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Notes on Bryozoa from Rapallo and other Mediterranean Localities.—Chiefly Cellulariidæ. By ARTHUR WILLIAM WATERS, F.L.S.

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(PLATES 1 & 2.)

ALTHOUGH now at work upon material collected in Rapallo, near Genoa, it has seemed better to give this paper a wider range, so as to be able to include any observations resulting from comparison with my Mediterranean and other collections. In fact, it may be said to include a revision of my paper * on the Naples Bryozoa.

General questions of structure and classification have received considerable attention, but are only dealt with where there seemed sufficient reason for doing so.

When I wrote upon the Naples Bryozoa, a very large number of the descriptions, even by the leading authorities, were most unsatisfactory; nor did I possess my present large collection, including preparations made in various ways †, so that only limited comparisons could be made. Since then the student has had for reference, besides a large amount of general literature, Hincks's well-illustrated work on the British Marine Polyzoa, and

* Ann. & Mag. Nat. Hist. ser. 5, vol. iii., 1879.

† In all cases where I have had suitable material, stained sections have been cut, either for minute structure or, when the state of preservation has not been suitable for anything more, for the interzoœcial connexions; nor can any series be considered complete until there are stained specimens mounted whole, as well as preparations of the opercula and mandible, besides calcareous sections.

also two papers by the same author on the "Polyzoa of the Adriatic" *.

In the paper above-mentioned I showed the value of the operculum, and afterwards of the avicularian mandible, for classificatory purposes. These are now being examined by all workers; and in various papers, and especially in one recently read before the Microscopical Society, I have also shown that the rosette-plates are another important character; and now in this paper stress is laid upon noting the position of the radical fibre.

Therefore, with much extended means of study, it is not surprising that, upon re-examining my Naples material and collection, points should turn up which were overlooked or not recorded.

The greater part of the present communication relates to the Cellulariidæ. Most members of this family throw out corneous tubular radicals; and the position from which these grow is, as a rule, fairly constant in each species, so that it may be used as a specific character, or even in some may have generic importance. This, however, has been neglected, and has seldom been fully and correctly described. Also in other families more use may be made of the *position* of the origin of these tubes, by which the colony becomes firmly attached.

In the description of the species, it is now shown that in the Cellulariidæ there are two distinct kinds of articulation. In the larger number the new branch is given off from a small chamber formed for the purpose. As the type of this section, *Menipea Buskii* is figured (Pl. 1. fig. 10); and I propose to restrict *Menipea* to those forms having this kind of articulation; and it will then include *M. Buskii*, MacG., *M. crystallina*, Gray, *M. cyathus*, Thompson, *M. cervicornis*, MacG., *M. compacta*, MacG.

On the other hand, probably †*M. cirrata*, Lamx., *M. gracilis*, Busk, *M. patagonica*, Busk, *M. funiculata*, MacG., *M. triseriata*, Busk, *M. flabellum*, L., *M. ternata*, Ell. & Sol., must, on this account, be elsewhere located; and in fact, before noting this distinction, it had been felt that several species should be removed from the genus.

In another section, including *Scrupocellaria*, the jointing consists of nothing more than a partial breaking through or thinning

* Ann. & Mag. Nat. Hist. ser. 5, vol. xvii. p. 254, and vol. xix. p. 302.

† *M. cirrata* and *M. flabellum* are Lamouroux's types; but these, I think, will fall into other established genera.

of the walls of the zoœcia near the commencement of the branch. In the zoœcia in which this breaking through of the wall of the zoœcial chamber has commenced, the polypide is seen unaffected, partly above and partly below this incipient division (see Pl. 1. figs. 11, 12).

Menipea and *Bugula* are evidently very closely related; for a specimen from Florida, sent to me as "*Bugula*?" by Miss Jelly, has zoœcia with an area, just as in *Bugula*, and a sessile avicularium similar in shape and position to that occurring in *B. avicularia*, but the branches are articulated, with three zoœcia to an internode, as in *Menipea*. The jointing here occurs by breaking through or thinning of the walls without any chamber being formed; the younger parts of the branch, however, show no trace of articulation.

The Cellulariidæ are still in a state of confusion, and the genera are based upon very unsatisfactory characters. Smitt, recognizing this, united *Cellularia*, *Scrupocellaria*, and *Menipea* as *Cellularia*; but Busk and Hincks have not followed him in this. The retention of the name *Cellularia* has long seemed most undesirable, as it has been used in most various senses, and has included forms which are now placed under widely separated genera. Pallas, who gave the name *Cellularia*, had under it *Tubucellaria*, *Cellaria*, *Notamia*, *Bugula*, *Scrupocellaria*, *Eucratea*, *Aetea*, and others. With the exception of *Cellularia cuspidata* and *C. Peachii* (both of which should be placed with *Scrupocellaria*), the only other remaining species of *Cellularia* are from the 'Challenger;' but I think if we turn to Mr. Busk's definition of the genus in his Report we must consider it as an admission, on his part, of inability to find characters upon which to base it; for "zoarium bi- or tri-serial with more than four cells in each internode; with or without a sessile avicularium behind the upper and outer angle; with or without a pedunculate fornix," does not contain a single definite statement.

Then Hincks in his description says, "avicularia and vibracula usually wanting;" but of six 'Challenger' species, five have avicularia. However, since Hincks wrote this the presence or absence of avicularia has been shown in many families to be without value in generic classification. MacGillivray writes, "zoœcia biserial . . . avicularia usually absent."

As Busk in his 'Challenger' Report neither figures nor mentions the articulation when describing his species, I do not feel

able to discuss the position of his species without further examination, but think most will fall under *Scrupocellaria*, though *Cellularia cirrata* and *C. quadrata* may have to be placed in another family.

If a name which has been used in such various ways can now be buried for ever, it will be a great gain, and it now seems quite superfluous.

Among other points mentioned in the present communication is the existence of ovicells on the erect tube of *Aetea*, a genus which has always been described as without ovicells.

The stalk of *Chlidonia Cordieri* exhibits a very curious structure; for the central parenchym-cord gives off a branch to a disk about the middle of each internode.

In *Bugula plumosa* there are cases of long tubes starting from the lower part of the colony, having much the same appearance as the radicals, but at the end they produce a polypide, and in this way a new colony may arise.

Although sections have been cut wherever there was suitable material, the gland-like bodies have not been found in any of the groups under consideration; and I may now mention that nearly all the truly calcareous species have these glands, whereas none have been found in the corneous ones.

