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XXX.—*On the Genus* Haliphysema, *with Description of several Forms apparently allied to it.* By the Rev. A. M. Norman, M.A.

[Plate XVI.]

It is now many years since *Haliphysema* first attracted my attention; and well do I remember the extreme interest felt at finding the type of *H. ramulosum*, which was dredged off the Guernsey coast, attachedto a dead *Gorgonia verrucosa*, which came up laden with a forest of treasures growing on it.

The genus is now attracting considerable attention; and as I cannot entirely agree with some of the views either of Mr. Carter, on the one side, or of Prof. Haeckel on the other, I propose to give my reasons for dissenting from certain points which they hold with regard to the systematic position of these animals, or the relationship which exists between the known forms.

I feel the more called upon to state my opinion upon the questions at issue because I have undertaken to edit the fourth and last, posthumous volume of my late friend Dr. Bowerbank's 'Monograph of the British Spongiadæ.' It will be necessary, in the first place, briefly to trace the outlines of what has been written upon *Haliphysema* before entering upon an investigation of the views of different authors with respect to the species of this and allied genera which have fallen under their observation.

I. *History of the Genus* Haliphysema.

In the year 1862 Dr. Bowerbank first characterized the genus *Haliphysema*, in the third part of his memoirs "On the Anatomy and Physiology of the Spongiadæ," published in the 'Philosophical Transactions.' The characters given were as follows:—

"Sponge consisting of a hollow basal mass, from which emanates a single cloacal fistula. Skeleton: spicula of the base disposed irregularly; spicula of the fistula disposed principally in lines parallel to the long axis of the sponge, without fasciculation."

The type species was *H. Tumanowiczii*, Bow., figured pl. lxxiii. fig. 3. The author stated that he was unable to detect either oscula or pores, but held that the general structure of the organism showed relationship to *Alcyoncellum* and *Polymastia*. In the first volume of the 'Monograph of the British Spongiadæ,' the above-mentioned figure and description were reproduced; and there can be no question that up to the year 1865 Dr. Bowerbank held that the spicules incorporated in the structure of *Haliphysema* were the secretion of the animal, and not the product of other sponges selected by *Haliphysema* and built into its walls. It was in this year that I discovered in Guernsey a second species of the genus, *H. ramulosum*, and, sending it to Dr. Bowerbank for examination, called his attention to the masonic properties of the animal. In his second volume (1866), in describing *H. ramulosum*, he fully recognized "the selection and incorporation of the extraneous material of the skeleton," and, in his account of *H. Tumanowiczii*, described the pedicel and head as having "an incorporation of fragments of spicula of various sizes and forms and of minute grains of sand."

It seems extraordinary that after this, in one of his very last papers, Bowerbank should have described a sponge as belonging to this genus, of which he states that there are "no adventitious substances incorporated in the skeleton, as in the other two species, and all its spicula are undoubtedly secreted by itself"—a statement which seems fully borne out by his description and figures, and which renders it impossible that *Haliphysema tubulatum** should be retained in the genus to which it was assigned by its describer.

* Bowerbank, "Report on a Collection of Sponges found at Ceylon by E. W. H. Holdsworth, Esq.," Proc. Zool. Soc. 1873, p. 29, pl. vii. figs. 1–6. *H. tubulatum* appears to be a remarkable sponge, consisting of an agglomeration of very numerous elongated tubuli without terminal openings, closely appressed together and forming a mass nearly 3 inches long by 2 wide. The cylindrical tubuli, when separated from each

In 1868 Mr. Parfitt* described with accuracy the structure of the base or dome-shaped bulb by which the type species is attached to the seaweed or Hydrozoon on which it lives. This bulb, when carefully opened, Mr. Parfitt stated, has "five, six, or even seven radii, like the spokes of a wheel."

We now come to the observations of Mr. Carter, who, in 1870, having met with *Haliphysema Tumanowiczii* at Budleigh-Salterton, accurately described the test with its incorporation and garnishing of extraneous objects, consisting chiefly of sand-grains and both siliceous and calcareous spicules belonging to various species of sponges, which *Haliphysema*, by some wonderful collective and selective power, gathers together, and, clever builder as it is, appropriates and uses either for the purpose of strengthening its test or as weapons of defence, inserting them, in the latter case, into the walls of its dwelling, like pins stuck into a pin-cushion. Next Mr. Carter entered into a minute description of the chambered character of the discoidal base, thus confirming Mr. Parfitt's observation, of which, however, he does not seem to have been aware. Mr. Carter expected to find pseudopodia issuing from the minute rounded orifice which is situated at the distal end and immersed among the brush of terminal appropriated spicules; but he did not succeed in detecting them. Arguing, however, chiefly from the pseudo-septate structure of the adherent bulb-disk, he gave it as his opinion that Bowerbank's so-called sponge was no sponge at all, but a Foraminifer, which he assigned to Schultze's genus *Squamulina*, and called *Squamulina scopula*.

In the next number of the 'Annals' Mr. Carter made a few observations upon *Haliphysema ramulosum*, a specimen of which he had examined in the British Museum†. These specimens were sent to the Museum by Prof. Oscar Schmidt, having been collected by Count Pourtales on the coast of Florida.

Four months later Mr. Carter was fortunate enough to meet with *H. ramulosum* (or, as he calls it, a "branched form of

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other, are found to have their surface bristling with numerous acuate spicula, some of which are subflecto-attenuate and incipiently spinous, while other spicula, used for defence and as skeleton-spicula, are large flecto-attenuate-acuate and smooth. The latter spicula are of great size as compared with the diameter of the tubuli. Tubuli apparently devoid both of oscula and of pores. The sarcode is blood-red. I know of no genus into which this Ceylon sponge can fall, and will propose for it the name *Aulospongus* (*αὐλός* and *σπόγγος*); and the species will become *Aulospongus tubulatus* (Bow.).

