MEMOIRS.

NOTES *on a* PECULIAR FORM *of* POLYZOA *closely* ALLIED *to* BUGULA (*Kinetoskias*, Kor. and Dan.). (With Plates I and II.) By GEORGE BUSK, F.R.S.

AT a meeting of the Scientific Society of Christiania on the 15th March, 1867, D. C. Danielssen gave a preliminary account of two new forms of Polyzoa found by him in Nordland and Finmark, and referred to a new genus *Kinetoskias*.[1]

Of these a fuller account has since been published by Koren and Danielssen, accompanied with figures;[2] and one of the two forms in question was enumerated by Sars, in a catalogue of deep-sea species, under the name of *Bugula Smittii*.

In May, 1867, Professor Smitt, apparently not aware that a new generic name had been already applied to it by Danielssen, described apparently one of the two forms noticed by that observer under the name of *Bugula umbella*.[3] Smitt's specimens were procured from Wijde Bay, Spitzbergen.

On the 30th January, 1873, on the "Challenger" Expedition, a specimen of large size, of a form very closely allied to if not identical with one of those described by Koren and Danielssen, was described and figured by Sir C. W. Thomson,[4] under the name of *Naresia cyathus*. This specimen was procured in the North Atlantic in lat. 36° 23′ N., long. 11° 18′ W., from a depth of 1525 fathoms. A second specimen of the same form, but of smaller size, was procured on the 2nd March, 1876, in lat. 36° 44′ S., and long. 46° 16′ W., from a depth of 2650 fathoms. Other specimens of a closely

[1] 'Forhandl. i Videnskabsselskabet i Christiania,' 1867, p. 23.

[2] 'Fauna littoralis Norvegiæ,' part iii, 1877, p. 104, pl. iii, figs. 12—14; pl. xii, figs. 4—14.

[3] "Kritisk förteckning öfver Skandin. Hafs-Bryozoer," in 'Öfversight af Kongl. Vetensk.-Akademiens Handlingar,' May, 1867, pp. 292 and 353, pl. xix, figs. 28—31.

[4] 'Nature,' i, p. 387.

allied but quite distinct form were obtained on the 10th September, 1875, in lat. 9° 5′—10′ S., long. 30° 49′—53′ W., from a depth of from 32 to 400 fathoms; and again, on the 14th December, 1875, in lat. 33° 31′ S., long. 74° 43′ W., from a depth of 2160 fathoms.

These different forms constitute certainly three and, as I am inclined to think, four distinct and well-characterised species; but they all agree in certain very peculiar characters, which would seem to be almost, if not quite, sufficient to render the group composed of them of generic value, or, at any rate, to rank as a distinct sub-genus of *Bugula*.

To this genus or sub-genus the appellation bestowed upon it by Koren and Danielssen obviously has priority over *Naresia*.

The species belonging to this group at present known are:

1. *Bugula* (*Kinetoskias*) *Smittii*, Dan.; *Kinetoskias Smittii*, Kor. and Dan., l. c.; *Bugula Smittii*, Sars.

2. *B.* (*Kinetoskias*) *arborescens*, Daniells.; *Kinetoskias arborescens*, Kor. and Dan., l. c.; *Bugula umbella*, Smitt, l. c.

3. *B.* (*Kinetoskias*) *cyathus*, W. T.; *Naresia cyathus*, C. W. T., l. c.; ? *Kinetoskias Smittii*, K. and D., l. c.

4. *B.* (*Kinetoskias*) *pocillum*, n. sp., mihi.

1. *K. Smittii* is thus characterised by Koren and Danielssen.

"Zoarium umbellate, with four strong main branches springing from a stem about 150 mm. (6 inches) in length, which is cylindrical, naked, and completely pellucid, and gradually thickened towards the lower end, from which numerous radical fibres proceed, by which the growth is affixed to small stones or sand. The branches are biserial, and divide several times dichotomously. The zoœcia are about 0·8 mm. (0·03 inches) long, with a breadth of 0·31 mm. above, and of 0·13 mm. below. In shape they are elongated and tapering below, truncate above. The posterior surface is striated transversely towards the lower part. A short spine is placed on the upper and outer angle. On the upper and anterior border of the *zoœcium* there is a blunt, solid, horny, conical process, which appears to serve as the point of insertion of a strong muscle, which expands on the anterior surface of the superjacent *zoœcium*. This muscle is attached to the conical process by a tendon."