Before proceeding to the special descriptions, I must express my warm thanks to the owners of the small zoological laboratory in Rapallo (Professors L. Camerano, M. G. Paracca, and D. Rosa of Turin), for kindly placing it at my disposal during my three weeks' stay in Rapallo in March 1893; and specially thank Dr. Paracca for the trouble he took in seeing that arrangements were made. This was rather too early for satisfactory work, as a large number of the specimens brought in were not living, or were in an unsatisfactory condition for showing minute structure. This, however, was not the case with all; and I was enabled to see the gland-like body in a large number of species, and also to study the interzoœcial connexion in many.

The list of species collected some years before from the seaweeds thrown up on the beach was almost doubled, as the dredge brought up specimens which would easily be overlooked among the seaweed. The ground is mostly mud, and the neighbourhood cannot be called favourable for Bryozoa. The best places for dredging are where the mud ceases, about two or three miles out; and probably a better locality for the larger coral-like forms such as *Porella cervicornis*, *Hornera*, would be near Camogli,

where the depth is much greater but, not being as protected, the sea will often be more agitated.

AETEA ANGUINA, forma RECTA, *Hincks*. (Pl. 1. figs. 1–5.)

In Rapallo I saw, in March, a large number of specimens with a small transparent ovicell, at the top of the tubular prolongation which has been called a peristome. In most cases there were four divisions in the ovum, but in a few there were eight. The ovicellular wall is very thin and delicate; and unfortunately the material at command has not enabled me to study the ovicell and ova as fully as I hoped.

The discovery of an ovicell is extremely interesting, as the genus has always been described as without one; in fact, Jullien * created a "tribus" Inovicellata for the Aeteidæ; but classification based upon the absence of a character is always rather risky.

What Mr. Hincks calls the zoœcium in this family, Jullien (*loc. cit.* p. 25) would call the peristome. Now, while Jullien is correct in refusing to call this tubular prolongation a zoœcium, it does not seem that this tube, which has a hinged opening at the termination, should be compared with a peristome, which is a prolongation beyond the opercular opening. Jullien seems to fancy that he was the first to notice that the polypide did not live entirely in this part, but was also in the portion which Mr. Hincks speaks of as the "elongate subfusiform body." On reference to Smitt's figures †, and to my figure and the text of the same paper ‡, he would have seen that it had been appreciated that the polypide is not only lodged in the upright portion, as Busk erroneously believed, but is also in the lower part. I think that both Hincks and Jullien must have overlooked my paper. In one case in which the ovicell contained a large unfissured ovum, the tentacles and stomach were mostly in the tubular prolongation, and the fusiform body was nearly filled up with the ovarium in which there were at least four young ova.

Aetea truncata also occurs near Rapallo §.

* 'Mission du Cap Horn,' p. 23.

† Hafs-Bry. Utv. 1865, pl. ii. figs. 11, 12.

‡ Ann. & Mag. Nat. Hist. ser. 5, vol. iii. p. 114, pl. xv. fig. 7.

§ I have to add to the list given in my paper on the "Bryozoa of Naples,' and a supplementary one given in a note to a paper in the 'Transactions of the Microscopical Society,' ser. 2, vol. v. p. 6, the following Neapolitan species:—*Aetea truncata*, Landsborough; *Bugula spicata*, Hincks; *B. ditrupæ*, Busk; *B. neritina*, L.; *Scrupocellaria Bertholletii*, Aud.; *S. Delilii*, Aud.; *S. in-*

SCRUPOCELLARIA REPTANS, *L.*, var. BERTHOLLETII, *Aud.* (Pl. 1. figs. 18 & 19.)

Acamarchis Bertholletii, *Audouin in Savigny's Égypte*, pl. xi. fig. 3.

Scrupocellaria Bertholletii, *Hincks, Ann. Mag. Nat. Hist.* ser. 5, vol. xvii. p. 258, pl. ix. figs. 1–2.

This only differs from *S. reptans* in having a less-developed scutum, for the zoœcial characters and the shape is the same in both, and in the type and the variety there are three or four external spines; the chambers for the avicularia and the radical fibres are exactly similar, as is also the ovicell and the terminal disks of the radical. At the bifurcation, in both, there is a single vibraculum.

To return to the scutum: this is very variable, and I have specimens where some zoœcia have no scutum; in others it is small bifurcate, then again some are larger bifurcate or cervicorne, while in *S. reptans* occasionally the scutum is only bifurcate, other zoœcia showing gradations to the fully-developed characteristic scutum. When previously working on the Naples Bryozoa I came upon this, and made a note of it as a variety of *S. reptans*, with but slightly-developed scutum, but do not seem to have considered it worth describing. Both forms occur at Naples, Capri, Rapallo, and Trieste, and the variety probably came from Egypt. Jullien * says that he has obtained *Scrupocellaria reptans* with lateral avicularia; but in the specimens of both the type and the variety in my collection, from various places, this seems to be common; and Hincks, in his 'British Marine Polyzoa,' had previously mentioned this character, which had been overlooked by older writers. On account of these lateral avicularia Hincks had removed it from *Canda*, where it had been placed by Busk. *S. reptans* has two lateral rosette-plates, and Levinsen says that *scruposa* and *scabra* have also two. *S. Delilii* and *obtecta* have the same number, while in several species of *Bugula* there are four lateral plates. In the Cellulariidæ this character would seem to be of *generic* rather than of specific value; whereas we have seen that in *Flustra* the *specific*

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curvata, Waters; *Beania hirtissima*, var. *robusta*, Hincks, and var. *cylindrica*, H.; *Schizoporella armata*, Hincks; *S. magnifica*, Hincks; *S. marsupifera*, B.; *S. ambita*, Waters; *Hornera lichenoides*, Pontop.; *Entalophora clavata*, Busk; *Buskia socialis*, Hincks; *Retepora complanata*, Waters; and *Palmicellaria parallelata*, Waters.

* Mission du Cap Horn, p. 69.

differences in the number and form of the rosette-plates are very considerable *.

Of the seven Mediterranean species of *Scrupocellaria*, all except *S. incurvata* and the variety *Bertholletii* occur elsewhere. *S. reptans*, *scruposa*, *scrupea*, and *inermis* are Northern, while *S. reptans* and *scrupea* are also found in the Australian seas.

SCRUPOCELLARIA DELILII, *Aud.* (Pl. 1. figs. 14, 15.)

Crisia Delilii, *Audouin in Savigny's 'Description de l'Égypte,'* p. 242, pl. xii. fig. 3.

Scrupocellaria Delilii, *Busk* (*non Alder*), *Q. J. Micro. Sc.* vol. vii. p. 65, pl. xxii. figs. 1–3.

Specimens from Naples, Rapallo, and the Gulf of Taranto belong most undoubtedly to the species figured by Savigny. The two converging spines are characteristic. Most colonies have no frontal avicularium, and in those that have it is only found on some zoœcia. In one good colony there is only one, and that on a zoœcium just below a bifurcation.

