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[FOURTH SERIES.]

"................. per litora spargite muscum,
Naiades, et circùm vitreos considite fontes:
Pollice virgineo teneros hìc carpite flores:
Floribus et pictum, divæ, replete canistrum.
At vos, o Nymphæ Craterides, ite sub undas;
Ite, recurvato variata corallia trunco
Vellite muscosis e rupibus, et mihi conchas
Ferte, Deæ pelagi, et pingui conchylia succo."
N. Parthenii Giannettasii Ecl. 1.

No. 43. JULY 1871.

I.—*A Description of two new* Calcispongiæ, *to which is added Confirmation of* Prof. James-Clark's *Discovery of the True Form of the Sponge-cell (Animal), and an Account of the Polype-like Pore-area of* Cliona corallinoides *contrasted with* Prof. E. Häckel's *View on the Relationship of the Sponges to the Corals.* By H. J. Carter, F.R.S. &c.

[Plates I. & II.]

In the following paper I propose to describe and illustrate two new calcareous Sponges from this locality (Budleigh-Salterton, Devon), one of which will form the type of a new genus, and the other, although before noticed, has not been properly recognized; also to confirm Prof. James-Clark's discovery of the true form of the sponge-cell in *Leucosolenia botryoides*, Bk., by recent observations and experiments on the structure of *Grantia compressa*; further, to describe and illustrate the polype-like pore-area of *Cliona corallinoides*, Hancock, for the purpose of contrasting it with the views of Prof. E. Häckel on the organization of Sponges and their relationship to the Corals; to which are added a few remarks on the groundwork or basis of his proposed classification of the Calcispongiæ.

Trichogypsia villosa, nov. gen. et sp.
Pl. I. figs. 1–4.

Massive, sessile, depressed, greyish or greenish white; base subelliptical. Surface uneven, rough, ridged, villous (Pl. I.

fig. 2), presenting a single vent at one end of the ellipse (fig. 2, *a*), about midway between the border and the centre, at the bottom of an oval excavation, furnished internally with a circle of minor vents arranged round the large one (fig. 3). Pores scattered over the surface generally. Internal structure close, areolar, accompanied by the branching excretory canal-system. Spicules of one form only (fig. 4), viz. linear, sinuous, fusiform, spino-tuberculate at the extremities, especially the outer one, which is most attenuated, the internal one being obtuse and less tuberculated; arranged more or less perpendicularly, so as to present a villous surface. Size of spicule averaging 32-1800ths of an inch long by 1-1800th of an inch broad. Size of specimen (fig. 1) 5-12ths of an inch long by 3-12ths broad, and 1-12th of an inch high.

Hab. Marine. Laminarian zone, in company with *Isodictya simulans*, Bk. (*Halichondria simulans*, Johnston).

Loc. Budleigh-Salterton, south coast of Devon.

Obs. I have only obtained one specimen of this sponge; it had grown upon the deciduous shell of a shark's egg, together with branching and inosculating *Isodictya simulans*, the whole of which had probably become entangled in the Laminarian zone, whence it had been torn off in a storm and cast upon the beach, where I found it about a year since.

It consists of a single individual, with one vent, growing flat upon the horny egg-shell, and is so far like *Leuconia nivea* that the vent branches off directly into the areolar parenchyma of the sponge; but its surface, instead of being depressed, flat, and smooth, is rather elevated and rough, or irregularly ridged, while the whole mass has the appearance of the pile on white velvet which, having been moistened with gum-water, has been allowed to dry in a ruffled state. How far this may be owing to the washing of the sea-water, I cannot say; but it is chiefly caused by the projection of the attenuated spinous ends of the sinuously straight spicules, which, arranged perpendicularly to the surface, give the latter its villous appearance. The colour is greyish or greenish white, of that tint which is perhaps the most common in the crystalline salts of lime—calc spar, gypsum, &c.

While, however, there is only one kind of spicule, and that linear, this Calcisponge further differs from all the others with which I am acquainted in possessing *no* triradiate or quadriradiate spicules.

It is necessary to make a new genus of it, for which, from its calcareous nature and hair-like appearance, I propose the name of "*Trichogypsia*," designating the species by the term

"*villosa*," from its surface being somewhat like the pile on velvet, as above stated.

The spicule happens to be almost a facsimile of that which forms the tubercles and crust on the back of *Doris tuberculata*, and, like it as well as all the other calcareous spicules that I have met with in the Calcispongiæ, Foraminifera, Gorgoniidæ, Echinodermata, and compound tunicated animals, presents no central canal, but is solid throughout.

Leuconia Johnstonii, mihi.
Pl. I. figs. 5–12.