* Trans. Devon Assoc. Sci. Literat. and Art, p. 14 (separate copy).

† Ann. & Mag. Nat. Hist. ser. 4, vol. v. (1870) p. 389.

Squamulina scopula") at Budleigh-Salterton, and made the following observations :—" On cutting off the branched head with a pair of scissors across the main stem, and placing it in a watch-glass, the truncated end soon after threw out a bunch of obliquely branching and anastomosing filaments or pseudopodia, to the extent of a sixtieth of an inch long, all round, which continued retracting and extending themselves and exhibiting the granule-circulation, after the manner of the sarcode of the Foraminifera, for six hours, when the whole were gradually withdrawn and did not reappear. Thus the Foraminiferous character of *Squamulina scopula* and its branched variety is proved. I could not see any filaments projected from the head in any of the specimens; nor would it be easy to do so, as these probably entwine themselves about the spicules which are always raised up from the bottom of the water; but the truncated end of the stem lay on the watch-glass, over which it was easy to see the extended filaments with a one-inch compound power" *.

Mr. Carter has also met with what he regards as another form of the same genus at Budleigh-Salterton. To this he has given the name *Squamulina varians*. It consists of a little rounded dome, commonly semiglobular, but varying much in shape, attached by its flat side to the fucus or other object on which it grows, having a test composed of colourless grains of quartz and sponge-spicules incorporated in a chitinous substance, with a slight admixture of calcareous particles. The dome is furnished with an extended margin, projecting beyond the body of the test, and terminating in a thin edge, the basis of attachment of the organism being thus greater than the size of the dome itself. A single rounded aperture is situated either at the base or summit, or anywhere between the two, and this aperture is somewhat funnel-shaped, widening outwards. Size seldom exceeding 1-30th of an inch in diameter.

It is this *Squamulina varians* which comes nearest in general form to *Squamulina lævis*, Schultze; but, besides other differences, while the test of Carter's so-called *Squamulina* is arenaceous, that of the type of the genus is calcareous.

Squamulina varians is in general form very like the base of *H. Tumanowiczii* before the development of the column and clavate head; but unless it be the *immature* stage of that or of an allied species, it cannot take its position with them in *Haliphysema*.

But we have to consider the position of the type with refer-

* Ann. & Mag. Nat. Hist. vol. vi. (1870) p. 347.

ence to Mr. Carter's investigations. Even granted, for the sake of argument, that he has made out a strong case for the Foraminiferal, or, at any rate, Rhizopodal character of the animals constituting Bowerbank's genus *Haliphysema*, it appears to me that they have not the remotest claim to be included in Schultze's genus *Squamulina*. But on what principle has Mr. Carter changed the specific name and substituted *scopula* for the prior appellation given by Bowerbank, *Tumanowiczii*? There can be no justification for such a step. No one could possibly mistake the animal which was first described and figured; and the supposition that Dr. Bowerbank had assigned the dead tests of an obscure organism, which he had not observed in a living state, to a wrong class, is no justifiable reason for rejecting the specific name he gave. If errors in first description invalidated the names then assigned, where should we stop in changes of nomenclature? Confining criticism to the Protozoa, and not even there condescending to notice mistakes as regards single species or even genera, are all the Foraminifera to be renamed which were originally described as Mollusca? or the sponges which were regarded as plants? If Mr. Carter's mode of proceeding as regards *Haliphysema Tumanowiczii* is right, such wholesale alterations in nomenclature as I have hinted at would, on the same grounds, be allowable.

I was unable to regard the arguments which Mr. Carter adduced in favour of the Rhizopodal nature of these organisms as conclusive at the time when they were first published. The partitioned character of the base might perhaps be nothing more than a means of additional hold upon the body to which the test is attached, and of giving strength to the dome which supports the column. It is of importance, moreover, as bearing upon one of the arguments of Mr. Carter in favour of the foraminiferal nature of *Haliphysema*, to observe:—first, that he entirely failed to discover pseudopodial processes naturally extruded*; and, secondly, that though, on being cut in two, the injured parts did elongate themselves after the manner of pseudopodia, yet we have evidence that pseudopodial movements are quite consistent with sponge-structure. Haeckel, in speaking of what he calls the ectoderm, or animal germ-lamella of the young calcisponge, says that if torn mechani-

* Mr. Kent, in the 'Annals,' 1878, i. p. 14, speaks of Mr. Carter as "witnessing the protrusion of pseudopodia from the *terminal orifice* of the types in question." I am not aware that Mr. Carter has anywhere stated that he has witnessed such a protrusion; he only witnessed the extension of pseudopodium-like processes from the exuding syncytium which escaped from the pedicel of *H. ramulosum* when cut in two with a pair of scissors.

cally the fragments will take the form of *Amœba* and walk about, and that if the endodermal cells, which so closely resemble (if they be not actually) flagellate Infusoria, be liberated artificially they also will assume amœboid shape and motions. Mr. Kent, again, says that he has frequently observed "the withdrawal by the adult individual collar-bearing monad of the characteristic hyaline collar and the extension of pseudopodic processes," and is of opinion "that in a true sponge, agreeing in all structural details with the simple *Haliphysemata*, we should expect to find the sarcode or syncytial element protruded in such a fashion for the seizing of the fragmentary foreign particles out of which it builds up instead of secreting, as do ordinary sponges, a protective and supporting framework." Just so. The supposition of such protrusion is the only possible way of accounting for the wonderful building-feats of this creature. Where is the hand to be found to select, to grasp, to convey, and to arrange the spicula and sand-grains built into the walls, unless it be in the extension, flexibility, and retraction of extrusive portions of the sarcode or syncytium? Is such motion compatible with sponge-structure? and have we any thing like it in a universally acknowledged sponge which can serve as a precedent? The genus *Dysidea* or *Spongelia* affords an almost exact parallel, save that in that instance the extraneous material is taken into the interior of the organic parts instead of being built into their outer wall; or, in other words, it is used to form an internal skeleton instead of to furnish a dermal crust. The grains of sand which occupy the areno-fibrous structure of *Dysidea* must have been grasped, and placed in the position in which they are ultimately enclosed by the investing material, by a process similar to that employed in the case of *Haliphysema*; and sarcodic extension is the only grasping-instrument which we can conceive possible in animals presenting the organization of these genera.

