XXXI.—*On the Ultimate Structure of Marine Sponges.* By H. J. Carter, F.R.S. &c.

The "ultimate structure" of the marine is, *mutatis mutandis*, the same as the "ultimate structure" of the freshwater Sponges.

In July 1857 I described and illustrated the "Ultimate Structure of *Spongilla*," (Annals, vol. xx. p. 21, pl. 1). In January 1859 I expressed doubt as to the position of the cilia in the "ampullaceous sac," and my conviction that they were external instead of internal, contrary to my first statement (*ib.* vol. iii. p. 12). In October 1861 I again returned to my original view, viz. that the cilia were inside (*ib.* vol. viii. p. 290).

This discrepancy I can now adjust; for, the cilium of the sponge-cell being retractile and the sponge-cell itself amœboid and free to change its position *in situ*, the cilia may at one time be put forth outside, and at another inside the ampullaceous sac, the latter probably being their normal position.

Now what is this "ampullaceous sac"? for although it is twelve years since my description of it was published (viz. 1857), no one, to my knowledge, has referred to it but Professor H. James-Clark, of Boston, in June 1866 (Mem. Boston Soc. Nat. Hist. vol. i. pt. 3, p. 1, 1867), a fact which may be excusable to those who have been brought up in a language different from that in which it was published.

"Ampullaceous sac" is the term which I applied to certain groups of unciliated and monociliated sponge-cells or monad-like bodies which are tessellated together in a globular form, and scattered plentifully here and there throughout the sponge so as to make up the greater part of its bulk. The globular form presents a circular opening or transparent area through which the cilia may be observed to play internally; and when the young *Spongilla* is grown from the seed-like body, and a solution of carmine is put into the water around it, these globular bodies *alone* become coloured; that is to say, they alone take in the carmine; and thus their globular form becomes clearly defined and differentiated from the rest of the mass.

Hence the little globular bodies are clearly the animal expression of the sponge in particular, as they are respectively the only mouths and stomachs of the sponge—in short, the nutritive apparatus, all the rest being subsidiary.

When the *Spongilla* thus fed with carmine is torn to pieces, the monad-like bodies (which we shall henceforth call "sponge-cells") of which the ampullaceous sac is composed are found to have taken in the carmine, while the absence of the cilium in some, and not in others, may be explained, as just stated, by its being retractile.

Further, it was observed that after a time those portions of the carmine which were unappropriated to nourishment were rejected, and, as they fell into the adjoining canal of the excretory system, were thus voided. But whether they passed into the excretory canal through the circular opening or transparent area in the ampullaceous sac, or through another opening in it unseen, or directly through the substance of the body of the sponge-cell, *Amœba*-like, into the excretory canal, I could not determine.

The particles of carmine could be seen to pass in through the holes of the veil or sarcodal investing layer of the *Spongilla*, and thence into the bodies of the sponge-cells; but whether through the circular opening of the ampullaceous sac mentioned or by impinging upon the sponge-cells direct on the external side of the ampullaceous sac, or both alternately, according to circumstances, I also could not determine. All that I can assert is that the particles of carmine did pass into the sponge-cells, and that the undigested parts passed into the neighbouring excretory canal, about the branches of which the ampullaceous sacs are hung like grapes on a grape-stem, and so ultimately out at the single vent (for there is but one at this period), as represented in the illustrations to which I have alluded. I could follow them to the sponge-cell and see them immediately after they fell into the excretory canal; but their intermediate course I failed to observe.

So far, then, it was evident that the ampullaceous sac is the expression of the alimentary apparatus.

To conceive that the nourishing portions of the food, after having been resolved into chime in these sponge-cells, subsequently passed, by endosmosis, into the general mass to become assimilated, is only to assume a fact common to all living structures, a fact which is as certain by assumption as the ejection of excrement is open to ocular demonstration.

Thus the normal course in *Spongilla* is for the particles of food to be received through one channel and its undigested portions to be ejected by another. Where the opposite takes place, it is an exception to the rule, or abnormal.

When the young *Spongilla* became replete with carmine, it closed the pores of the investing membrane and the single osculum of the excurrent system of canals; but after a certain time all were again opened, and then the carmine, which during the interval still remained in the sponge-cells (*not in the excretory canals*), began to be separated from its nutritive portion and its particles to fall from the sponge-cells into the excretory canals and so be voided.

