom I wish to express my sincere thanks for his most generous advice and assistance.

EXPLANATION OF PLATE.

aut — autozooid of Ptilosarcus.
bas coen. — basal coenosarc of hydroid.
dact. — dactylozooid of hydroid.
ect. — ectoderm.
ect. man — ectoderm of manubrium.
end. — endoderm.
end. can. — endoderm canal.
end. lam. — endoderm lamella.
end. man — endoderm of manubrium.
gast. — gasterozooid of hydroid.
gon. — gonozooid of hydroid.
mes. — mesentery of autozooid of Ptilosarcus.
nem. — nematocyst.
ov. — ovum of Ptilosarcus.
rad. can. — radial canal.
spic. — spicule.
stol. — growing tip of stolon.
sub. ect. — ectoderm lining the cavity corresponding to the sub-umbrella cavity of a medusa.
sup. ect. — superficial ectoderm of gonophore.
tent. — tentacle.
t. p. — tentacles of Pennatulid.

Fig. 1. External view of parts of two successive leaves of the Pennatulid, shewing the extent of the surface of the leaves, affected by the hydroid.

Fig. 2. Drawing of a microscope preparation of part of the free edge of a leaf of Ptilosarcus, shewing the hydroid running out over the spicular projections of the autozooids $\times$ 20.

Fig. 3. Drawing of a preparation similar to 2. $\times$ 68.

Fig 4. Longitudinal section of a Pennatulid leaf shewing the hydroid growing over the free edges of the leaf.

Fig. 5. Vertical section of basal coenosarc of the hydroid shewing superficial and lower ectoderms, and endoderm canals.

Fig. 6. Optical section of dactylozooid of hydroid shewing solid endoderm, and the characteristic four tentacles.

Fig. 7. Longitudinal section of gonozooid arising from base of gasterozooid.

Fig. 8. Transverse section of gonozooid.

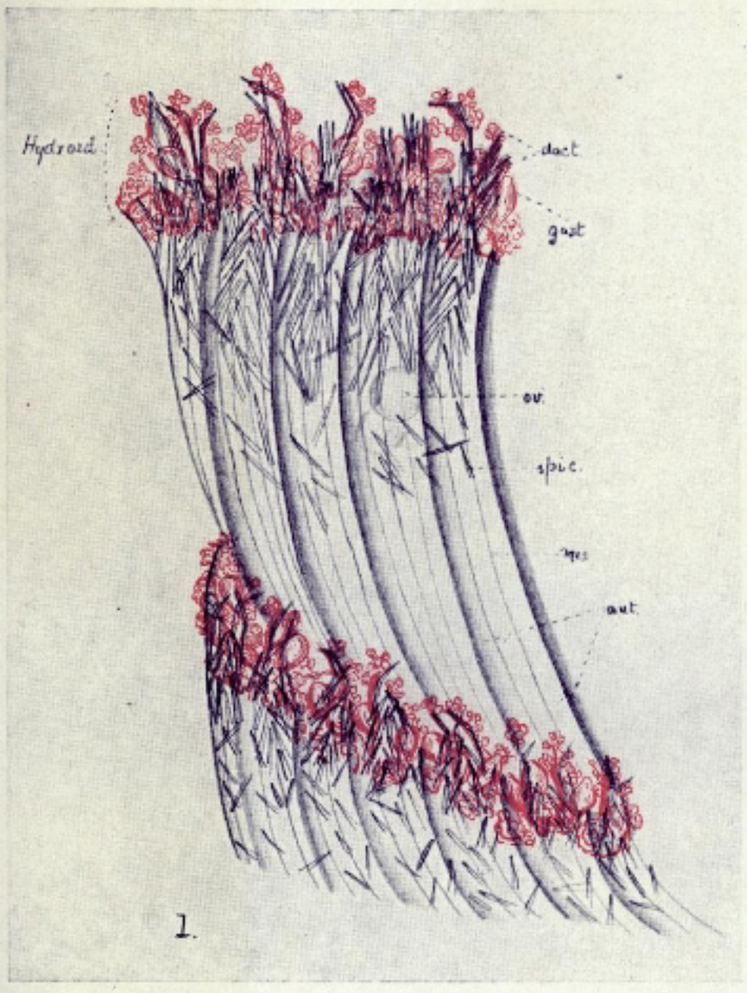

Fig. 1.