The zoœcium at each bifurcation has a central spine, a character which Mr. Hincks mentions in *S. scabra*, but which seems to be fairly common in the genus, as it occurs in *S. scrupea*, *S. Bertholletii*, and *S. reptans*. On the dorsal surface at the bifurcation there are two vibracula, whereas in *S. scabra* there are none; but the most important distinction between the two species is in the vibracular chamber, which is much narrower and longer than that of *S. scabra*, and the rooting attachment is more directly under the vibraculum.

It will thus be seen that *S. scabra* remains a Northern form not yet found south of the British Isles, while *S. Delilii* is Southern, occurring in the Mediterranean and Madeira. The internodes are much longer than those of the Mediterranean *S. scrupea*.

This is closely related to *S. Macandrei*, but from the figures in the 'Challenger' Report they would seem to be distinct.

SCRUPOCELLARIA SCRUPEA, *Busk*.

There are two vibracula at a bifurcation similar to those which Levinsen has described as occurring in *S. scruposa*. The only other species in which I have found two are *S. ornithorhynchus*, *Delilii*, and *incurvata*. The small avicularia, by the ovicells, are similar to those which Levinsen describes on *S. scruposa*. These

* "Interzoœcial Connection in *Flustra* and other Bryozoa," Journ. Roy. Micro. Soc. p. 279, pls. vii. & viii. (1896).

had previously been overlooked, as they are very minute, and being on the inner side of the ovicell are in most positions of the zoarium concealed; however, when looked for, they can generally be found upon Mediterranean specimens.

The shape of the vibracular chamber and of the chamber for the insertion of the rooting-fibre is the same in *S. scrupea* and *scruposa*, and these species are closely allied. It may be mentioned that, while the presence of the scutum is a distinguishing character, it does not occur in all the zoœcia.

SCRUPOCELLARIA INERMIS, *Norman*. (Pl. 1. figs. 11 & 12.)

Scrupocellaria inermis, *Norman, Quart. Journ. Micr. Sc.* n. s. vol. viii. p. 215 (4) pl. v. figs. 1–3; *Kirchenpauer, Jahresb. Comm. wissensch. Unters. d. deutschen Meere*, Jahrg. ii. & iii., 1875, p. 180.

A fine stained and decalcified specimen, collected in Trieste, is figured, as it shows so well the way in which the articulation is formed, for in the zoœcium at the bifurcation the polypide is seen on both sides of the articulation, proving that this is a break formed in mature zoœcia. Although the object of the figure is to explain this structure, it will be as well to also consider the species systematically. This specimen has no median avicularia, and the lateral one is much smaller than in Norman's figures. There are no spines and no scutum; whereas, as I have shown *, *S. elliptica*, Reuss, has both, and therefore the two specific names must be retained. The vibracular chamber is small, and appears to be narrower than in the specimens described by Norman, but being decalcified a complete comparison cannot be made. This chamber is much shorter and wider than that of *S. scruposa*, and the chamber for the insertion of the radical is distinctly separated, both chambers being about the same width.

The vibraculum is very delicate, but I should scarcely call it short. At a bifurcation there is only one vibraculum; thus it is distinguished from *S. scruposa*, in which there are two. Pergens says † that *S. scruposa* form *elliptica* is found at Palavas (Dépt. de la Hérault) and at Banyuls. Presumably it is this species; but as there has been confusion between *S. elliptica*, Reuss, and *S. inermis*, Norm., we cannot be certain without a re-examination.

* "North Italian Bryozoa," Quart. Journ. Geol. Soc. vol. xlvii. p. 6, pl. i. figs. 16, 17.

† "Notes sur les Bryozoaires," Ann. Soc. Roy. Malac. Belgique, vol. xxiv. p. 7.

SCRUPOCELLARIA INCURVATA, sp. nov. (Pl. 1. figs. 16, 17.)

Specimens from Naples in most respects resemble *S. Delilii*, but the branches of the zoarium are stouter, with a much larger scutum extending beyond the opesium. There is usually a spine at each upper corner converging as in *S. Delilii*, Aud. Also the median avicularia are similar to those of *S. Delilii* and the ovicell is entire; but the two can be distinguished by the vibracular chambers, for in the present species they are somewhat oval, extending half across the zoœcium, with the groove turned inwards, and the pair of vibracular chambers at a bifurcation have similar curved grooves. It will be seen that this curved groove, though not as large, is similar to that of *Caberea*, and, except on account of the difference in the oral aperture, it is difficult to see any reason for separating the two genera.

S. scabra, *Delilii*, and *incurvata* seem to be a natural group, distinguished, however, by striking differences in the vibracular chambers.

In the whole of the Cellulariidæ one of the most useful specific characters is the way in which the radical fibre is attached, for in each species there seems nearly always to be some definite position from which it starts in all zoœcia. In *Scrupocellaria* and *Caberea* it grows from a chamber at the base or side of the vibracular chamber. In *Menipea aculeata*, *M. Buskii*, *M. cirrata*, and *M. funiculata* the radical arises from the base of the internode; whereas in *M. cervicornis*, *M. compacta*, and *M. ternata* var. *gracilis*, it arises from the top. It is, however, not only in the Cellulariidæ that the position of the radical is a useful character, but in the description of all rooting forms it should be mentioned.

CABEREA BORYI, *Aud.*

The oval body to which I refer in my paper* on gland-like bodies (p. 277) occurs constantly in the Rapallo specimens. It is rather smaller than in those from Trieste, and stains deeply and uniformly.

There is one very large avicularium below the bifurcation. This is apparent in the Rapallo, Naples, and Roscoff specimens, and also in one from Adelaide which I consider to be *C. Boryi*. It appears to have been overlooked in this species, but somewhat similar avicularia in the same position have been figured in *C. rostrata*, B.

* Journ. Linn. Soc., Zool. vol. xxiv. p. 272.

C. Darwinii, Busk, dredged by the 'Challenger' from Nightingale Island, is very similar to the European *C. Boryi*, as the vibracular chambers are identical in shape, so are the avicularia both lateral and median. The character by which the two species are distinguished is that in *C. Boryi* there is a calcareous bar below the proximal border of the oral aperture, and to this the upper part of the scutum is "soldered," while in *C. Darwinii* (Pl. 1. figs. 13, 21–25) the scutum is free and there is no bar right across the front, though sometimes it has commenced at both sides, thus showing us the early stage of *C. Boryi*. The 'Challenger' specimens do not show the helicine mark on the scutum to which MacGillivray refers. The differences are so slight that I should have called *Darwinii* a variety of *C. Boryi*.

Caberea Boryi, however, also occurs in the Southern hemisphere, from New South Wales, Adelaide (Victoria), and New Zealand; but in all these the lateral avicularia are somewhat larger than in the European specimens.