Perversions of the currents do take place occasionally under certain circumstances. Thus Dr. Bowerbank, in his "Report on the Vital Powers of the Spongiadæ," published in the Report of the British Association for the Advancement of Science for 1856, alludes to an occurrence of this kind, on which he observes:—"(June 9.) The reversal of the action in the osculum in this instance was apparently effected by the vigour of the action in the *other* group of oscula, the whole of these organs being more or less connected." The italics are mine.

On the other hand, Häckel ("On the Organization of Sponges and their Relationship to the Corals," translated in the Annals, vol. v. p. 1, January 1870) observes at p. 9:—"I (with Miklucho) designate the largest cavity into which the canal-system is dilated in the sponge-body, and which is usually called the excurrent tube or flue (*caminus*), as the stomach, or digestive cavity, and its outer orifice, which is usually called the excurrent orifice or osculum, as the buccal orifice or mouth."

Marine Sponges.

The chief part of what I have described in *Spongilla* I have been able to identify in the "ultimate structure" of the marine sponges, both calcareous and siliceous,—that is to say, the presence and persistence of the ampullaceous sac, which may always be recognized, entire or fragmentary, as the case may be, in a more or less globular group of spherical monociliated sponge-cells in the living state—and in the dried or wet preserved state (here of course without the cilium), innumerably scattered throughout the mass, and thus presenting the points at which the nourishing-apparatus is situated, just as certainly as if this had been proved by the testing process of carmine practised in *Spongilla*.

Were it as easy to keep the marine sponges alive as the freshwater sponges, no doubt their growth in a watch-glass, feeding with carmine &c., and the consequent phenomena might also be as easily observed; but the recognition of the existence of the ampullaceous sac, as all the rest has been witnessed in *Spongilla*, is sufficient. The only wonder to me is that what I have stated of *Spongilla* has not been identified by others; it is so easy to grow this sponge in watch-glasses from the seed-like bodies.

Siliceous Sponges.

I first noticed more particularly the ampullaceous sac in the marine sponges in December last, viz. in *Halichondria simu-*

lans, Johnston (*Isodictya simulans*, Bowerbank), which, with the exception of *Halichondria panicea*, Johnston, is the commonest sponge in this locality (Budleigh-Salterton, Devon). It has been figured by Schmidt in *Reniera*=*Isodictya*, viz. in *R. aquæductus*, Sdt., and *R. semitubulosa*, Sdt., in the Histiological Supplement to his 'Sponges of the Adriatic Sea' (Taf. 1. figs. 17 and 18 respectively, 1864), under the name of "Wimperkorb."

The smaller the specimen is, provided it be entire, the better, because it lives longer than the large portions, which require so much more water and the water to be so often changed that, although this be done daily, they soon die and get putrid. Besides, a small portion can be kept in a watch-glass and thus easily brought under a high power of the microscope for observation, which with a large portion is almost an impossibility.

That which I selected was about a quarter of an inch in diameter; and when torn to pieces for microscopical examination (which must always be conducted in fresh sea-water to keep the cilia moving and alive), the ampullaceous sacs were observed to be about 1-750th of an inch in diameter, and the sponge-cells of which they were composed about 1-8000th of an inch in diameter. The ampullaceous sac was also seen *in situ* among the meshes of the spicular structure, and there also to be of the same size.

On a subsequent occasion I found a *pink* portion of the same sponge, which appeared to have obtained its colour from growing in contact with a species of *Rhodymenia*; and on tearing this to pieces I observed that the pink colour was confined to the ampullaceous sacs—that is, to the sponge-cells composing them. Hence I inferred that the sponge had been feeding on the fronds of the *Rhodymenia*, which sponges will do, just as fungi enclose and feed upon leaves and wood.

As regards the colouring-matter of sponges generally, I think it will be found to be chiefly confined to the granular contents of the sponge-cells composing the ampullaceous sac.