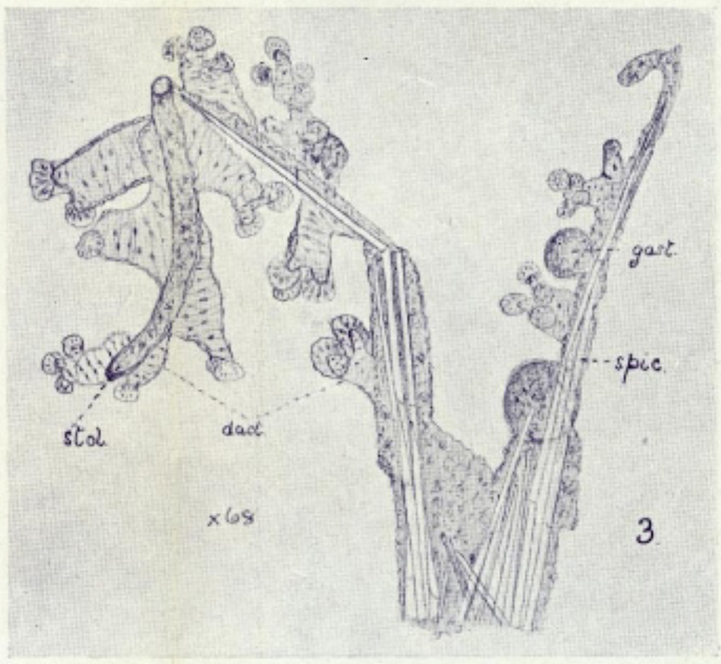

Fig. 3.

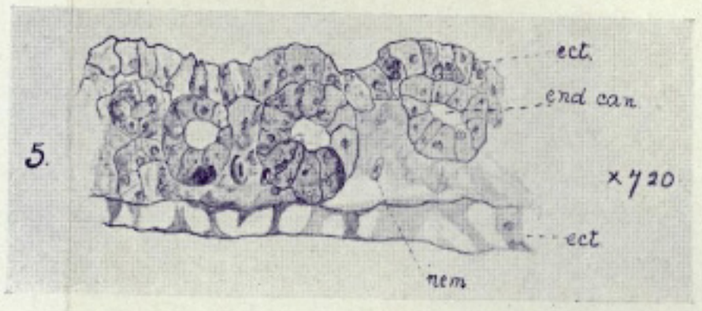

Fig. 5.

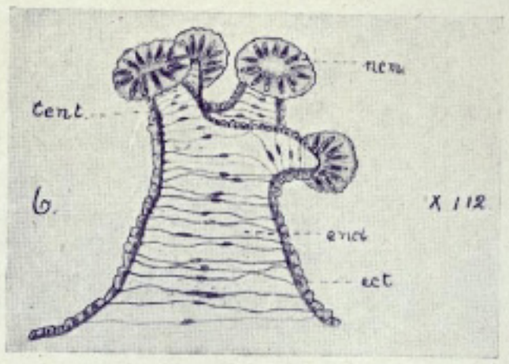

Fig. 6.

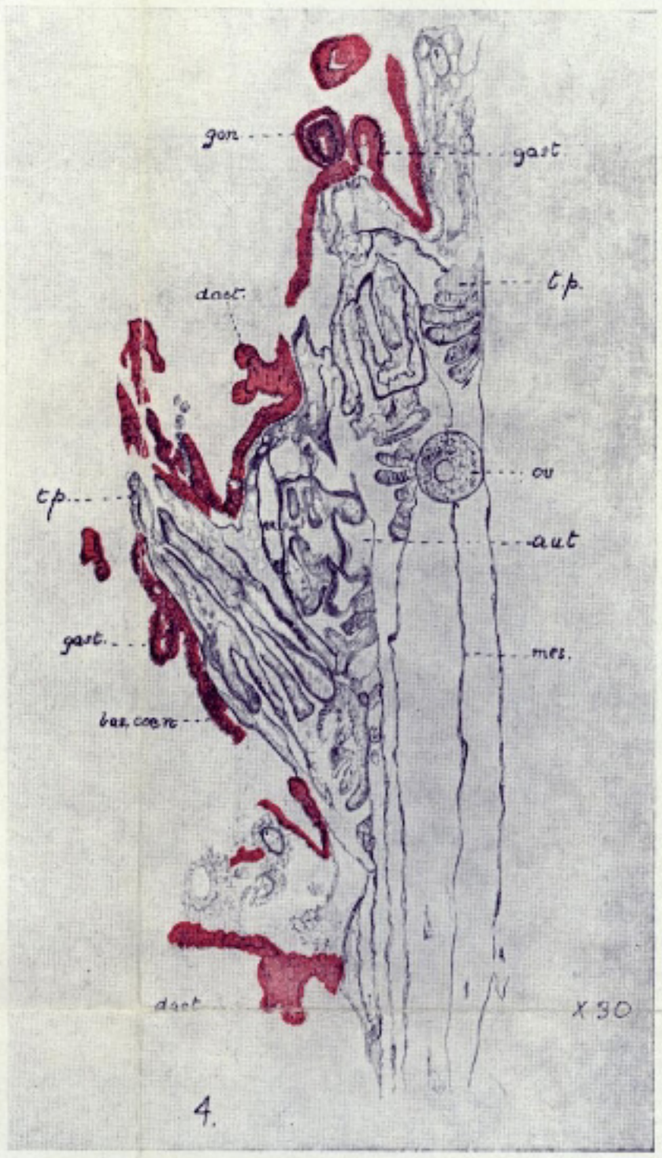

Fig. 4.