"The avicularia are placed on the outer border of the *zoœcia*, a little above the middle. They are of an elongated form, with a rather long mandible curved at the point. The

oœcium is sub-globular and affixed to the upper and outer border of the zoœcium, arching, as it were, over the aperture."

The anterior muscle above mentioned is described as lying between a fine exterior membrane and the proper ectocyst. This membrane, again, is said to pass down from one zoœcium to another, and as connecting the branches together, being finally continued into the stem.

Amongst other particulars, the authors state that the ovary is attached to the endocyst on the upper and anterior part of the surface of the zoœcium, consisting of an agglomeration of cells wherein the ova are developed. The testis, on the other hand, they state, is situated at the bottom of the zoœcium, and is formed of similar cells to those forming the ovary, but filled with spermatozoa.

Kinetoskias, therefore, is regarded by them as a complete hermaphrodite.

The incurvation of the branches of the *zoarium* towards their termination is ascribed to the action of the anterior muscles above noticed. There is, they observe, no common colonial muscular system.

2. *Kinetoskias arborescens* is described as having a flexible zoarium, supported on a very short stem, from which radiate four large main branches which sub-divide dichotomously. The zoœcia, which are biserial and alternate, are 0·58 mm. long by 0·31 broad above, and 0·18 mm. below. They are of a narrow form, and nearly pointed below, especially when viewed from behind; above they are broad and rounded, the upper border being oblique in a direction from within upwards and outwards, so that the upper and inner angle is rounded off, and the outer rendered more acute; there is no spine on this angle. From the middle of the upper convex border of the zoœcium nearer the anterior margin is a strong, horny, obtuse conical process or apophysis, which is said to give attachment to a muscle, which, as in *K. Smittii*, is described as spreading out over the anterior surface of the superjacent zoœcium.

The anterior surface is said to be covered with scattered calcareous granules, and the posterior surface, which is very convex, is strongly striated transversely. The striæ or rugæ are elevated and oblique from below upwards and inwards.

The avicularia are placed on the upper and outer angle of the zoœcia. They have the form of an eagle's head, and are supported on a short articulated stem. No oœcia were observed.

Professor Smitt, in his independent account of the latter of the two species described by Koren and Danielssen, remarks that the zoœcia are widely distinguished by their form from those of other species of *Bugula*, inasmuch as the lower tubular portion is entirely wanting, as viewed in front, the membranous aperture occupying the entire anterior face. The aperture is wider above than below, so that the zoœcium, he observes, has more or less of a boat shape, as in *Beania*. But the *Bugula type* is nevertheless evidenced in the incurvation of the inner border, whilst the lower border of the aperture is straight. The upper and inner angle is rounded off, and the outer more acute. The avicularia are placed high up on the upper and outer angle of the zoœcium, and assume the same position, he says, as in *B. avicularia*, though rather more pointed upwards.

On the dorsal aspect the zoœcia present a still greater peculiarity. In this aspect they are flatly convex, with the outer border acute and the inner more rounded.

The surface, as in *Ætea anguina*, is traversed by raised granular lines or ridges, which curve obliquely upwards and inwards.

The lowest portion of the zoœcium, which is in other species of *Bugula* more or less tubular, is in this case simply constricted, so as to constitute a laterally compressed peduncle, placed somewhat external to the middle line of the zoœcium.

Close to this constricted part, and near the inferior and outer angle of the zoœcium, the radical tubes arise, the somewhat dilated commencement of which completely fills up the space between the summit of the inferior or older zoœcium, and the base of the superior or younger, being wedged in, as it were, between the two. From this point a radical tube grows downwards, running along the outer border of the lower zoœcium, near the bottom of which it unites with a similar radical tube arising from that zoœcium.