I maintain, therefore, that the presence of pseudopodial action is not inconsistent with the position of *Haliphysema* among the sponges; and although such action has not yet been seen to take place from the body of the uninjured animal, we may pretty safely predict that it will hereafter be found to exist.

We now come to Prof. Haeckel's memoir, in which he has described and figured the presence of flagellate epithelium with its flagellate cells (*Geisselzellen*) as he calls them, or "collar-bearing monads" according to the views of those who differ from him. Presuming these observations to be substantiated, the theory that *Haliphysema* is a Foraminifer

of course falls to the ground. Haeckel's observations altogether appear to give the strongest confirmation to the opinion originally entertained by Dr. Bowerbank as to the position of this animal, though in the arrangement of genera it is very far removed from *Polymastia* on the one hand, and from *Euplectella* (= *Alcyoncellum*, Bow.) on the other, in juxtaposition with which its describer placed it. Taking Mr. Carter's to be the best classification as yet suggested for the Spongida, I should place the "*Physemaria*" of Haeckel as an order between Carter's Order II. *Ceratina* (=the horny-fibrous-skeleton sponges), and Order III. *Psammonemata* (=sponges having a skeleton composed of fibre in which sand is incorporated); and I would suggest as the name of such an order Psammoteichina (τεῖχος, a wall). The genera and species adopted by Haeckel will be noticed further on.

Mr. Kent's "Observations upon Prof. Haeckel's Group of the '*Physemaria*,' and on the Affinity of Sponges," published in the 'Annals' for last January, while it makes us anxious to see the full illustration of his views in the forthcoming memoir in the 'Linnean Transactions,' does not throw any special light upon *Haliphysema*, which he does not appear to have ever seen. His observations confirm those of Prof. H. James-Clark in every particular, carrying investigation further into those orders of the sponges in which Clark had not observed the presence of the "collar-bearing" monads. Prof. Clark found himself unable to do more than infer the position of the mouth, which he regarded as situated at the base, or close to the base, of the flagellum, to which place he believed that the particles of food were brought by the rotatory action of the flagellum. Mr. Kent assumes that the whole of the collar, "consisting of an exquisitely delicate film of sarcode, and exhibiting a circulating stream, ascending on the outside and descending on the inside," and "constituting a wonderful and most admirably constructed trap for the purpose of drawing towards it and arresting passing particles of food," "must necessarily be characterized as the oral or inceptive" organ. I would ask him to consider whether organs designed for the purpose of bringing food-particles within reach of the mouth are to be regarded as the mouth itself. The action of the collar performs, it would appear from his description, an office similar in function to that discharged by the cilia of the "wheels" of the Rotifera.

Lastly, we have the paper by Mereschkowsky upon *Wagnerella*, a highly interesting little sponge. But this animal, though in form assimilating closely to *Haliphysema*, apparently widely differs, since the spicules both of the stem and head are

the result of its own secretion, and not extraneous matter incorporated in the test. Attention may also be called to the fact that, whereas in *Haliphysema* the arrangement of the spicula in the pedicel is always parallel to the axis of the sponge, in *Wagnerella* the short acerates are uniformly arranged transversely to the axis.

II. *The Species of* Haliphysema *and its Allies.*

Order PSAMMOTEICHINA, Norman.

Genus Haliphysema, Bow.

= *Squamulina*, Carter (but not of Schultze).
= *Gastrophysema*, Haeckel.

The characters of Schultze's genus *Squamulina* are :—"Test like a plano-convex lens, with the flat side attached; calcareous; enclosing a simple undivided cavity ('eine einfache ungetheilte Höhlung umschliessend'); a large opening on the convex side; without small pores." Carter, in 1870, apparently had not Schultze's 'Ueber den Organismus der Polythalamien' at hand, and only knew that author's genus through Carpenter's 'Introduction.' It so happened that Carpenter omitted all reference to the "simple undivided cavity;" and thus Carter fell into the mistake of placing in *Squamulina* a form the foraminiferal nature of which he was attempting to establish on account of the *non-simple* and pseudo-septate character of the pedestal or plano-convex foot. Foraminifer or not, the pseudo-septate-based, arenaceous *Haliphysema Tumanowiczii*, with its great (great as compared with the plano-convex base) obversely conical column and body, has most certainly no near relation to the little scale-like, calcareous *Squamulina*, with its simple, little, dome-shaped undivided chamber. It is probable that Mr. Carter, with his present knowledge, would not now attempt to maintain that position; a much stronger argument might have been based on comparison with such a masonic foraminifer as *Lituola nautiloidea*, Lamk., which, commencing with a small spiral arrangement of cells, suddenly altering its growth, develops a straight series of chambers of great size as compared with those preceding.