Thus, in *Spongilla*, when any part of this sponge presents a green colour, it appears to be confined to the granules of the sponge-cells of this sac,—that is, if the colour be in the sponge itself and not owing to the presence of a foreign agent. In the scarlet sponges, to wit, *Microciona atrosanguinea*, Bowerbank (*Scopalina*, Schdt.), it is confined to the ampullaceous sac and the still more scarlet gemmule which I have reason to think is but a transformation of this sac. Lastly, in a soot-black sponge (*Dercitus* (G.) *niger*, mihi) belonging to the Tethyad family of Dr. J. E. Gray ("Notes on the Arrangement of Sponges," Proc. Zool. Soc. Lond. May 9, 1867, p. 542), which appears to me to be undescribed, and which I have just found on the rocks here, the black colour is owing to the ampullaceous sacs, which, although scattered throughout every part of the sponge, are brought together in much more close approximation on the surface, where they form a layer 1-12th of an inch thick, of intense blackness; and when a portion of this layer is torn to pieces, the black colour is found to arise from the presence of one or more black granules in each of the sponge-cells, which thus collectively give the black colour to the ampullaceous sac, and the latter, in great numbers and close approximation, to the uniform and characteristic blackness of the surface of the sponge.

(This layer, which is supported on another internally, formed of stout quadriradiate spicules, and covered externally by a thin transparent dermal layer charged with short bacillary spinous ones, the spicules of the body being 4-radiate and *tricurvate*, I propose to notice more in detail in a future communication, describing and illustrating the whole sponge.)

But to return to the ampullaceous sac in the living marine sponges, I have, besides observing it in *Halichondria simulans*, seen it in all the rest that I have examined where I have looked for it particularly. I have dried pieces of the Geodidæ, too, in which it is obvious; but in the dried sponges the ampullaceous sac or little globular group of sponge-cells which represents it will not be preserved if the specimens have not been dried while fresh and living. Putridity destroys them; and therefore all weathered specimens, such as are chiefly found on beaches, will probably fail to exhibit them.

Calcareous Sponges.

In the calcareous sponges, on the other hand, the tessellated arrangement of the sponge-cells in distinct compartments has been well described by Dr. Bowerbank since 1848 (Trans. Microscop. Soc. vol. iii. p. 137); and it only remains for me to add that, by making sections of dried specimens of *Grantia ciliata* in all directions, these compartments are found to open into each other, finally terminating by a round aperture in the general cavity or cloaca of the sponge.

I have also lately observed, in tearing to pieces portions of living *Grantia nivea*, which is a massive sessile form with branched system of excretory canals and oscular vents, and also portions of a beautiful *Clathrina* (Gray) which extends its white lace-like network over the under surfaces of rocks here in great abundance, with many other species of calcareous sponges, that the same kind of ampullaceous sac with its cilia waving internally exists in all, as in the siliceous *Isodictya* above mentioned, but with this difference, viz. that the sponge-cells are double the size of those in *Isodictya* and the siliceous sponges—that is, about 1-3000th of an inch in diameter.

Thus it is proved that the ampullaceous sac is the eating-organ in *Spongilla* and in the marine sponges, both calcareous and siliceous, generally.

I have alluded to the "investing membrane," or veil of sarcode which covers the young *Spongilla* (Annals, *l. c.*), in which I have also shown that holes are extemporized for allowing the particles of food to enter into the interior and be there taken up by the sponge-cells of the ampullaceous sac; and it is this veil which in all sponges alike (that I have examined) creates a cribriform layer over the inhalant areæ as it is required, but *never* over the exhalant areæ or oscula.

For a more complete account of the nature of this veil and its apertures I must refer the reader to my paper "On the Ultimate Structure of Spongilla" (*l. c.*), and for illustrations of it in the Geodidæ (*Sphærospongia*, Gray) to my illustrations of *Pachymatisma Johnstonia* (Annals, vol. iv. p. 8, pl. 2. figs. 10–12, July 1869). Further in, in the pore, in the latter there is an expansion of the sarcode which has been called by Dr. Bowerbank the "diaphragm;" but it is generally, if not always, a more or less spiral plane of the sarcode (fig. 12, *l. c.*) in conjunction with the spiral arrangement of the minute holes respectively in the cribriform layer of sarcode overlying it externally, each of which is also more or less spiriform, as may be seen by placing a perfect portion of the crust under the microscope with its inner side uppermost, and viewing it by transmitted light through the pores.