Sometimes, however, he observes this conjunction does not take place, but the two (or more) tubes are continued side by side. But, generally speaking, as they descend all distinction between the tubes disappears, their *lumina* appearing to run together, so as to form a broad expansion, which fills up the angular space between two contiguous branches of the zoarium, stretching across from one to the other.

Professor Smitt also states that in the interior of this expansion numerous colonial nerve filaments may be seen,

besides which are only some free nucleiform particles (fettkropskulor).

It is not clear, in Professor Smitt's description, whether the specimen of *Bugula umbella*, from which it was drawn, had or had not a simple peduncle. But, so far as my imperfect knowledge of Swedish enables me to say, I should gather that he thinks it possible that the growth may be more or less detached or free, the radical fibres only penetrating the loose muddy bottom without, as in most other cases in the Polyzoa, the fibres being attached to any fixed object.

The above brief summary comprises, I believe, the main points hitherto made known with regard to the structural peculiarities of *Kinetoskias*. My object in the present communication is to show how far the accounts given by the eminent and excellent observers above cited are in accord with what I conceive, from direct observation of two closely allied forms, to be the actual conditions.

The two forms that have come under my own observation from the "Challenger" collection are:

1. *Kinetoskias cyathus*, C. W. T., and
2. *Kinetoskias pocillum*, n. sp. (fig. 3).

1. *B. cyathus*.—The general aspect and dimensions of this remarkable and beautiful form are well shown in Sir C. W. Thomson's account of it,[1] and to which, so far as external characters go, I have but very little to add. The *zoarium* consists of an elegant infundibuliform, vase-like expansion, constituted of numerous, long, sparsely dichotomising, biserial branches, springing from an apical point at the bottom, and curving gently outwards till, towards the extremities, they are curled round upon themselves, the anterior aspect of the zoœcia looking outwards. This infundibuliform portion of the zoarium is supported on a point, a little to one side of the actual apex, upon the summit of a terete peduncle, about four or five inches in height, and from about half an inch in diameter at the bottom, tapering to a diameter of less than the one tenth of an inch at the summit. At the lower part of the vase-like cup the branches, to a height of about an inch, are united, like the ribs of an umbrella, by a delicate transparent membrane, stretching across from one to the other. This membranous cup is brought to a point at bottom, a little to one side of the spot from which the branches diverge, and it appears to be quite closed, a very tight constriction existing at its junction with the peduncle. The latter, though

[1] L. c.

flattened in the spirit specimen, is, in the natural condition, cylindrical, and probably, when distended, sufficiently stiff to support the upper portion in an upright position, whose weight, of course, must be very little in the water. The wall of the peduncle, though perhaps rather thicker than the web, is perfectly transparent, and, so far as I can make out, quite homogeneous; and in the interior, in the spirit specimen, nothing is to be seen except a few minute nuclei and slender branching threads, probably belonging to an extremely delicate endosarc, and which it is allowable to suppose may represent the so-called "colonial nervous system," seen by Smitt in the radical tubes of his *B. umbella*.

The zoœcia are about 0·045 inch long by 0·02 in width, which is tolerably uniform from top to bottom. The outer border, as in most species of *Bugula*, is hollowed on the external border and towards the lower end in most of the zoœcia, a sort of step is thrown out (Pl. I, fig. 1), upon which is articulated the *avicularium*. The inner border is evenly rounded, and the upper and inner angle is completely rounded off, whilst the external is produced and crowned with a short, pointed, spinous process.

Viewed behind, the zoœcium is convex and the surface perfectly smooth, without a vestige of any transverse ridges. The outline is much the same as in front, and the outer border is acute, the inner rounded. At bottom the zoœcium is seen to arise from the back of the subjacent one by a constricted neck, on the outer side of which there is a chitinous, thickened, ring-shaped process, which appears to represent the spot from which, in the lower part of the branches, the radical tubes spring; and the insertion of the zoœcium appears to be also surrounded with a rather thick, chitinous ring. The oœcia are of large size, attached to the middle of the summit of the zoœcium in front, and projecting forwards in the form of a wide shallow hood.