Haeckel's views of nomenclature are peculiar to, and, it is to be hoped, always will remain peculiar to, himself. He appears to take pleasure in establishing spurious genera and subsequently demolishing them*. I am sorry to anticipate

* It is really much to be regretted that Haeckel, using the slightest modifications, or supposed possible modifications, of character, which no other naturalist has ever dreamt of regarding as of even varietal importance,

him with respect to *Gastrophysema*, and thus deprive him of the pleasure he experiences in the art of "happy despatch." I thoroughly indorse Mr. Kent's argument. I have several two-celled, and some three-celled, examples of true *Lagenæ* in my collection; are new genera to be created for them? A Greenland Nodosarian (*Dentalina pauperata*, Parker and Jones) has much more commonly one chamber only than two

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should manufacture, and often immediately afterwards proceed to destroy, innumerable genera and species. We already, without this sort of thing, have only too much useless synonymy. As an example of Haeckel's treatment of the calcareous sponges take our poor little friend *Grantia compressa*, a species which, until the advent of the Professor of Zoology at Jena, we all thought we knew. Behold the atlas which Haeckel has laid upon this miserable little creature's shoulders to bear—1. *Sycarium compressum*, 2. *Artynas compressus*, 3. *Sycidium compressum*, 4. *Artynium compressum*, 5. *Sycocystis compressa*, 6. *Artynella compressa*, 7. *Sycophyllum compressum*, 8. *Artynophyllum compressum*, 9. *Sycometra compressa*, 10. *Sycum lingua*, 11. *Sycarium rhopalodes*, 12. *Artynas rhopalodes*, 13. *Artynella rhopalodes*, 14. *Dyssycum clavigerum*, 15. *Sycophyllum lobatum*, 16. *Sycurus compressus*, 17. *Syconella compressa*, 18. *Sycothamnus compressus*, 19. *Sycinula compressa*, 20. *Sycodendron compressum*, 21. *Sycandra foliacea*, 22. *Sycandra pennigera*, 23. *Sycandra clavigera*, 24. *Sycandra rhopalodes*, 25. *Sycandra lobata*, 26. *Sycandra polymorpha*, 27. *Sycortis compressa*! The first fifteen of these names were established in the 'Prodromus eines Systems der Kalkschwämme;' but in his 'Die Kalkschwämme' he knocked upon the head eleven out of the fifteen generic names just before coined, but immediately proceeded to construct twelve more names to take their place. This done, he again bowls his nine-pins over, and leaves us with a twenty-eight-synonymed *Sycandra compressa*, which he would have us accept as the mother of all his still-born children. I am sorry that we cannot even oblige him in that. *Grantia compressa* is the name under which our old lady was baptized; and that name has been, is, and will be the honoured name she loves to own; but if she changes her name at all, it must be to that of *Artynes*, of Gray, of which she is the type. But the Professor has not even yet done. At page 381 he favours us with "Zweite Abtheilung. Künstliches System der Kalkschwämme." "Künstliches" indeed! Here we find I know not how many subgenera formed for the "generic varieties;" and the much-enduring *Grantia compressa* is made to undergo the further torture of having its *disjecta membra* thrown, in the form of six "subspecies," into each of the nine following new and euphonious "subgenera"—*Sycurandra*, *Syconellandra*, *Sycandrarium*, *Sycocystandra*, *Sycothamnella*, *Sycinulandra*, *Sycodenandrum*, *Sycandrophyllum*, *Sycandrometra*. The magician waves his wand: "Behold! *Grantia compressa* might be, can be, *is* divided into fifty-four (6×9) subspecies; and then do not forget my 'connexive Varietat,' which makes fifty-five. It is done! Veni, vidi, vici!!" We gladly leave with him the victory; but surely a man of Prof. Haeckel's genius might more worthily employ his time. Had his demonstration been that fifty-five forms which had been named and placed by other naturalists as so many species in twenty-seven genera, were nothing more than the unstable modifications of one type, and, as possessing no constant character, must be brought together in one so-called species, a benefit would have been conferred upon science.

or more; must a genus be created for this, to separate it from species which often have twenty and more chambers? Lists of such comparisons might be multiplied to any extent. *Gastrophysema* is simply *Haliphysema* more fully developed.

Haliphysema Tumanowiczii, Bow.

1862. *Halyphysema Tumanowiczii*, Bowerbank, Philos. Trans. p. 1105, pl. lxxiii. fig. 3; Monog. Brit. Sponges, vol. i. (1864) p. 179, pl. xxx. fig. 359, vol. ii. p. 76.
1866. *Halyphysema Tumunowiczii*, O. Schmidt, Zweites Supplem. d. Spong. d. Adriatischen Meeres, p. 13, plate, fig. 13 (copy from Bowerbank).
1868. *Halyphysema Tumanowiczii*, Parfitt, Trans. Devon Assoc. Sci. Literat. and Art, p. 14 (separate copy).
1870. *Squamulina scopula*, Carter, Ann. & Mag. Nat. Hist. ser. 4, vol. v. p. 310, pl. iv. figs. 1–11, and vol. xx. (1877) p. 337.
1877. *Haliphysema primordiale*, Haeckel, Biologische Studien, p. 180, pl. ix.
1877. *Haliphysema Tumanowiczii*, Haeckel, *l. c.* p. 192.
1877. *Gastrophysema dithalamium*, Haeckel, *l. c.* p. 196, pls. xii.–xiv.
1877. *Gastrophysema scopula*, Haeckel, *l. c.* p. 206.

Hab. Hastings (*Mr. Tumanowicz*), Berwick Bay (*Dr. Johnston*), Cullercoats (?) (*Alder*), Budleigh-Salterton (*Carter*); Bergen, Norway (*Haeckel*); "*H. primordiale*," Mediterranean, Corsica (*Haeckel*); "*G. dithalamium*," Mediterranean, Smyrna (*Haeckel*).

Mr. Carter found this species at Budleigh-Salterton, and, though he renamed it, at the same time identified it with Bowerbank's type species of *Haliphysema*. Haeckel, however, denies that Carter had ever seen Bowerbank's species. Mr. Carter has replied that he has *now* had the opportunity of comparing his own specimens side by side with those of Dr. Bowerbank, and that they are identical. This last statement I am in a position to entirely indorse. In my collection are some of Mr. Tumanowicz's type specimens on *Halecium Beanii*, which were given to me by Dr. Bowerbank, and also type specimens of *Squamulina scopula*, for which I am indebted to Mr. Carter. They are *absolutely identical*. I have not seen any specimens with the constrictions so deep and strongly marked as Carter's pl. iv. fig. 2; but the largest of Mr. Tumanowicz's examples closely resembles his chief figure (3), while the youngest resemble the typical figures of *Tumanowiczii*, and *primordiale* and those of intermediate age, *dithalamium*; at the same time monothalamous specimens often exceed in size the dithalamous. They range from 1 to 2 millims. in length.