This spiral arrangement of the holes in the dermal sarcode overlying the pore as well as that of the diaphragm in the pore itself, I have just now satisfactorily seen in a piece of *Pachymatisma Johnstonia* that I found growing on the rocks here; also I observe that the "diaphragm" is just as much developed in the large oscula as in the pores, so that it is not peculiar to the latter.

Owing to the short shafts of the triradiate spicules which support the crust of globular crystalloids in *Pachymatisma Johnstonia*, portions of the latter come off entire when the sponge is roughly raised from the rock on which it may be growing; and thus the organs and structure of the surface may be easily seen, especially after exsiccation—differing thus from *Geodia*, where the shafts of the triradiate spicules are so long and so numerous and the whole zone so much more developed in this respect, that the crust and the zone of triradiate spicules generally come away together, and cannot be separated without much injury to the former.

On comparing the Sponges with the Polypes or Corals, one cannot help being struck with the want of a second channel for the evacuation of excrementitious or undigested portions in the latter, while its presence in the former allies the sponge more to the Polyzoa and Tunicata. Then the total absence of thread-cells in the latter and their invariable presence in the former still further allies the Sponges to the Tunicata, while it equally separates the Sponges from the Corals. It is true that the organs of the Tunicata are much more developed or differentiated than those of the Sponges; so are the ovaries &c. of the Corals. But this does not militate against the Sponges being at the end of the branch of palæogenetic development leading to the Polyzoa and Tunicata rather than to that leading to the Corals.

Again, the little heads of inhalant areæ in *Osculina polystomella*, Scht. (Spong. Algier.), in *Grayella cyathophora*, Cart. (Annals, vol. iv. September 1869, pl. 7), and probably more or less in all the Clionidæ, have a structure very much like the tentacular orifices of Polypes—indeed so much so that in *Cliona coralloides*, Hancock (Annals, vol. xx. April 1867, p. 229, pl. 7. fig. 3), which I have just had under observation in salt water, I thought I had a colony of little Polypes under the microscope. They were scattered (upwards of one hundred of them, each about 1-48th of an inch in diameter) over the outer side of a deciduous *Balanus*-shell, which was about an inch wide at the base and about half an inch high; and when first I observed them, each presented the appearance of the convex iron grating used for sinks. Some were round, but most oval; and all possessed this grating-like opening, except the vents, which were known by their single circular aperture. On examining the little heads, however, more particularly, it was observed that each consisted of a variable number of prolongations of the sponge-structure (often more than a dozen), which, tentacula-like, rose upwards all round to form the dome-like prominence of the head during projection—that, also tentacula-like, they ended in tongue-like terminations, but that these terminations were tied together by the investing layer of transparent dermal sarcode, which thus transformed the whole head into a convex cribriform structure into which the floating particles of the vicinity were observed to be drawn, as, on the contrary, they were observed to issue from the pores or vents with *single* circular aperture.

(On removing the calcareous shell of the *Balanus* by acid and drying the remainder, these little heads, which presented a white colour, were found to be wide at their base where they joined the sponge, then constricted so as to form a neck, and then expanded into the head, while the white crust was formed of the peculiar bacillary, sinuous, spined, minute spicule which Hancock gives (*l. c.*) as the characteristic one of the species, pierced by the points of a bush of pin-like spicules, which, as I have before stated, in the Clionidæ appear to be almost exclusively confined to these heads, the incipiently but densely spinous acerate spicules of this species being, as in *Grayella*, almost as exclusively confined to the body of the sponge.

Thus in the extension upwards of the ribs, composed of sarcode charged with spicules and based on the general structure of the sponge of which they thus formed tongue-like prolongations, I thought I saw the tentacles of a polype; but the clathrous netting together of their tips and sides with the investing sarcode, and the rush of particles in through the lattice-work thus produced, showed me that, however much these little retractile heads were like in form, they were not so in function to the tentacular mouth of a polype. In short, they did not act as the fringe of tentacles in *Actinia* and the Polypes, which are prehensile organs. They acted as sieves to strain the water and prevent the entrance of particles which might be too large for the sponge-cells to enclose, or otherwise inconvenient for the sponge to receive. Thus in form they partly represented Polypes, but in function sponge-structure.