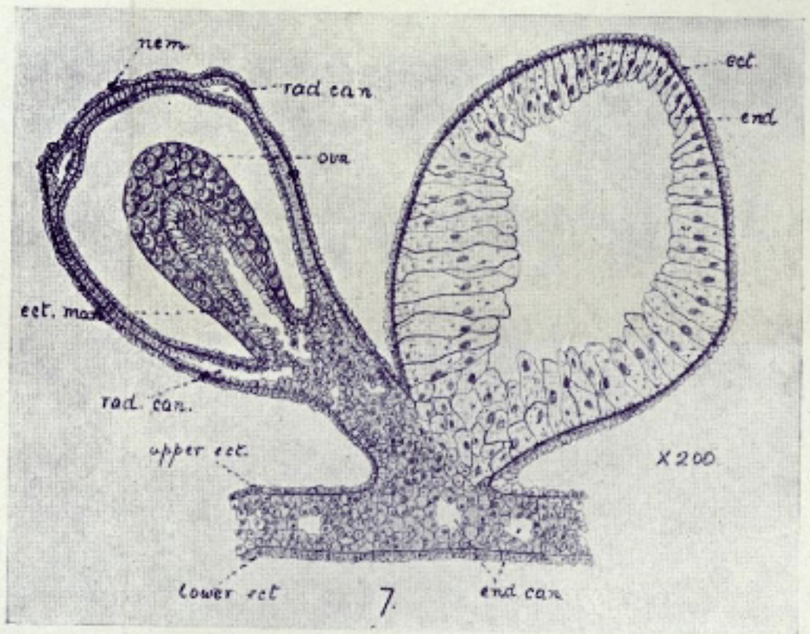

Fig. 7.

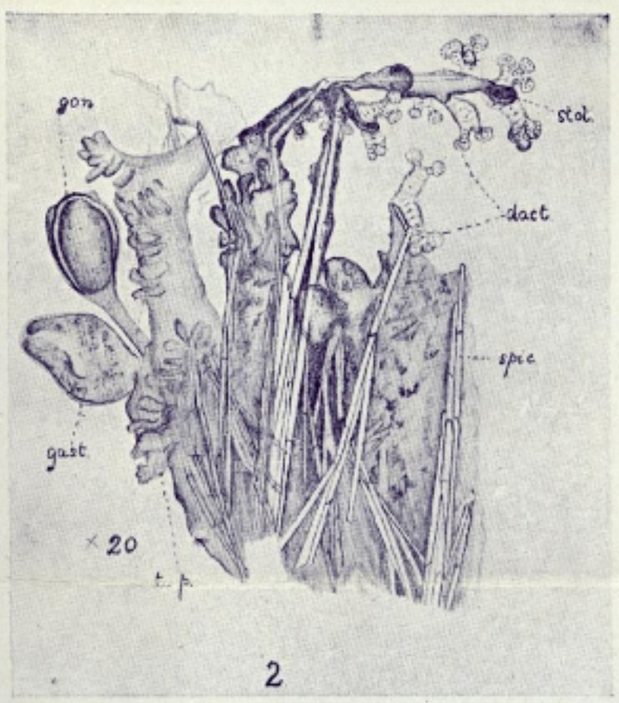

Fig. 2.

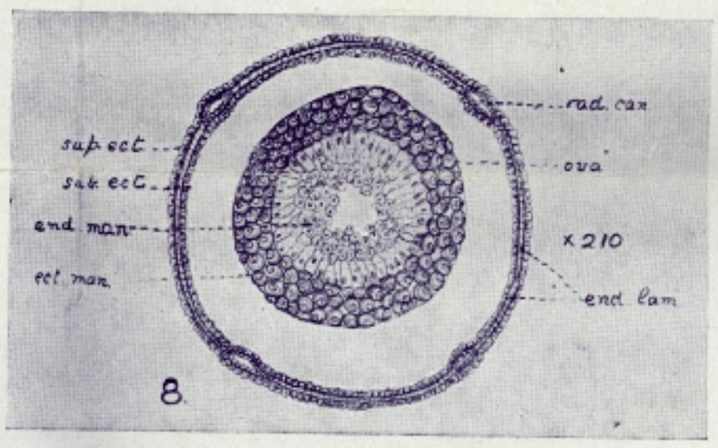

Fig. 8.

W. E. Coward del.