Haeckel's characters for his so-called species are:—

H. primordiale. "Body of person spindle-shaped, attached

by a short thick pedicel. Pedicel solid, cylindrical, scarcely half as long as body. Body-cavity spindle-shaped. Mouth-opening simple. The extraneous bodies which incrust the exoderm consisting on the lower (aboral) half chiefly of sand-grains, on the upper (oral) half by preference of spicules of different sponges, both siliceous and calcareous, spicules arranged oralwards."

G. dithalamium. "Body of person, taken as a whole, long and club-shaped, divided by a median constriction into two chambers lying one over the other; attached by means of a short cylindrical pedicel. Pedicel placed upon a disk-shaped widening base. At the opposite (upper) end a simple, circular mouth-opening. The uppermost (distal or oral) chamber elliptical or egg-shaped, one third larger each way than the under round chamber. Pedicel and foot-disk solid. The cavities of the chambers joined by a narrow neck (sipho). In the aboral chamber (*Bruthöhle*) the ova are developed. A ciliated spiral is found in the oral chamber near the mouth-opening. Extraneous bodies which incrust the exoderm composed on the under half, for the most part, of sand-grains and fragments of spicula; on the upper half (in the wall of the second or largest chamber), of long spicula of different species of sponges; these stand out on all sides, and have their points directed forwards."

I cannot think that the fact of the pedicel in the forms described by Haeckel being characterized as solid, while in those examined by Carter it is hollow, is of any consequence. Carter's observations were quite correct as regards dead specimens; but he himself, in cutting a living *H. ramulosum* across the pedicel, observed the escape of the sarcode or syncytium with which it was filled; and I take it that all that Haeckel means, and all that he figures, is that the pedicel is filled with such syncytium, whereas the chambers have a hollow cavity. In drying, the syncytium, shrinking up against the pseudo-skeleton of the surrounding wall, leaves the pedicel, as observed by Carter, hollow; and the cavity of the body will, in that condition, extend from the mouth-opening to the plano-convex disk of attachment.

I have given Haeckel's characters of *primordiale* and *dithalamium*, which will speak for themselves. Without further evidence these scarcely appear to be of specific or even varietal importance.

2. *Haliphysema ramulosum*, Bow.

1866. *Halyphysema ramulosa*, Bowerbank, Monog. Brit. Sponges, vol. ii. p. 79, and vol. iii. (1874) pl. xiii. fig. 1.

1870. *Halyphysema ramulosa*, Carter, Ann. & Mag. Nat. Hist. ser. 4, vol. v. p. 389. *Squamulina scopula*, var. *ramulosa*, id. ibid. vol. vi. p. 345.
1877. *Haliphysema ramulosum*, Haeckel, Biologische Studien, p. 193.

Hab. Dredged off Guernsey on *Gorgonia verrucosa*, and in Birterbuy Bay, Ireland, on *Phyllophora rubens* (*A. M. N.*); among sponges and on rocks between tide-marks, Budleigh-Salterton, Devon (*Carter*); off the coast of Florida, U. S., dredged by Pourtales, *fide* Schmidt (*Carter*).

I regard this as entirely distinct from *H. Tumanowiczii*; indeed the differences are so important that it is probable they will hereafter be regarded as generic.

In *H. Tumanowiczii*, with the development of the animal, a series of incompletely separated chambers is formed by greater or less *transverse* constrictions of the test.

In *H. ramulosum*, with the development of the animal, a series of completely separated chambers is formed by *longitudinal* fission and entire partition of the last-formed chamber; and this process, continually repeated, issues in the building up of a colony consisting of a many-branched head surmounting a long pedicel, the branches dichotomously divided with great regularity, and each terminating in a rather small rounded chamber.

A single head of either, however, may be distinguished at a glance, apart from the mode of growth; or they may again be separated in the early stages when only a single chamber is developed, since in *H. Tumanowiczii* that chamber is more or less elongate-ovate, and has the points of its garnishing spicula all directed forwards; but in *H. ramulosum* it is round or subrotund, and has its garnishing spicula radiating in every direction.

In 1874 I procured in Birterbuy Bay a piece of *Phyllophora rubens* covered with the young of this species in their early unbranched condition with only a single head; from their young state they were very fragile, and the greater number in drying separated from their bases. But the *Phyllophora* was sent for Dr. Bowerbank to see; and among his unpublished manuscript I find the following note:—"Among the specimens I received from the Rev. A. M. Norman for examination there was a portion of a thin foliaceous *Fucus*, rather exceeding two inches in length and three in width, both surfaces of which were nearly covered by small patches of various species of *Lepralia*, small shells, and other parasites; and amid these, based on the *Fucus*, there were numerous young specimens of *Halyphysema ramulosa*. They consisted of single tubes of the sponge, very rarely exhibiting

any rudiment of terminal branches, each springing from a small circular basal patch. Although in so young a condition, they were identical in structure with the type specimen represented in pl. xiii. fig. 1, vol. iii., Mon. Brit. Spongiadæ." I quote this as confirming my own opinion respecting the unbranched young of *H. ramulosum*.

On the other hand, the largest specimen I have seen is one for which I am indebted to Mr. Carter, who found it at Budleigh-Salterton. It is 7 millims. high, of which 5 millims. is occupied by the slender unbranched stem, nearly another millim. is taken up by the first fork; and in the last millim. of length the branches divide and subdivide, extending themselves in all directions, and terminating ultimately in sixteen branchlets with their terminal heads.