In *C. Boryi* there is one vibracular chamber at the bifurcation. There are 13 tentacles.

In *C. Darwinii* there are two spines at the lower edge of the oral aperture and two at the distal.

BUGULA PLUMOSA (*Pallas*). (Pl. 2. figs. 5–7.)

See *Hincks, Brit. Mar. Polyzoa*, p. 84, for synonyms.

Bugula plumosa, var. aperta, *Hincks, Ann. & Mag. Nat. Hist.* ser. 5, vol. xvii. p. 261, pl. ix. fig. 6.

Bugula simplex, *Hincks, loc. cit.* p. 262, pl. ix. fig. 7.

This seems to be subject to a certain amount of variation in the matter of spines. In some they are scarcely distinguishable, in others the outer one attains a moderate size. Again, on the inner corner of most specimens no spine can be found, in others only a protuberance, while, again, in some it is distinct. In Trieste I noticed that those collected in the sea had a fairly prominent outer spine, while those growing in the aquarium had only a protuberance; and there seems to be no difference in the colonial growth of the *B. simplex* form and the *B. plumosa* form from this locality. I have from Trieste typical specimens of both forms, but upon examining a series I am unable to separate them *.

* In an undoubted *B. plumosa* from Roscoff, occasionally a slight prominence on the inner border may be detected.

From Rapallo I have the *plumosa* form with the small cap-like ovicell of the variety *aperta* of Hincks, and it occurs on both the forms from Trieste; but from analogy with other Bryozoa it would seem possible that the remarkably small ovicell may be a stage of growth; that is to say, the ovicells are only in the initial stage. We may in colonies of Bryozoa find the ovicells in every stage of growth; on the other hand, this is not always the case, for I have specimens of *Retepora* in which most zoœcia show the small semicircular plate, indicating the commencement of the ovicell, though none have complete ovicells.

If more abundant material should show that I am wrong in the interpretation of these points, then we have *B. spicata* var. *aperta*, *B. spicata*, *B. plumosa* var. *aperta*, and *B. plumosa*—all living side by side; but if these are to be specifically separated, it must be upon other distinctions than those at present indicated.

The primary zoœcium has a central spine at the base of the area *, and on each side two spines near the distal end. It is not only the first zoœcium which may possess ancestral characters, but two, three, or even more uniserially arranged may have the same shape before the normal zoœcia are formed; and in this species there are sometimes near the base a number of zoœcia longer than the normal ones, but with the area very short. The repetition of the ancestral characters in the few first zoœcia we may see in *B. avicularia*, *B. calathus*, and *B. neritina*; and further, in *B. plumosa* from a single zoœcium zoœcia may spring out at each side and form new branches, but this does not seem to be a common method of increase.

Another mode of increase is of great interest, and was found in colonies growing in the aquarium of the Zoological Station in Trieste—some basal zoœcia producing either direct (Pl. 2. fig. 7), or from lateral zoœcia (fig. 6), long processes which seem scarcely to differ from the radicals, or attachment fibres, except in being rather stouter. These processes may equal ten zoœcia in length, and at the end a young polypide buds, and in some cases from

* I term this "area," for "aperture" seems eminently unsatisfactory seeing that there is no aperture, but only a thinner portion of the front wall. It might perhaps be better to term it "opesium," but at present a general term may be safer. "Aperture" is probably a relic from times when only dried specimens were examined and low powers used, and a real aperture was thought to exist.

this there is a second bud (Pl. 2. fig. 7), showing that a new colony may arise from this elongated process. This budding may occur in a colony in which the polypides are all dead, and the zoœcia only contain brown bodies, as well as in colonies in full vigour.

Bugula is without an operculum, but there is in the membrane of the upper part of the area a diaphragm, similar to the "irisoïde" of Jullien, and through this the polypide is extruded. In not having an operculum attached by muscles, this genus would seem to be widely separated from *Membranipora*, but, on the other hand, the primary zoœcia remind us of *Membranipora*. When the polypide is protruded, the front wall of the zoœcium is carried with it, so that the way in which the polypide comes out cannot be compared with most other Chilostomatous genera: in fact, it seems in this respect to have most analogy with the Ctenostomata.

On the dorsal surface, the distal wall ends lower down than on the anterior surface, and forms a sharp curve. In the above and most other species this is the only divisional mark on the dorsal surface, but in *B. dentata* there is another at the height of the distal end of the area. The space thus enclosed has a large opening and can therefore hardly be called a chamber, and is often filled with protoplasmic threads as well as the testes and spermatozoa.

Round the edge of the distal walls close to the upper border, and near the dorsal surface, there is a row of numerous small rosette-plates. These rosette-plates and the four lateral ones seem to occur in the same position throughout the genus. They have been figured by Levinsen in 'Danske Dyr,' pl. ii. figs. 5, 6.

The radical tubes are thrown off from near the base of a zoœcium.

The fact may be mentioned for what it is worth, that as a rule the *Bugulæ* in the Northern hemisphere have the avicularia placed high up on the zoœcia, whereas those in the Southern hemisphere have them near the base. *B. neritina* has them low down, and we may ask whether this form has been introduced from the Southern hemisphere.

BUGULA DITRUPÆ, *Busk*. (Pl. 2. figs. 2 & 3.)

Bugula ditrupæ, *Busk, Q. J. Micro. Soc.* vol. vi. p. 261, pl. xx. figs. 7, 8; *Hincks, Ann. & Mag. Nat. Hist.* ser. 5, vol. xvii. p. 260, pl. ix. figs. 3, 4.

Specimens from Naples show that the "additional spine" about midway on one side of the area is not a constant character,

some specimens being entirely without while others have it to some zoœcia. This "additional spine" is found quite as frequently in the Mediterranean *Bugula calathus* as in *B. ditrupæ*. Some specimens have to some zoœcia three outside spines and two inside, while other zoœcia have three outside and three inside.

The primary zoœcium has a central spine at the base of the area, flanked by a spine on each side, and at the top of the area a pair of spines at each corner, and in more than one specimen this primary zoœcium has an avicularium; and this is the only species in which I have seen avicularia to the primary cells.

The beginning of the colony grows up straight at first, then dichotomizing from a centre forms a cup.

This is in most respects very similar to *B. spicata*, H., which I have biserial from Naples and Capri, while from Naples and Trieste it is 4-serial, and in these the outer avicularia are larger than the inner. The avicularia of *B. spicata* and *B. turbinata* are almost identical in shape.

The *B. ditrupæ* in my collection from Naples and Capri are biserial, while those from Trieste are 4-serial, and in these again the outer avicularia are larger than the inner.

A specimen from Rapallo, having been decalcified, does not admit of complete comparison.

BUGULA CALATHUS, *Norman*. (Pl. 2. figs. 4 & 10.)