In Häckel's valuable paper (Annals, *l. c.* p. 4) Leuckart is quoted as having stated that, "if we imagine a polype-colony with imperfectly separated individuals without tentacles, stomachal sac, and internal septa, we have in fact the image of a sponge with its large 'water-canals' opening outwardly." That is to say, in short, "we have only to pick out the polypes of a polype-colony to have a sponge."

After this, at p. 10 (*op. cit. l. c.*), Häckel alludes to certain "fine apertures in the skin [of corals] usually perceptible only through the microscope," which he considers deserving of the term "incurrent apertures" designed for respiratory purposes just as much as the pores of the sponge; but he previously admits that "the part played in the process by the cutaneous pores of the corals is unfortunately still as good as unknown."

With equal reason it seems to me we might liken the canaliferous structure which pervades the cartilaginous cœnosarc of the compound Tunicata, if not that of the tests of the Polyzoa and Ascidians also, to the canaliferous structure of the Sponges. Nor are many of the compound Tunicata wanting in the spicular element—which, under definite forms, abounds in some species to such an extent as to give them the white appearance of calcareous sponges, for which, at first sight, they may be easily mistaken. Up to this time, however, I have only found this spicular element to exist in the shape of two forms of globular crystalloids of carbonate of lime covered with points similar to some of the siliceous spherical stellate bodies of *Geodia arabica* (Annals, vol. iv. July 1869, pl. 1. fig. 13 *a*)—not of the globular crystalloids of the crust, which all have a depression in one part of their surface. Such a depression does not appear to exist in the radiated globular crystalloids (spicules) of the compound Tunicata.

Hence it seems to me that the Sponges are just as much a step to the Polyzoa and Tunicata as to the Corals, if not more so.

But when we turn to the Foraminifera, the case is quite different; for here indubitably (as in *Difflugia*, which belongs to this class) the food is taken in and the undigested portions ejected through the same aperture. And if we advert to *Squamulina scopula*, which I described and illustrated in the Annals (vol. v. p. 309, May 1870), we shall there see that the *Difflugia*-like head arises from hypertrophy of the central cell of a nautiloid form of Foraminifera, while the ovary is divided among the atrophied septa and chambers of the nautiloid test at the base or "pedestal," which thus at once gives us an early condition of an *Actinia* or polype, the pseudopodia being the early condition or true homologues of the tentacles of the latter, if not the "atrophied septa" those of the septa also.

Still where, it may be asked, is the canaliferous structure? Observation seems to point out that there are tubular communications directly through the tests of *Difflugiæ* and the Foraminifera whose functions have not yet been defined. Like the minute apertures on the skin of Corals, they may perhaps be for respiratory purposes, and, if connected with the stomachal cavity, would be the homologues of the cœlenteric vascular system in the Corals. But, as Häckel states of the cutaneous pores of Corals, the part they play "is unfortunately still as good as unknown."

One does not assume that the inhalant pores of Sponges may not be in part respiratory organs, but that, unlike the Corals, they serve the purpose also of sifting the nutritive material which is drawn in through them by the internal organs of the sponge—in short, that, as in the Tunicata and Polyzoa, the respiratory water and the food enter the body through one aperture and come out at another.

I have stated that there is only one vent in the young *Spongilla* grown from the seed-like body; but sometimes (see my "Ultimate Structure of *Spongilla*," *op. cit. l. c.* p. 31) "it happens that one of the large branches of the efferent system bursts and gives rise to an efferent current before the tubular vent resumes its original dimensions and opens its aperture, by which two efferent currents are subsequently established, for the abnormal one does not close when the normal one becomes opened."