3. *Haliphysema echinoides*, Haeckel.

1877. *Haliphysema echinoides*, Haeckel, Biologische Studien, p. 186, pl. x.

"Body of person round or subspherical, attached by a long and slender pedicel. Pedicel cylindrical, conically widened above, solid, 2–3 times as long, but scarcely $\frac{1}{6}$ as wide as the diameter of the ball. Body-cavity round or subconical. Mouth-opening widening into a somewhat funnel-shaped form. Extraneous bodies, which incrust the exoderm of the pedicel, consisting of sand-grains and longitudinally arranged sponge-spicules; extraneous material of the ball-shaped body consisting of spicules of various sponges, which stand out on all sides, chiefly, however, radiating from and covering the middle of the body" (*Haeckel*).

There is but little in the above description to distinguish this from the last-described species, to the young unbranched stage of which it bears a very close resemblance. I, however, keep it apart, because the ball is represented as much larger in proportion to the pedicel than I have ever seen it to be in *H. ramulosum*; and the character of the spicules employed seems to show that it is a deep-sea species, whereas *H. ramulosum* lives in shallow water. When Haeckel's species is better known, it may prove to be more distinct than it now appears. Moreover the large size of the ball, as compared with the axial column, will be seen to present difficulties in the way of the longitudinal fission of the heads and their conversion into branches, which I regard as so important a feature in the evolution of the colony of *H. ramulosum*.

Hab. Atlantic Ocean (*Koren* fide *Haeckel*).

It is surprising that Haeckel should have thought that there was any relation between the animal he described as

above and *Wyvilletomsonia Wallichii*, P. Wright. The apparent resemblance is a mere matter of isomorphism. Any spongologist looking at Stewart's beautiful figure illustrating Wright's paper will at once see that he has a sponge before him, that the spicula are in natural position in the tissues, and the whole spicules are those of *Tisiphonia agariciformis*, Wyv. Thomson, of which I agree with Mr. Carter in considering Wright's little sponge to be the young stage. The aspect of *H. echinoides* is wholly different; the spicules are stuck into the tissues as adornments or objects of defence, and clearly have just as much connexion with the animal that wears them as the upstanding feathers of the head-dress of a Red Indian have with the man who puts them on. It is true that *H. echinoides* has appropriated, for the most part, the spicula of *Wyvilletomsonia* or of some closely allied corticate sponge; but mixed with these are the spheroids of a *Geodia*, together with some recurvo-ternates, which, from the robust character of their prongs, also seem referable to the latter genus.

4. *Haliphysema globigerina*, Haeckel.

1877. *Haliphysema globigerina*, Haeckel, Biologische Studien, p. 189, pl. xi.

"Body of person pear-shaped, attached by a very slender and long pedicel. Pedicel solid, cylindrical, conically widened above, about 4–6 times as long, but scarcely one tenth as wide as body. Body-cavity pear-shaped. Mouth-opening simple. Extraneous bodies, which incrust the exoderm, composed of the elements of deep-sea mud, consisting in the body-wall chiefly of Rhizopod shells, in the pedicel chiefly of coccoliths and coccospheres."

Hab. "North Atlantic Ocean (*Randropp*)" (*Haeckel*).

The above species differs entirely from the rest in its selection of shells of Foraminifera, Polycystina, Coccoliths, and Coccospheres as the strengthening material of its body-wall, which exhibits, on the other hand, a total absence of sponge-spicules.

I am strongly reminded by this species of an approaching isomorph found in deep water in the Atlantic, and which Mr. H. B. Brady proposes to describe under the name "*Hyperammina*," on account of its pestle-like form. There can, however, I think, be no doubt that *Hyperammina* is a foraminifer. The expanded extremity has no mouth-opening; and the colour of the walls, which consist entirely of sand-grains, is, as in many other arenaceous Foraminifera, ferruginous.

5. *Haliphysema confertum*, n. sp. (Pl. XVI. figs. 1, 2.)

Animal consisting of a bunch of "persons" attached together by their bases, and forming nearly a complete ball. Body of person nearly spherical, attached by a long slender pedicel. Pedicel 3–4 times as long, and not more than one fourth as broad, as the body. Mouth-opening very large. Extraneous bodies, which incrust the animal, consisting, on the pedicel, of sand-grains and other very minute bodies; on the body, of sand-grains and Foraminifera.

Diameter of a cluster, containing forty or fifty "persons," about one millim.; length of a "person" about one third of a millim.

Hab. 'Valorous' Expedition, 1875, Station No. 9, lat. 59° 10′ N., long. 50° 25′ W., 1750 fathoms. The position of this dredging is just within Davis Strait.

Two clusters of the above organism were found; the one had all the bodies broken off, and consisted of a nearly globular aggregation of the pedicels; the other had several of the bodies still remaining. It is not without doubt that I place this organism in the genus *Haliphysema*, because the extraneous material is not apparently completely built into the substance of the body-wall, but appears rather as though clinging to a viscid substance which holds it. The fact, however, that in the pedicels the extraneous bodies are all of very minute size, whereas on the exterior of the round body-cavity an occasional minute *Globigerina* is found to have a place, seems to argue a selection on the part of the animal; and I know of know other order to which these animals can be referred.

III. *On two new Genera perhaps allied to* Haliphysema.

Genus Technitella, n. g.

(τεχνίτης, an artificer.)

Test elliptical, cylindrical, or subfusiform, composed of the broken fragments of sponge-spicula arranged parallel to the axis and enclosed entirely, or rarely only partially, in the body-wall. Unattached below and closed. A tubular mouth-opening formed by a contraction for a short distance of the body-walls so as to form a short tube.