Bugula calathus, *Norman, Q. J. Micro. Sc.* (n. s.) vol. viii. p. 218, pl. vi. figs. 3-8; *Hincks, Brit. Mar. Polyzoa*, p. 82, pl. xi. figs. 4-6; *id. Ann. & Mag. Nat. Hist.* ser. 5, vol. xvii. p. 260.

Bugula avicularia, forma flabellata, *Waters, Ann. & Mag. Nat. Hist.* ser. 5, vol. iii. p. 117.

It has been considered by Pergens and others that the Mediterranean form should be called *Bugula calathus*; and although I should not have been prepared myself to separate it from *B. flabellata*, yet in deference to the opinion of others I leave it as *B. calathus*, instead of considering it the Mediterranean form of *flabellata*. The cells, ovicells, and avicularia are smaller than those of *B. flabellata* from Roscoff; whereas Hincks says of the British *B. calathus* that these organs are on a larger scale than in *B. flabellata*. The mandible in *B. flabellata* is 0·16 mm. long, and in the Mediterranean *B. calathus* 0·12 mm. The character chiefly relied upon for the separation of the two species is the contrast in colour; but Vigelius ("Ontogenie der Marinen Bryozoen," Mitth. a. d. Zool. Stat. z. Neapel, vol. vi.

p. 505) points out that the colour varies considerably in the Gulf of Naples according to the time when they are taken.

The primary zoœcium has a central spine at the base of the area, and one on each side halfway up as well as three spines at each upper corner. The three lower spines are often reduced to mere protuberances. An "additional spine" on the margin of the aperture about halfway up occurs in many zoœcia of all ages; in fact I have found it more frequent than in *B. ditrupæ*, where it was first noticed by Hincks.

The number of spines is undoubtedly a character of great diagnostic value in the *Bugulæ*, but until every character has been compared we are likely to go astray sometimes.

SYNNOTUM AVICULARE, *Pieper*. (Pl. 1. figs. 6, 7.)

Gemellaria avicularis, *Pieper, Jahresber. Westfälischen Provinzial-Vereins*, vol. ix. p. 43, pl. ii. figs. 5–9.

Notamia avicularis, *Waters, "On the Use of the Avicularian Mandible" &c., Journ. R. Micro. Soc.* ser. 2, vol. v. p. 6 (name only).

Synnotum aviculare, *Hincks, Ann. & Mag. Nat. Hist.* ser. 5, vol. xvii. p. 257.

? Gemellaria egyptiaca, *Savigny* (name on plate), pl. xiii. fig. 4, *but* Loricaria egyptiaca, *Audouin, 'Description de l'Égypte'* (in text).

Mr. Hincks has given a full description, in which he allows that the structure of the zoarium is essentially the same as in *Notamia* (now *Epistomia*), and agrees with Pieper that it may perhaps be regarded "als Verbindungs-Glied zwischen *Gemellaria* und *Notamia*." For my own part I should not have removed it from *Epistomia* (*Notamia*), and still doubt whether a new genus is required, but, as that is not an important point, have put it under the genus proposed by Pieper and Hincks. There has been great confusion concerning the nomenclature of the genera *Gemellaria* and *Notamia*; and while recognizing the correctness of Gregory's remarks * on the use of the name *Gemellaria* †, I feel much

* "British Palæogene Bryozoa," Trans. Zool. Soc. vol. xiii. p. 227.

† In reference to the date of publication of Savigny's plates, on which the name "Gemellaire" first appeared, there seems a probability that they were placed in the hands of various naturalists before the text was published. I purchased a volume of plates from Friedländer, without text, but there was a manuscript list of plates and figures, headed 'Zoologie de l'Égypte: Iconographie des Échinodermes, des Polypes, et des Zoophytes; par Jules César de Savigny, 1806–1812." This may have been copied from an older list! The names of all the genera, whether established or new, appear at the foot of the plates in the French form.

hesitation in making a change, seeing that the two names have been used by Hincks, Busk, Smitt, Vigelius, Lorenz, Freese, Winther, Levinsen, and others.

As Hincks did not publish a figure, and as Pieper's paper is not very accessible, one is now given.

This is a very delicate species and may be easily overlooked. One specimen from Rapallo has the long tubular rooting-process given off from the back of the zoœcium near the middle. *Diploecium simplex*, Kirkpatrick, has similar rooting-fibres from the centre of an internode, but this is not mentioned in the description; and as some specimens of *Synnotum aviculare* have few or no radicals*, I would again call attention to the frequency in the attached Bryozoa of radicular disks being formed without a chitinous tube growing from them. This occurs in *Palmicellaria parallelata* and *Alysidium Lafontii*.

The first internode in a branch has one zoœcium. This is also the case in *Epistomia bursaria*; and in *Didymia simplex* similar internodes occur in the earlier branches, but not throughout the colony. *Calwellia bicornis*, however, has the first internode of a new branch double; whereas a specimen from Port Phillip sent to me, named †*Calwellia gracilis*, MacG., is *Synnotum aviculare*.

The shape of the colony, and the zoœcia, as well as the position of the radical, leaves no doubt in my mind that this is the *Gemellaria egyptiaca* of Savigny, and that the avicularia were overlooked, but this was often the case when their importance was less understood.

Loc. Trieste; Naples; Rapallo; Portland, Victoria (*MacG.*); Port Phillip; S. Africa, a small specimen submitted to me in Miss Jelly's collection.

EPISTOMIA BURSARIA, *L.* (Pl. 2. figs. 8 & 9.)

Notamia bursaria, *Hincks, Brit. Mar. Polyzoa*, p. 100, pl. iv. figs. 1–5; which see for synonyms.

This, so far as I am aware, has not before been found in the Mediterranean, and I only obtained one specimen from Rapallo. The supporting stalk carries an avicularium just below the first

* See "Mediterranean and New Zealand Reteporæ," Linn. Soc. Journ., Zool. vol. xxv. p. 267.

† MacGillivray, "New or little-known Polyzoa," pt. ix., Trans. Roy. Soc. Vict. vol. xxii. p. (1).

internode, and this upper portion does not seem to have contained any polypide. It would thus seem that the upper part of the stem may be cut off as a barren internode, carrying a sessile avicularium identical in structure with those on the mature zoœcia.

The erect stem does not start direct from the creeping tube, but evidently there is a diaphragm, or rosette-plate, in the extended stolon by which stem and stolon are in connexion.

BEANIA MAGELLANICA, *Busk*. (Pl. 2. figs. 11–14.)

The small projections on the distal end of the zoœcium, described from my Naples specimens, are also seen in those from Rapallo. These Jullien did not find in the specimens from Cape Verd or from Tierra del Fuego, but my observation has been confirmed by others.