Massive, flat, sessile, lobulated, snow-white, each lobule having a single vent situated at the end of a more or less elongated, conical or rounded eminence (Pl. I. fig. 6). Surface smooth, covered with very large quadriradiate spicules (fig. 6, *c*). Vent circular, and surmounted by a crown of erect linear spicules (fig. 6, *a* and 7, *e*), or simple and bound down marginately by the spreading arms of the great quadriradiate spicules of the surface (fig. 6, *b*, and fig. 40, *b b b*, Pl. II.), leading into a cloacal cavity (fig. 7, *a*) which soon branches off into the excretory canal-system (fig. 7, *b b*). Pores scattered irregularly over the surface, in the dermal sarcode, chiefly opposite the interstices of the intercrossing subjacent spicular structure (fig. 9, *a*, *b*). Internally areolar for the most part, accompanied by the branching excretory canal-system (fig. 7, *d d d d*); areolar cavities opening into each other (8, *a*) and finally into the cloaca directly (fig. 7, *c c*) or indirectly into it through the branches of the excretory canal-system. Spicules of seven forms:—1, the largest, quadriradiate (fig. 10, *a*), one arm of which is directed internally (*c*), while the three others (*b b* & *d*), lying flat upon the surface (fig. 6, *c*), thus, nail-like, bind down the spicular structure; internal arm (*c*) much curved, projecting into the cloacal cavity, where it presents a formidable spur bent *towards* the vent (fig. 7, *f*); the junction of the radii marked by a transparent area, which is white or dark according to the direction of the light, and arises from the presence or junction of the internal or fourth arm, whereby this part often has the appearance of a pore (fig. 12); 2, triradiate (*g*), very much smaller than the last, but of different sizes, and forming, as in most calcareous sponges, the staple spicule of the mass; 3, thick, long, linear, smooth, inæquifusiform, slightly curved, larger at the proximal than at the distal end (*e*); 4, long, delicate, hair-like, straight (*f*); the last two are confined to the vent (fig. 7 *e*); 5, small quadriradiate (*i i'*), with one arm straight and long, two short and opposite or lateral, and the fourth forming a long curved spur directed forwards, which, as this spicule is chiefly confined to the cloacal surface, projects into the latter after the manner of the fourth arm of the large quadriradiate; 6, minute, fusiform, acerate, curved, spinous, presenting for the most part the appearance of one end having been broken off and again united, but in the opposite direction to the curve of the spicule generally (*k*, and fig. 11, *a*); 7, minute quadriradiate, with one short and three longer arms (*l*, and fig. 11, *b*), chiefly confined, with the two preceding ones, to the surface of the cloacal cavities, where they form a more or less dense layer, pierced only by the fourth or internal arm of the great quadriradiate and the openings of the excretory canal-system (fig. 7, *a*, *f*, *c*). These spicules, although they vary somewhat in size, are, on the average, as they are successively described, 100, 36, 62, 58, 10, 4, and $1\frac{1}{2}$ 1800ths of an inch in their length and spreading respectively. Size of the specimen (fig. 5) about 9-12ths long, 6-12ths broad, and $1\frac{1}{2}$-12ths of an inch high.

Hab. Under surface of the rocks, in company with most of the other siliceous and calcareous sponges here, about low-water mark, in the Laminarian zone. Not uncommon.

Loc. Budleigh-Salterton, south coast of Devon.

Obs. I have found several specimens of this sponge. In some the vents are ciliated, in others unciliated; that is, crowned with a row of erect linear spicules, or with none at all. Both kinds occur in the specimen from which the illustration is taken; and where the crown is absent or broken off, perhaps from the waves beating upon it twice a day at each falling of the tide, the margin is chiefly bound down by the arms of the great quadriradiate spicule of the surface.

It differs from *Leuconia nivea* in the vents being ciliated, in the great spicules of the surface being quadri- instead of triradiate, in the projection of the curved or fourth ray of the great quadriradiate spicule into the cloaca, in the presence of the dark area or point in the centre of the radii of the latter (fig. 12), which at once distinguishes it from *Leuconia nivea*, where there is no fourth ray to occasion this; in its lobulated form, where one-third or more of the individual sometimes projecting above the common level of the sponge entails a short cloacal cavity (fig. 7, *a*) before branching off into the excretory canal-system generally, while in *Leuconia nivea* the vent, being on the same plane as the rest of the surface, which is flat, branches off *immediately* into this canal-system.

Thus in *Leuconia Johnstonii* we have a form midway between *Grantia ciliata* and *Leuconia nivea*.

After having described *Leuconia nivea* and its large triradiate spicules, Dr. Johnston concludes with the following paragraph:—

"Mr. M'Colla has furnished me with a variety from the Irish coast that merits to be distinguished. The sponge rises up in compressed sinuous leaf-like lobes, which are united together so as to form a lobulated crust nearly an inch in thickness, with a circular osculum on every projecting angle (pl. 20. fig. 6). Were we to imagine that a cluster of *Grantia compressa* had grown so close as to press against each other, and the various specimens to have coalesced into one mass, we would have a correct idea of this variety. That it is, however, no variety of *G. compressa*, is proved by the difference of its texture as well as by the form of the spicula." (Brit. Spong. 1842, p. 183.)