Dr. Bowerbank also (Brit. Assoc. Advanc. Science, Report for 1856) notices ("June 10") the opening of several new oscula and the closing of old ones in the piece of *Hymeniacidon caruncula* which he was watching, as if they could be closed and extemporized like the holes of the investing sarcodal layer when and wherever required. On *Pachymatisma Johnstonia*, too, and many other sponges, the great vents are congregated into groups in one or two places, and not distributed generally, as if the sponge were divided into districts each having its respective vent. Yet Häckel states (p. 8, *l. c.*) that his investigations have confirmed him "in the opinion quite recently put forth by O. Schmidt, that every part of the sponge-body which possesses an excurrent orifice (*osculum*) is to be regarded as a distinct 'individual.' This 'true individual' of the sponge-body I [Häckel] denominate, in accordance with my theory of individuality, a 'person;' and every sponge-body that consists of two persons (*i. e.* that possesses two or more oscula) I denominate a 'stock' or 'cormus.'" Häckel's theory may suffice for the Calcispongiæ, but I doubt if it will apply so generally to the Siliceous Sponges.

Generative Organs.

What these are in the Corals or Polypes and Tunicata is evident. But where are they, and what are they, in the Sponges?

The seed-like bodies of *Spongilla* I have long since compared with the winter-egg of the freshwater Polyzoa (Annals, vol. iii. p. 331, May 1859, pl. 8); and the ciliated gemmules appear to me to be only another form of them, while all appear to me originally to be but transformations of the ampullaceous sac.

But what is the ovum and what the spermatozoon of the sponge?

In November 1854 (Annals, vol. xiv. p. 334) I published (the reader will be tired of my referring to my publications; if not, I am) a short account, with illustrations, of certain monociliated sponge-cells, which at the time I conjectured to be the zoosperms or spermatozoa of the sponge. In 1858 (Annals, vol. iii. p. 14, pl. 1, January 1859), on account of the conjecture, I put this to the test by feeding a suitable piece of *Spongilla* with indigo, in order that I might see if these monociliated sponge-cells enclosed any, in which case they might be considered not to be spermatozoa, for spermatozoa do not take in nutriment, at all events not in the form of crude material. They did enclose portions of indigo, as my illustration (fig. 12, *l. c.*) shows; and having made the announcement, I from that time forward hoped that I should never hear any thing more of my original conjecture. Nevertheless it is every now and then brought up as if I had only published it yesterday, and had never added the contradiction which followed about five years afterwards, viz. in 1859.

Thus Häckel, in 1869, states on the subject (p. 110, *l. c.*):—"What Carter describes as the zoospermia of *Spongilla* are, as Lieberkühn perceived, Infusoria; and what Huxley figures as zoospermia of *Tethya* are very probably vibratile cells. No less doubtful are the filaments which Kölliker describes as the zoospermia in *Esperia*." .... "O. Schmidt and Bowerbank, who have examined microscopically many thousands of sponges, have, like myself, sought in vain for male organs of any kind whatever."

Now, as regards my so-called zoosperms in *Spongilla* not being so, my experiment above related, performed and published eleven years since, satisfactorily settles this point. As regards their being Infusoria, every one who knows any thing of living sponge-structure knows that such monociliated cells not only abound in, but absolutely form almost the greater part of it. And as regards Lieberkühn's view, expressed elsewhere, that they were specimens of Ehrenberg's *Trachelius trichophorus* (Dujardin's *Astasia limpida*, see my observations on this point, 'Annals,' vol. iii. Jan. 1859, p. 16), I am rather surprised that Lieberkühn should have come to this conclusion, seeing that *Trachelius trichophorus*, like *Euglena*, progresses by means of its cilium in *front*, and the monociliated cells which I figured and conjectured to be the zoosperms of *Spongilla* progress by means of the cilium *behind*. Kölliker's description of the filaments which he observed in *Esperia* I have not seen. But Huxley's, in a species of *Tethya* described and figured in the 'Annals' (1851, vol. vii. p. 373), so well as I can remember, closely resemble in form what I have just observed in *Microciona atrosanguinea*, which is a very common sponge in this locality.