The mandible of *Beania magellanica* and *B. bilaminata*, Hincks, has a double "columella." This I have figured (Journ. Roy. Micro. Soc. ser. 2, vol. v. pl. xiv. fig. 4).

Ortman states that in the Japanese specimens the border of the avicularium is dentate, but this is not the case with those from the Mediterranean.

As the large figure, given by Jullien, does not correctly show the muscles of the avicularium, I have added figures showing that besides the large adductors there is a semicircular row of short muscles, which no doubt contracts the integument behind the mandible and thus helps in the slow opening of the beak. The "cellular body" of the avicularium, as elsewhere mentioned, occurs in a sheath, the equivalent of the sheath of the polypide.

The "eggs" described by Jullien occur one on each side of the zoœcium, in the same position as the ovarium, contain refractive cells, and are similar in structure to what I term the "median body" * in *Schizoporella sanguinea*. In my specimens of *Beania magellanica* they are usually globular, but sometimes become sausage-shaped.

The zoœcia are often nearly filled by the testes which seem to grow from the two sides, lower down than the ovarium. The remains of the polypide become encysted, forming brown bodies. The budding polypides originate from close to the connecting tubes, in fact sometimes seem to be almost within them.

* "Observations on Gland-like Bodies in the Bryozoa," Linn. Soc. Journ., Zool. vol. xxiv., 1892.

These connecting tubes have usually but one rosette septum, but occasionally there are two, with the parenchym threads attached to both and passing through the junction (see figs. 11 and 12.)

Loc. Adriatic, Naples, Marseilles, Rapallo, Riou and Podestà (*Marion*), Bonifacio; Straits of Magellan, New Zealand, Port Jackson, Portland (Victoria), Mauritius, Cape Verd Is., Kerguelen Island, Japan.

BEANIA MIRABILIS, *Johnst.* (Pl. 2. fig. 1.)

In the Rapallo specimens there are normally two radicals to each zoœcium, and this would seem to be generally the case.

The position of the septum a short distance from the parent zoœcium appears to be constant. There is no septum in the neighbourhood of the new zoœcium. The septal division takes place in the stolon very soon after its formation.

Although there is no "Kapsel," the position of the septum may be compared with that in the stolon of *Hypophorella expansa*, Ehlers; namely, immediately beyond each new zoœcium.

BEANIA HIRTISSIMA, *Heller*, var. ROBUSTA, *Hincks.*

Diachoris hirtissima, *H.*, form robusta, *Hincks, Ann. & Mag. Nat. Hist.* ser. 5, vol. viii. p. 74, pl. v. figs. 9, 9 *a*; *Waters, Journ. Micro. Soc.* ser. 2, vol. v. pl. xiv. fig. 5 (mandible).

This form occurs fairly abundantly at Naples, Capri, and Rapallo. It often has the avicularium showing on the dorsal surface instead of in front. There is no definite radical as in *B. hirtissima* var. *typica*, but there are often numerous fibres on the dorsal surface, which in some cases look like spines, in others more resemble the rooting-fibres.

In a specimen from New Zealand the distal spines are rather smaller than in the Mediterranean specimens, but both these and the marginal spines correspond in structure and position. In the New Zealand specimen the ovicell is larger than in those from Naples, with the mandible nearly twice as wide and with the distal end round.

Hincks described this variety from Algiers.

BEANIA HIRTISSIMA, *Heller*, typica.

Diachoris hirtissimia, *Heller, Bry. Adriat. Meeres*, p. 94, pl. i. figs. 6, 7.

I have characteristic specimens from Rapallo. The usual armature may be taken as 7 stout spines round the oral aperture close

up to the border, and six others of the same size farther removed, making an irregular second row. On the lateral margins of the zoœcia there are about 10 delicate spines, directed inwards towards the median line, and 4–6 directed outwards. Dorsal surface with numerous spines, and sometimes, but not always, a radical tube starting from close to the proximal end. In *Beania magellanica* this tube is almost central. The *Chaunosia hirtissima* of Busk would seem to be the var. *cylindrica*, and I am not sure, therefore, which variety was dredged by the 'Challenger' at Cape Verd Islands.

CHLIDONIA CORDIERI, *Aud.* (Pl. 1. figs. 8 & 9.)

Eucratea Cordieri, *Aud. in Savigny's 'Égypte,'* p. 74; *Waters, Bry. of the Bay of Naples, Ann. Mag. Nat. Hist.* ser. 5, vol. iii. p. 116, pl. xv. figs. 9, 11, pl. xxiii. fig. 12.

Cothurnicella dædala, *W. Thomson, Proc. Zool. Bot. Assoc. Dublin*, vol. i. p. 85, pl. viii. figs. 3–5, & *Nat. Hist. Rev.* vol. v. p. 146.

Chlidonia dædala, *MacGilliv. Zool. Vict.* dec. xi. p. 35, pl. cviii. fig. 2.

Chlidonia Cordieri, *Savigny's 'Égypte,'* pl. xiii. fig. 3 (*in text* Eucratea); *D'Orbigny, Paléont. Franç.* p. 40; *Busk, 'Challenger' Report*, p. 8, pl. xxviii. fig. 11; *Hincks, Ann. Mag. Nat. Hist.* ser. 5, vol. xvii. p. 258; *MacGillivray, Cat. Mar. Polyz. Vict.* p. 10.

The stalk, consisting of calcareous cylinders connected by corneous tubes, has a parenchym running through it, which in each cylinder sends out a branch to an external disk (see fig. 8). There are three other stalked genera, namely *Rhabdopleura*, *Kinetoskia*, and *Stirparia*, but in none of them, so far as can be judged from the descriptions, do the stalks resemble those of *Chlidonia*. A fuller knowledge of the earlier stages of these stalked species is much wanted, for of course these stalks are quite different from the radicals thrown out by many species of Bryozoa. In none of the species with stolons and stalks do we know the form of the primary zoœcium. The stalk of *Stirparia glabra* (see opposite) has two interior chitinous cords (woodcut fig. 3), which are formed by an internal thickening of the chitinous wall, and the structure of the stalk in no way resembles that of *Chlidonia*.

Rhabdozoum can scarcely be compared with the other stalked genera, as from the front of the zoarium a plain pedicular tube is given off, from which a fresh branch grows. In the stalked specimens of *Rhabdozoum* that I have examined many stalks grow from one stolon.

Epicaulidium has somewhat similar internodes.

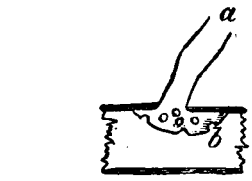
Busk in the 'Challenger' Report makes the zoœcium of *Chlidonia* bicamerate with no connexion between the chambers, but sections show that there is no division. A very considerable thickening of the shell in front (Pl. 1. fig. 9) contracts the zoœcial chamber, but nowhere does there seem to be a second chamber. At the distal end there is certainly a small portion cut off, into which the parenchym passes, through pores of communication, then reaching the next zoœcium after traversing the horny internode.