The avicularia are about 0·02 inch long and about 0·006 wide. The mandible is about 0·01 inch in length, and much curved; within it presents the usual arrangement of muscles, and a thickened, glandular, (?) digitiform sac or pouch.

Within the zoœcium a rather large polypide is lodged, of the usual conformation and muscular connections, and having about twenty-four or twenty-six tentacles. So far there is nothing very remarkable: but other peculiarities remain to be mentioned, possessed in common by this and the other species of *Kinetoskias*. These are—1. The existence of a distinct muscle, which, arising from the front of

the base of the zoœcium passes obliquely backwards and upwards, expanding in a fan-shaped manner, to be inserted into its hinder wall to the height of about one third or one fourth of the zoœcium (fig. 1 *a*). The action of this muscle must be to draw the entire zoœcium downwards and forwards, or, in other words, to bend it on itself, and thus, by the concurrent action in many zoœcia, to curl the branches forwards; an action that has, in fact, been noticed by Koren and Danielssen in the living condition. Besides this flexor muscle in *K. cyathus* there is an additional, smaller, fan-shaped bundle of fibres, for the purpose, apparently, of curving the step-like process of the wall of the zoœcium, upon which the avicularium is fixed, forwards, so as to cause the avicularium to come in front of the zoœcium (fig. 1 *c*), which appears in the spirit specimen to be its usual position. I have been unable to discern anything like ovary or testis within the zoœcia; but many, if not most, of the oœcia are filled with an apparently vitelline mass or ovum of large size.

Koren and Danielssen are inclined to consider that their *Kinetoskias Smitii* is identical with *Naresia cyathus* of Wyville Thomson; but, so far as I am able to judge, from their detailed description and figures, I do not see how this can well be. The form and size of the zoœcia and of the avicularium and oœcia undoubtedly appear to correspond with those of *B. cyathus*; but the general aspect of the zoarium in the two cases is utterly dissimilar. In this particular, however, it must be remarked that the natural-size figure given in pl. iii[1] does not at all correspond with the description in the text. 2. In *K. cyathus* there are no transverse *rugæ* on the back of the *zoœcia*. 3. The avicularium is attached in *B. Smitii* above the middle of the outer border of the zoœcium, whilst in *K. cyathus* it arises from a distinct step-like process, quite at the bottom.

On these grounds there does not appear to me sufficient reason to regard *Kinetoskias Smittii* and *Naresia cyathus* as specifically the same.

2. *Kinetoskias pocillum.*—Though very much smaller than *K. cyathus*, the structure of the zoarium is exactly the same. Like that species it consists of a vasiform infundibuliform expansion composed of branches springing from a common point, and, as in that form, united at their base by a transparent membrane, which is connected with an equally transparent, terete, membranous stem, about one and a half to two inches high, which, as in *K. cyathus*, terminates inferiorly

[1] L. c.

in a thick tuft of very fine tubules or hollow fibres, each of which is individually affixed to an empty *globigerina* shell, or to some other Foraminifer. And there is the same complete constriction between the stem and the membranous expansion forming the bottom of the infundibular cup. The zoœcia differ from those of *K. cyathus* in having no spine on the upper and outer angle, and in having the avicularium attached by a distinctly articulated peduncle to the outer border rather above the middle and without any projecting process for its reception. Posteriorly, the *zoœcia* are irregularly oblong, the outer border being sharp and nearly straight, and the inner as it were gibbous. The surface, as in *K. cyathus*, is perfectly even and smooth, and very convex. In many of the zoœcia, more especially towards the lower end of the branches, a small tubercular projection rises from the upper border of the *zoœcium* (fig. 2) in the middle, which would seem to correspond to the "horny conical process" in the same situation noticed by Koren and Danielssen, and supposed by them to serve for the attachment of a muscle; but it is clearly nothing of the kind, and, as it seems to me, merely a rudimentary oœcium. In *K. pocillum* these organs are much smaller than in *K. cyathus*, but, as in that species, cucullate in form. They differ, however, very markedly in the direction in which the opening looks, which, in *K. cyathus*, is directly downwards, and the *K. pocillum* obliquely outwards and downwards. In the interior of the zoœcia the arrangements are of the usual kind, except in the presence of the additional fan- or rather brush-shaped flexor muscle, which, in this species, is of larger size or more developed than it is in *K. cyathus* (fig. 2.). The additional muscle connected with the insertion of the *avicularium* is absent in *K. pocillum*. Besides these parts, there may be also seen within the base of the zoœcium behind, an apparently chitinous process of irregular figure, and probably hollow. It springs apparently very close to the spot whence the radical tubes arise, and may have some connection with them. Koren and Danielssen notice a similar process in *K. Smittii*, and I have seen it occasionally of smaller size than in *K. pocillum* in *K. cyathus*. I am unable to define its function, but it most certainly does not serve as the point of attachment for a muscle as supposed by Koren and Danielssen.