Technitella legumen, n. sp. (Pl. XVI. figs. 3, 4.)

The form of the test in this animal reminds one somewhat of the outline of the pod of the edible pea, being cylindrical throughout the greater part of its length, with the aboral

extremity slightly extruded, and that rather out of the central line, as is the distal point (style) of the pea-pod, while the mouth-opening is in the form of a contracted tube, representing about the same proportional length and width to the cylinder as the basal portion of the pea-pod, where it passes into the calyx, does to the pod itself.

The body-wall of *Technitella* is an exquisite specimen of perfect masonry: it is beautifully built up of the fragments of minute acerate spicula, laid in regular order side by side, and cemented with a mortar composed probably of the finest dust of quartz, so that the whole test is of exquisite snowy whiteness, corresponding in this respect to that of *H. Tumanowiczii*. Length 1·25 millim.

Hab. Found among rich foraminiferous sand dredged by Dr. Jeffreys's yacht 'The Osprey,' in 112 fathoms, 30 miles west of Valentia, Ireland, in 1870.

Technitella melo, n. sp. (Pl. XVI. figs. 5, 6.)

Test regularly ovoid, broadly and evenly rounded below (aborally); greatest diameter below the middle; above the middle sloped away to the central anterior (oral) opening. Oral opening not markedly extruded or tubular as in the last species, but compressed, so that the opening is in the form of a slit; this slit in the type is wider at the sides than in its central portion. The test is formed of minute linear sponge-spicules, built carefully into the wall, and the interstices filled with the same sort of snow-white cement as in the last species. Instead, however, of the whole of the spicula being entirely built into the body-wall as is the case in *Technitella legumen*, in this species the aboral portion is garnished with scattered acerate projecting spicula, the pointed ends of which are protruded considerably from the body-wall, and are invariably directed backwards. Length 1·4 millim., breadth 1 millim.

Hab. Found among material dredged about 60 miles south of Rockal, by the 'Porcupine' Expedition, in 1869. Station No. 28, lat. 56° 44′ N., long. 12° 52′ W., 1215 fathoms.

The form of this little animal is just that of such a *Lagena* as *L. melo*, D'Orb.; and its aspect under a high power, with its imbedded and here and there projecting little spicula, reminded me forcibly of the appearance of a cocoa-nut when the outer husk is stripped off.

The type was picked out from the 'Porcupine' material by Mr. H. B. Brady, and sent to me marked "sponge?" There is no higher authority among the Foraminifera than Mr. Brady; and it is important therefore, as bearing upon the position which I have provisionally assigned to this genus, that

he has rejected it from among the Foraminifera, on the description of which he was engaged.

Genus Marsipella, n. g.

(μάρσιπος, a purse.)

Test elongated, fusiform, centrally cylindrical, and drawn out to gradually attenuated extremities, open at both ends, monothalamous; anterior extremity much produced into a narrow contracted mouth-opening. Extraneous matter of body-wall consisting for the most part of sand-grains, but at the oral extremity composed almost solely of fragments of sponge-spicula longitudinally arranged.

Marsipella elongata, n. sp. (Pl. XVI. fig. 7.)

1875. *Proteonina* ——, Carpenter, The Microscope, p. 533, woodcut, *d*, *e*, *f*.

Test greatly elongated, the diameter equal to one seventh to one twelfth of length, gradually drawn out to the extremities, and nearly equally so orally and aborally. Oral extremity in the form of an elongated narrow mouth-opening. Test built up of coarse sand-grains roughly put together, interspersed here and there with a sponge-spicule. Tubular mouth-opening having its wall entirely formed by a faggot of acerate sponge-spicula longitudinally disposed and cemented together. Length 4–5 millims.

Hab. 'Porcupine' Expedition, 1869, No. 87, lat. 59° 35′ N., long. 9° 11′ W., 767 fathoms.

Dr. Carpenter has referred the foregoing to the genus *Proteonina* of Williamson; but that genus appears to have been founded upon imperfect specimens of *Lituola nautiloidea*, Lamk., and its connexion with the present species cannot be maintained.

I have introduced the descriptions of the genera *Technitella* and *Marsipella*—not that I am at all satisfied that their organization will ultimately prove such as to cause them to be left in juxtaposition with *Haliphysema*, but because they appear to me to be *genera incertæ sedis*, to which it appears desirable to call attention in connexion with *Haliphysema*. From this genus it will be obvious that they are at once to be distinguished by their free and unattached character; but there is much in the form of their body-cavity, as well as in the structure of their masonic walls and the peculiar way in which the incorporation of the sponge-spicules takes place, which suggests possible relationship. The snowy whiteness of the test of *Technitella* is, as far as I am aware, without

parallel among the arenaceous Foraminifera, while it is eminently characteristic of *Haliphysema*. *Marsipella* is described as unattached and open on the aboral extremity; for such is the condition of the specimens which I have seen; but it is possible that when living it may be attached by the base, since, if this were the case, it is hardly likely that such a little organism would maintain its attachment after the rough treatment of being dredged and drawn up through two miles of water.

Though these two forms appear to have so much in common with *Haliphysema* as regards external features, yet the deep Atlantic dredgings of the 'Porcupine' and 'Valorous' have brought to light such a remarkable assemblage of arenaceous Foraminifera, most of which are still undescribed, that it appears impossible to say where the line of demarcation is to be drawn between *Technitella* and *Marsipella* and such genera as *Trochammina* and *Lituola*. Future investigation can alone settle this point. Meanwhile I describe them here as appearing to me more nearly related to *Haliphysema*, though still I leave them as *genera incertæ sedis*.

Postscript.

The foregoing paper was sent to the Editors of the 'Annals' at the end of January. Mr. Carter's notes in the February number call for one or two additional observations.