Alysidium parasiticum, Busk, is rooted by corneous tubes, which sometimes have calcareous nodes, from which the stalk of a colony grows.

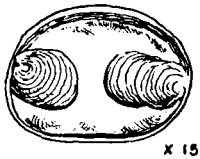
Loc. Naples, Trieste, Rapallo, Algiers, Nice, Tunis, Egypt, Tyre, Calvados, Victoria (Australia), Cape York, New Zealand; Atlantic (*fide* Carus).

On the stalk of *Stirparia glabra* there are capsules looking like the gonophores of Hydrozoa. These were a great puzzle; and I was unable to elucidate them until Mr. Kirkpatrick afforded me the opportunity of examining the British Museum specimens of *Stirparia*. However, Hincks mentions (Ann. Mag. Nat. Hist. ser. 5, vol. xi. p. 105) the radical tubes and the way in which they pass from one internode to another; and these radicals in the 'Challenger' *S. glabra*, from Bahia, are just below the internode, though sometimes passing from one internode to another, forming a knot of chitinous tubes, much like those occurring in *Cellaria*. But in an unnamed species from Kurrachee there are similar structures, which sometimes become very wide or club-shaped at the end of a short or long stalk-like tube (woodcut fig. 1). In one piece they are abundant, and one joint has as many as 17 radical tubes, some of which form capsules. Though some are torn or burst, there seem no definite opening and no contained organs, but at the apex there is an accumulation of protoplasm, such as is constantly seen in the tips of growing radicals.

It is thus seen that the radicals occur in specimens from Bahia, West Australia, and Kurrachee, and that in those from the last two localities they may take the form of a capsule; but the object of this modification is not clear.



× 85 Fig. 2.



× 150 Fig. 3.

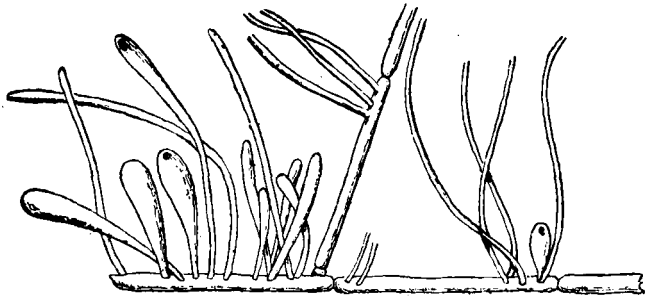


Fig. 1. × 15

Fig. 1. Stalk of *Stirparia* from Kurrachee, showing one branch and numerous radicals, some of which are club-shaped.

Fig. 2. Section of stalk (*b*) of *Stirparia glabra*, Hincks, from West Australia, showing origin of a radical (*a*).

Fig. 3. Transverse section through the stalk of *Stirparia glabra*, cutting through the chitinous cords formed by an internal thickening of the chitinous wall.

EXPLANATION OF THE PLATES.

Plate 1.

Fig. 1. *Aetea recta*, Hincks; showing ovicells. ×25.

2, 3. Do.; ovicells. × 85.

4. Do. The ovarium fills up most of the lower portion of the zoœcium, and the tubular prolongation which is bent back carries an ovicell. × 85.

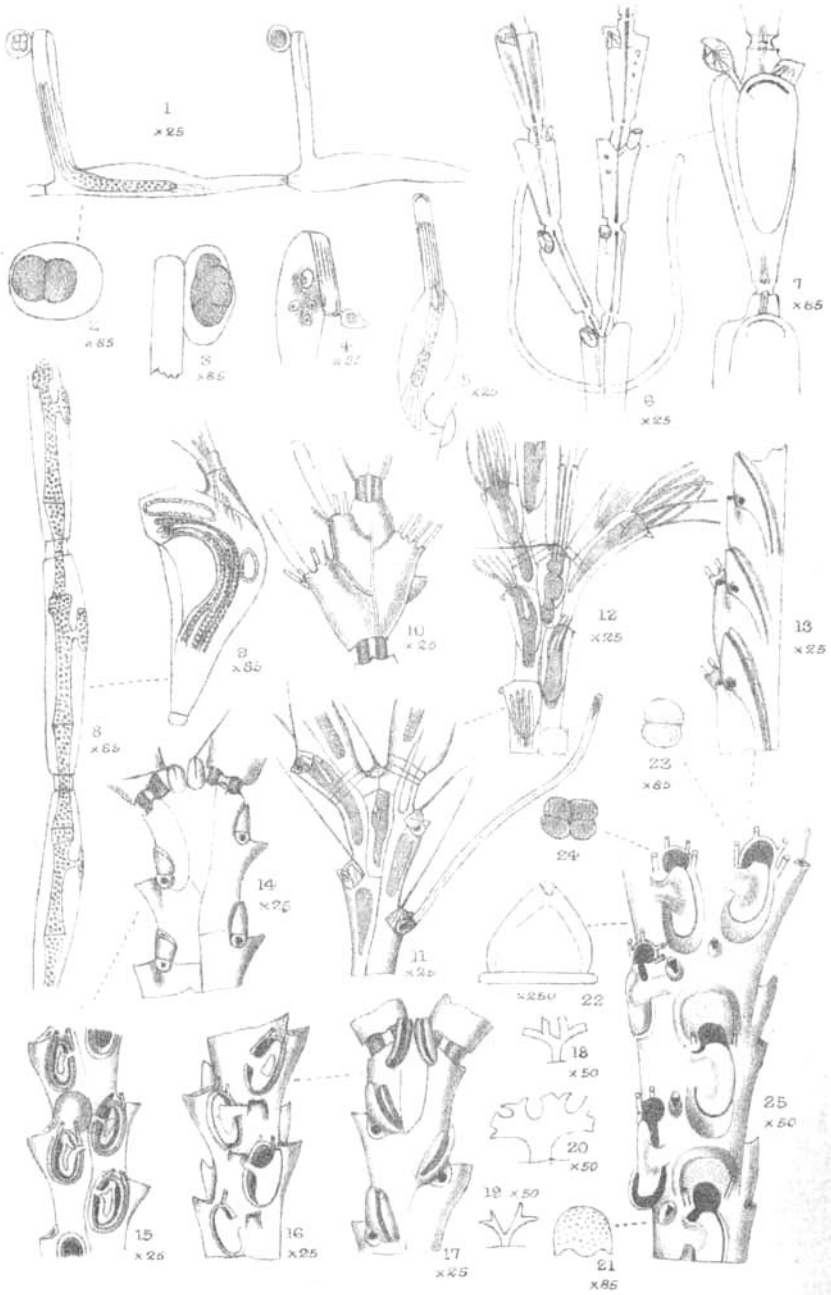
5. Do.; showing the position of the polypide in the zoœcium. × 85.