In *K. pocillum* the *avicularium* is of larger size, and wider in proportion to its length than in *K. cyathus*, resembling in that respect the avicularium of *K. arborescens*, but otherwise they are alike, both containing, besides the usual

muscles, a digitiform glandular sac, fine branching nucleated fibres, which may be nervous.

I have as yet scarcely adverted to the most remarkable feature of *Kinetoskias*, viz. the peduncle or stem, which appears to exist in all the species, though it is not shown in Professor Smitt's figure of his *K. umbella*, having probably, as I should imagine, become accidentally detached.

The mode of formation of this part of the zoarium, which is undoubtedly the homologue of the bundle of separate radical tubes so commonly met with among the Polyzoa, is extremely curious and interesting, and at the same time, in some points as yet, more or less obscure; as, in fact, may be said respecting the mode of formation and development of the more ordinary form of radical tubes.

In the more common form they are cylindrical, jointed, chitinous tubes, with rather thick walls, and with very scanty contents, beyond a few minute granular particles and irregular threads, representing, as it would seem, the remains of an endosarc, with which, in order that their progressive increase in length, and occasionally complicated branching, &c., may be effected, we must suppose the tube to be furnished. In fact, it is otherwise impossible, without assuming the presence of a germinal material to account for the fact, that even after the tubes have attained a considerable length the extremity, or a considerable part of the tube, may undergo great changes in form, as is seen in the production of hooks and other means of ensuring adhesion to foreign bodies; changes showing a most extraordinary adaptability to circumstances. Not the least remarkable of these adaptations is the division of the extremity of the tube into a multitude of very minute tubular filaments, each of which may be traced into independent connection with some small foreign body. In the deep oceanic forms these are most usually dead *globigerina* shells, or the skeletons of other foraminifera, so that having no more stable foundation than the soft globigerina ooze, which forms so extensively the bottom of the ocean, the delicate Polyzoan growths which inhabit those profound depths, are able to support themselves by the innumerable multitude of solid particles to which they are attached by the hair-like terminations of the radical fibres.

And this is well shown in the case of *Kinetoskias*, in which the dilated lower end of the peduncle breaks up into a thick and dense tuft of excessively fine filaments, at the end of each of which, when the tuft is slightly teased out, a *globigerina*, or other foraminiferous shell, is seen to be

firmly attached. In many instances the filament may be seen entering the cavity of the empty shell and coiling about within it.[1]

It is difficult to imagine how this subdivision of the distal end of the tube or stem can take place, unless at that part there is active power of growth, as at the extremities of the root fibres in plants, though in a different and at present unknown way. And a still more remarkable fact is the power of adaptation to the environment that is possessed by these delicate filaments, which might almost lead to the conclusion that an active living power resides in even the ultimate fibrillæ.

In *Kinetoskias* the peduncle, as I have observed, represents a radical tube, or rather, it may be said, a coalesced bundle of tubes.

The wall of the peduncle, in the living or fresh condition, is described by Sir C. W. Thomson as being as clear as glass, and it retains this transparency scarcely impaired even after long immersion in alcohol. Unlike the radical tubes in all other Polyzoa that I have examined, the corresponding structures in *Kinetoskias* have no action on polarised light.[2] Though very thin the wall is extremely tough, and beyond an obscure appearance, in the contracted state, of a very delicate, longitudinal, irregular striation, no trace of structure can be observed in it.