Mr. Carter makes the following remarkable declaration:—"Whether there be collared flagellated monadic bodies in *Squamulina scopula* or not, the polythalamous character, so appropriately given by the illustrious Ehrenberg to what we now call Foraminifera, decides the question with those who are well acquainted with the structure of the latter as well as that of the Spongida. No sponge, that I know of, presents the polythalamous character of *Squamulina scopula*, in its foot (root) or anywhere else."

I must decline to acquiesce in such a statement.

First. Because I deny that there is any "polythalamous" character in the base of *Haliphysema*; and I believe that this is the first time that Mr. Carter has made such a statement. He has before always correctly spoken of this dome-shaped base of attachment as internally "*partially* divided," "*pseudo*-septal," "*sub*-polythalamous." There really is but a single chamber, with recesses at the sides formed by the 5–7 radii, which, originating at the margin, stretch thence "toward the centre, which they seldom, if ever, reach." To compare great things with small, the single-chambered dome of the Reading-

Room of the British Museum with its radiating desks (supposing them carried up to the roof) will be analogous to what we have in the dome-shaped base of *Haliphysema*, while the long series of Libraries connected with each other only by doors represents the typical polythalamous character of the Foraminifera.

Secondly. Are we really to understand Mr. Carter to mean that if his own examination of living *Haliphysema* should confirm Haeckel's discovery of the existence of "collared, flagellated monadic bodies," or, as Carter has elsewhere named them, "spongozoa," he will still maintain that the organism furnished with these *spongozoa* is a Foraminifer? All I can say is that I should await with interest the arguments by which he would maintain such a view.

Further on Mr. Carter states that Schmidt (Archiv f. mikroskop. Anat. Bd. xiv. p. 260) has referred *Haliphysema echinoides*, Haeckel, to the genus *Stelletta*. I have not seen this paper of Schmidt. It is hardly conceivable that that eminent spongologist can have come to such a conclusion from the examination of Haeckel's figure and description; for if tab. x. represents accurately the type *, it appears to me as impossible to suppose that the spicules drawn belong to the sponge and are in natural position, as it is to suppose (as Haeckel wrongly imagined) that the spicula in Perceval Wright's admirable illustration of *Wyvilletomsonia* are not in their natural position †. It may be that Schmidt has examined the type specimen, that the drawing is wrong, and that on this ground he asserts that Haeckel's species is a *Stelletta*. If that be so, *cadat quæstio*.

Lastly, I do not understand what Mr. Carter means when, in reference to the form of the dome-shaped base of *Haliphysema*, he contrasts with it the "embryo of the Spongida," which "grows up into branches from a *root*." Barrois ‡ has represented the early canal-system (pl. xv. fig. 35) in the young of *Halisarca lobularis*, Schmidt, just passing from the

* Unfortunately we are never sure when looking at Haeckel's beautiful plates whether we have before us what the draftsman actually saw, or whether the figure is a representation of what he thought he ought to see, and which his theorizing led him to the conclusion should be seen.

† I have many specimens of *Wyvilletomsonia Wallichii*, P. Wright (= *Tisiphonia agariciformis*, Wyv.-Tom., = *Dorvillia agariciformis*, Kent), as small as that represented in the type, and one specimen not one fourth of that size; and it is from the examination of these specimens that I state positively that Wright and Carter have correctly regarded it as a corticate sponge.

‡ Barrois (C.), "Mémoire sur l'Embryologie de quelques Eponges de la Manche," Annales des Sci. Natur. vi^e sér. Zoologie, tom. iii. 1876.

embryo stage; and the form of that incipient canal-system is remarkably like the chamber left in the semiseptate dome at the base of *Haliphysema*. I may add, when referring to Barrois, that at pl. xiii. fig. 15 he gives a capital illustration of pseudopodial action in the young of *Grantia compressa*—an additional witness to what I have stated in the earlier part of this paper, that the protrusion of pseudopodial processes in *Haliphysema* is no proof whatever that it is not a sponge.

EXPLANATION OF PLATE XVI.

Fig. 1. *Haliphysema confertum*, Norman, × 40.
Fig. 2. *Haliphysema confertum*, Norman, a single individual separated from the group, × 150.
Fig. 3. *Technitella legumen*, Norman, × 40.
Fig. 4. *Technitella legumen*, Norman, anterior portion, × 40.
Fig. 5. *Technitella melo*, Norman, × 100.
Fig. 6. *Technitella melo*, Norman, posterior portion, × 40.
Fig. 7. *Marsipella elongata*, Norman, × 100.

XXXI.—*On the Architectural Achievements of little Masons, Annelidan* (?) *and Rhizopodan, in the Abyss of the Atlantic.* By the Rev. A. M. Norman, M.A.

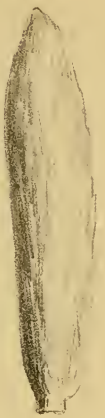
No group of Invertebrata has received more important additions through the recent dredgings in the North Atlantic than the Arenaceous Foraminifera. The mode of incorporation of extraneous material in the tests of these and of other Rhizopoda, and also in the tubes of what are presumed to be cases of minute Annelids, is not only marvellously beautiful, but appears also to be almost endlessly diversified. The power of selection evidenced is truly wonderful: from the same ground, and therefore from the midst of the same material for use, I have seen as many as seventeen different species, each of which has a specific individuality of its own in the choice and mode of appropriation of the particles, whether of mineral or organic origin, which it selects from the mud—and this wholly apart from characters which depend on the form of the one or more chambers which constitute the animal or tube. To exemplify my meaning I will throw the classes of diversity into tabular form, so as to give some slight idea of the varied ways in which these clever little artificers set about their work and construct their dwellings.

A. *Material chosen by the Artificers.*

1. Coarse sand-grains, almost entirely of quartz.
2. Medium-sized quartz-grains.


3.


6.


4.


5.


2.


7.


1.

W. Purkiss del

Mintern Bros imp