6. *Synnotum aviculare*, Pieper; showing the lateral sessile avicularia. × 25.

7. Do.; showing the large pedunculate avicularium. × 85.

8. *Chlidonia Cordieri*, Aud. Stalk showing disk, to which the parenchym is attached. × 25.

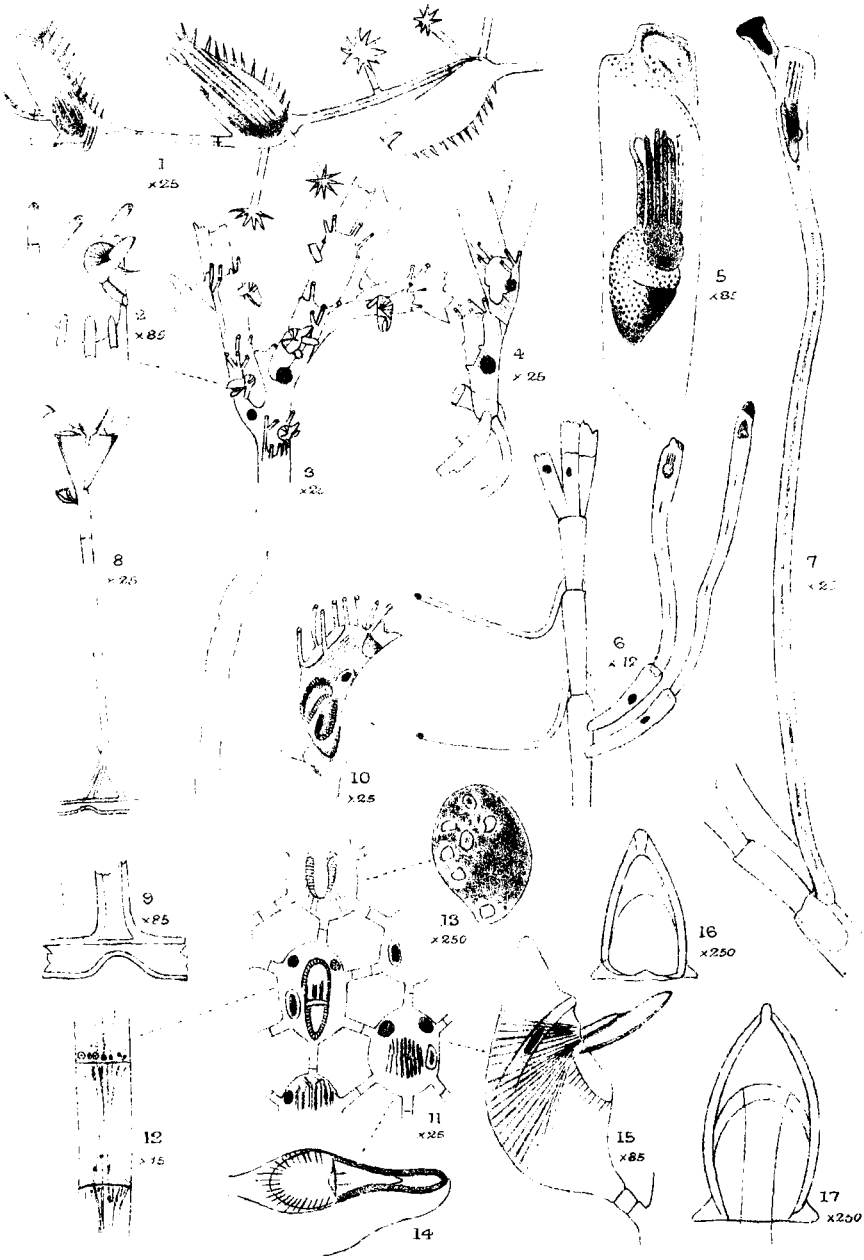
9. Do. Zoœcium, showing the position occupied by the polypide, and also the small separate chamber from which the next zoœcium starts. × 85.



A. W. Waters del.
A. T. Hollick lith.

West, Newman imp.

MEDITERRANEAN BRYOZOA.



A. W. Waters del.
A. T. Holhick lith.

West, Newman imp

MEDITERRANEAN BRYOZOA.

Fig. 10. *Menipea Buskii*, W. Thomson. Dorsal surface showing the two small chambers *a* and *b*, from which the next zoœcium starts. ×25.

11. *Scrupocellaria inermis*, Norman. Dorsal surface; transparent preparation showing the method of articulation, and the position of the polypide in the articulating joint. The vibracular chambers, and the chambers from which the radical starts are also shown.

12. Do. Anterior surface, showing the position of the polypide at the articulation.

13. *Caberea Darwinii*, Busk; Station 135, 'Challenger.' Lateral surface. ×25.

14. *Scrupocellaria Delilii*, Aud. Dorsal surface. × 25.

15. Do. Anterior surface. × 25.

16. *Scrupocellaria incurvata*, Waters. Anterior surface. × 25.

17. Do. Dorsal surface. × 25.

18, 19. *Scrupocellaria Bertholletii*, Aud. Fornices from one colony. ×25.

20. *Scrupocellaria reptans*, L. Fornix. × 50.

21. *Caberea Darwinii*, Busk. Operculum. × 85.

22. Do. Avicularian mandible. × 250.

23, 24. Do. Ova out of the ovicells. × 85.

25. Do. Anterior surface. × 25.

Plate 2.

Fig. 1. *Beania mirabilis*, Johnston; showing the two radical processes, and also the diaphragm in the stolon near to the zoœcium from which it has arisen. × 25.

2. *Bugula ditrupæ*, Busk. Primary zoœcium. × 85.

3. Do. The same, showing the commencement of the colony. × 25.

4. *Bugula calathus*, Norm. "Primary" and second zoœcium. × 25.

5. *Bugula plumosa*, Pallas. Young zoœcium from the extremity of a long basal process. ×85.

6. Do. Same colony. × 12.

7. Do. Process showing first and second zoœcium.

8. *Epistomia bursaria*, L. Stalk and lower part of colony. × 25.

9. Do. Origin of stalk from the creeping stolon. × 85.

10. *Bugula calathus*, Norman. "Primary" zoœcium. × 25.

11. *Beania magellanica*, Busk; showing position of egg-masses. × 25.

12. Do. Connecting-tube with two septa. × 150.

13. Do. Egg-mass. × 250.

14. Do. Avicularia. × 85.

15. *Bugula spicata*, Hincks. Mandible. × 250.

16. *Bugula ditrupæ*, Busk. Mandible. × 250.