Within, as I have stated, the remains of a very delicate endosarc or cyst may be observed, as represented by a few scattered, minute nuclear bodies, and irregular branching filamentous strings.

I have already cited Professor Smitt's account of the mode of formation of the radical tube or stem and sheathing membrane in *K. arborescens*, and this, in the main, is equally applicable to *K. cyathus* and *K. pocillum*.

In fig. 5 is represented the bifurcation of one of the branches in the latter species, just above the point at which the branches are connected by the sheathing, umbrella-like expansion.

In this figure are shown delicate, dilated, radical tubes, passing across from one branch to the other. These tubes arise from the constricted part of the *zoœcium* behind and immediately above its point of origin from the subjacent one. And they are apparently inserted into the corresponding point of the zoœcia in the opposite branch. The tubes

[1] This arrangement, however, is equally well shown in many other of the abyssal forms of Bugula, Bicellaria, and other genera.

[2] Which would probably indicate the absence of any calcareous element.

may be seen to arise with a small transparent protrusion (*a*, *a*, *a*, *a*), which gradually increases in length and diameter, but in the latter sense very irregularly. Whether those tubes, which are attached at both ends, *arise* at one end and are *inserted* by the other, or whether the continuous tube is formed by the coalescence of a separate one from each side, I am unable to determine, but am inclined, from the appearance the connecting tubes sometimes exhibit, to think that the latter supposition is the more probable.

The continuous web-like connecting membrane appears in like manner to be formed by the lateral fusion of similar connecting tubes. But how the peduncle itself below the constriction at which it is attached to the sheathing membrane is formed is very difficult of explanation. It seems to me not improbable that the stem, notwithstanding its size and length, actually represents merely a segment or internode of a largely dilated radical tube, extending from the point of constriction above to the lower expanded end, where it breaks up into the bundle of fibres and fibrillæ, all of which, it may be observed, are more or less distinctly divided into joints or internodes, as is the case almost universally, so far as I am aware, in all radical tubes among the Polyzoa.

In *Kinetoskias cyathus* I have not noticed any similar connecting tubes between contiguous branches, but the mode of formation of the web-like expansion is very plainly shown to arise from the coalescence of radical tubes.

In fig. 4 is shown the bifurcation of a branch at a point a little above and including a portion of the edge of the web, whilst on the two outer sides of the figure are shown adherent portions of the same. It will be seen, as described by Professor Smitt, that a radical tube arising from the hinder and inferior part of a zoœcium descends behind the outer border of the subjacent ones, and that the descending tubes on both sides becoming dilated, and gradually approaching each other, eventually coalesce to form the membranous expansion by which the branches are connected. It is to be remarked, however, that at the angle formed by the edge of the web (*b*), the contents exhibit an aggregation of minute germinal corpuscles, exactly like those which characterise the endosarc in cell-budding zoœcia. From this one might almost be tempted to suppose that the radical web possessed an innate power of growth or development like an ordinary zoœcium, and that it is not altogether beyond the bounds of probability that it may, in some cases, throw tubular prolongations *upwards* along the sides of the zoœcia above. This surmise is strengthened by

the circumstance that occasionally the lateral tube may be seen terminating in a rounded extremity, not at the constricted base of the zoœcium as usual, but at about the middle of its length, being, as it were, simply applied, like ivy to a wall, and without entering the zoœcium. In most cases, however, the radical tubes may be seen entering or emerging from the usual point at the base of the *zoœcium*.