This monociliated body, which may now be seen, in great plurality, with every portion of the *Microciona* torn to pieces for microscopical observation, consists of a rounded triangular head and long cilium. The head is pyriform or shaped like a Florence flask with the neck drawn out to a sharp point or beak, and the cilium attached to the large end, close to which there appears to be a single granule or nucleus; but in other respects the head is transparent. At first these bodies are in contact with the glass cover, but soon sink to the plane of the slide, about which they move with the head foremost, apparently urged on in a zigzag course by the undulations of the cilium behind. For the most part they are single, but occasional groups of four are seen rolling over the field after the manner of monociliated cells or spermatozoa which want to become separated from each other. When measured, the head, including the beak, was found to be 1-3000th of an inch long by about 1-12000th broad at the large end, and the cilium seven times as long as the body, or about 1-400th inch long. Under the action of iodine, the head became amber-coloured. While portions of *Microciona atrosanguinea* taken from different localities abounded with this body, together with a number of scarlet gemmules, in addition to the ampullaceous sacs and monociliated cells of the rest of the sponge, portions of other sponges, even on the same piece of rock (for it is most desirable, in examining the living sponges, to bring away with, and not detach from them, the piece of rock on which they grow), failed to present a similar body when torn to pieces under the microscope. Could this monociliated body with triangular head have been the spermatozoon of *Microciona*?

Häckel observes also, at p. 110 (*l. c.*):—" I regard it, therefore, as most prudent and advisable for the present, to doubt the sexuality of the Sponges," previously having stated, at p. 6, that " in the Sponges, just as in the Corals, and, indeed, in the Cœlenterata generally, all the different parts of the body originate by differentiation from two primitive simple formative membranes or germ-lamellæ, the endoderm and the ectoderm, ... produced by the segmentation of the ovum." And then, at p. 12, with reference to the development of the earliest young form of the Calcareous Sponges:—" After the egg has been broken up, in consequence of the process of segmentation, into a spherical, mulberry-like aggregation of closely adpressed, homogeneous, naked spherical cells, the mulberry-like embryo, by stronger growth in one direction, acquires an ellipsoidal or oval form, and covers itself with cilia. A small central cavity (stomach) is then produced in its interior; this extends, and, breaking through at one pole of the longitudinal axis, acquires an aperture, the mouth."

This is very like the development of the young *Spongilla* from the seed-like body. (See my illustrations of the ultimate structure of *Spongilla*, *l. c.*)

But, if there be an " egg," there must be a spermatozoon. Yet Häckel, as above stated, ends by doubting the " sexuality of Sponges."

Still further, in reference to this subject, I might add that I have twice found a living specimen of *Halichondria panicea* here, of a lilac colour, which, on being torn to pieces, was found to be densely charged with minute spherical capsules, 1-3000th of an inch in diameter, so like the sporidia of the Myxogastres that, as I have before stated in the 'Annals' (vol. v. p. 320, May 1870), but for the presence of the spicules and the specimens being fresh and living, I should have concluded that these cells came from one of the Myxogastres, and did not originally belong to the sponge. Could these have been the true sexual ova of the sponge? By development they would, of course, lose their homogeneous appearance, and become granuliferous.

Having endeavoured to show the near relationship which exists between the Sponges and the compound Tunicata, and the still nearer one which exists between the Foraminifera and Corals, I have only now to add a word or two in conclusion, on the real nature of the animal of the Sponges abstractedly.

The only naturalist, to my knowledge, who has turned his attention directly to this all-important point connected with them is Prof. H. James-Clark, of Boston, to whose valuable memoir on the subject (republished in the 'Annals,' vol. i. p. 133, Feb. 1868) I have alluded at the commencement of this paper.

The object of Prof. James-Clark is to prove that the monociliated sponge-cell is a distinct flagellated infusorium, possessing an oral and an anal orifice respectively, in close approximation, at the bottom of a funnel-shaped retractile expansion which surrounds the base of the cilium, and also a nucleus and two contracting vesicles; further, that this flagellated infusorium is in no sense whatever related to the Rhizopoda; and that it is an aggregation or colony of such Infusoria which produces the "true ciliated *Spongiæ*."

I cannot altogether endorse Prof. James-Clark's views, as I have stated (Annals, vol. iv. p. 196, Sept. 1869); nor do I desire to dispute his conclusions here, my object in this communication being to point out facts which seem to me worthy of consideration, and to leave all hypothetical arguments in support of particular opinions to those who think them of more consequence than I do, merely observing that the amœboid pseudopodia of the Foraminifera (*Difflugia*) and the cilium of the Flagellated Infusoria (*Trachelius trichophorus*, Ehr., *Astasia limpida*, Duj.) appear to be combined in the Sponges, and that, while the former may lead on to the Polypes, the latter may be the initiative form of the Polyzoa and Tunicata.