The inter-connection of the branches of a ramose zoarium by transverse tubes of the same nature as radical tubes is of common occurrence in more than one family of Polyzoa. As instances may be cited, among the Cabereidæ, the well-known *Canda arachnoides* with which I think the *Caberea* (or *Canda*) *reticulata* of Smitt[1] should be associated as a variety, whilst in the genus *Bugula* the occurrence of such a condition may be observed in several species. Of these I would more particularly notice two as yet undescribed forms in the Challenger collection, which I propose to name *Bugula reticulata* (fig. 7) and *Bugula unicornis* (fig. 8), in which this mode of connection is very well displayed; but in both these instances, as well as in *Canda arachnoides*, the connecting tube is distinctly seen to arise from a zoœcium in one of the branches, and to be attached to the other branch by means of clasping fibres, or by an expanded disc, obviously in this respect resembling a common condition in the radical tubes. In this respect, therefore, differing from the apparent condition of the transverse connecting tubes in *Kinetoskias pocillum*.

In a third species of *Bugula*, also, as yet unpublished, which I propose to name *Bugula mirabilis*, although there are no connecting tubes between the branches, the mode in which the radical tubes are collected into a long, rope-like peduncle, shows a complete analogy with, or approach to, the assumed mode of origin of the peduncle in *Kinetoskias*. In fig. 6 is represented the terminal portion of the zoarium of *B. mirabilis*, composed, as will be seen, of a bundle of tubes arising from the usual point in the lower zoœcia, and assembled into a close fasciculus, in which some of the tubes, in fact, may be seen in such intimate union as to render it uncertain whether their *lumina* are not confluent. The branching terminal portion of one of the radical tubes is shown subdividing into slender-jointed filaments, each of which, as in *Kinetoskias* and many other radicellate forms, is attached individually to a foreign body; and the figure also shows the segmented condition of the tube and filaments.

[1] 'Floridan Bryozoa,' p. xvi, pl. v, figs. 43—46.

In this particular species it will also be seen that the growth of the zoarium commences with an enormously elongated zoœcium, from the bottom of which two prolongations are continued, which at the upper part are slightly calcareous, but below become altogether chitinous or horny, and exactly like the other radical tubes. In fact, the branched termination shown in the figure belongs to one of these initial tubes as they may be termed.

That the radical and connecting tubes, like the avicularia and vibracula, represent modified zooids, is, I believe, generally admitted; nor can it be denied in this case that each successive joint or internode is a distinct zooid. In confirmation of this view I would take this opportunity of citing a very striking exemplification. This is afforded in a species of Carbasea (*C.ovoidea*, Bk.), in which, from the edge of the fronds, may frequently be seen numerous filamentous tubular processes, in all respects homologous with radical tubes, and like those destined to afford attachment to foreign bodies, or between the separate fronds themselves. A portion of the edge of a frond of this *Carbasea* is shown in fig. 9, in which it will be seen that cells of irregular form, and never containing a polypide or other structure, beyond the usual granular endosarc and branching fibres, lie along the border. And that from some of these aborted cells (for they cannot be termed zoœcia) tubular-jointed filaments arise, each of which may, in fact, be considered as representing one of the longitudinal series of zoœcia in the frond.

At *a* a short tubular process is seen from which two tubes arise, exactly in the same way that two zoœcia arise in the course of the longitudinal series of ordinary zoœcia; and what is very remarkable, as proving the homology of these aborted zoœcia with those of the ordinary kind, at *a* the first internode of one of the filaments is actually furnished with a semicircular lip, although there is not the faintest indication of muscles or polypide in the interior. The growing end of the tubular filament presents a granular substance in the interior (*b*), precisely like that with which all the young budding zoœcia are filled.

These marginal cells and their tubular prolongations appear to me to afford the clearest possible evidence of the true nature of the radical tubes and clasping organs of the Polyzoa.[1]

Note.—Since the above was written I have noticed in a

[1] In *Bicellaria* and in *Notamia* it may almost be said that the inhabited part of the zoœcia is simply a dilatation at one part of the internode of a radical tube, which is continued to the ultimate extremity of the branch.

species belonging to an abyssal genus, which I propose to name Angularia, a web-like expansion at the angle of most of the bifurcations, which is sometimes of considerable extent, and apparently homologous with that at the base of Kinetoskias. In this case, however, the web seems to be formed by an expansion and reduplication of a general epitheca, which is strongly developed in this and other of the abyssal forms.