I need hardly add, after this quotation, that Dr. Johnston was acquainted with the species which I have now the pleasure to dedicate to his respected memory; nor, on the other hand, need I allude further to Dr. Bowerbank's description of *Leuconia nivea* (Brit. Spong. 1866, vol. ii. p. 36) than to state that, as he has changed Johnston's name of *Grantia nivea* to *Leuconia nivea*, so he has lost sight of or ignored this classical writer's description of the true *Grantia nivea*, and replaced it by an imperfect one of his "variety."

That, however, Johnston's "variety" is entitled to a distinct appellation, the above description will show.

As the great quadriradiate spicule of the surface of *Leuconia Johnstonii* is but a larger form of that which is common to the cloacal surface alone of most of the calcareous sponges, I have given an illustration of that which is found in *Grantia ciliata* as a type specimen (Pl. II. fig. 32). It will be observed that one ray is straight (*b*), while two others are more or less curved and opposite to each other (*a a*); this is the common form of the *tri*radiate spicule; and it is in the straight ray alone that a trace of the central or axial canal common to the siliceous spicule is seen (*c*), which trace, however, is here the central canal filled up with a cylinder of the same material as the spicule, so that, in fact, there is no canal at all. The fourth ray (*d*) projects at about right angles to the other three, and sometimes is a little excentric—that is, arises from the straight ray at a little distance from its union with the two curved ones. This ray is also curved forwards (that is, *towards* the vent), and in this way projects into and forms the armature of the cloaca: it would have been opposite, probably, if the current had been so, and hence is one of the *structural* evidences of an aboriginal excretory stream.

What is remarkable, however, in *Leuconia Johnstonii* is, that this spicule is so large that its fourth ray not only projects in a formidable manner into the cloaca (Pl. II. fig. 40, *c c*), but its three other rays bind down the rest of the spicular structure on the surface at the same time (Pl. I. fig. 6, *c*). It is therefore as much a surface- as a cloacal spicule; while, in all the other calcareous sponges that I have seen, it (that is, the quadriradiate) is almost entirely confined to the cloacal surface. The two other quadriradiate spicules are also chiefly confined to the inner surface of the cloaca here as well as in *Leuconia nivea*, where, with the minute spinous spicule, they also chiefly form the lining of the excretory canals; but the great spur of the great quadriradiate spicule of *Leuconia Johnstonii* is, of course, absent.

Confirmation of Prof. James-Clark's *Discovery of the "Collar" round the Cilium of the Sponge-cell.*

In the October Number of the 'Annals' for last year my paper on the "Ultimate Structure of the Marine Sponges" was published (vol. vi. p. 329), at the end of which (p. 341) are the following paragraphs:—

"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, entitled, "Spongiæ ciliatæ or Infusoria flagellata" (Mem. Bost. Soc. Nat. Hist. vol. i. pt. 3, pls. 9 & 10, read June 20, 1866; reprinted 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, Sept. 1869, vol. iv. p. 196), nor do I desire to dispute his conclusions here."

It is with great pleasure that I *can* now endorse them—that is, that I am now able to confirm all that Prof. James-Clark has stated of the flagellated sponge-cell in the valuable memoir to which I have referred.

For two months past *Grantia compressa* has been growing

in clusters on branches of the delicate little seaweed called *Callithamnion roseum*, which fringes the overhanging edges and under surfaces of the rocks here, about midway between high- and low-water mark, where it is left uncovered by the water for some hours twice a day.

Thinking, therefore, from its hardiness, that it might serve to confirm Prof. James-Clark's observations on *Leucosolenia botryoides* (*l. c.*), I, about six weeks since, brought home some branches of the *Callithamnion* bearing specimens of *Grantia compressa*, which were put into salt water on the spot; and the day after, as these sponges were still living, I tore up some pieces and placed them under the microscope, with $\frac{1}{4}$-of-an-inch compound power for observation, when, much to my gratification, I witnessed exactly what Prof. James-Clark had described, as may be seen by reference to the four groups of figures (13–16 in Pl. I.) which were then made from them. I also saw immediately that the "ear-like points or spines" on the monociliated sponge-cell of *Spongilla*, which may be found fully described and figured in the 'Annals' (Jan. 1859, vol. iii. p. 14 &c., pl. 1. figs. 12, 13, 14) were, as Prof. James-Clark had suspected (footnote, p. 21, *loc. cit.*), "the right and left profiles of a membranous cylindrical collar."

Feeling satisfied that Prof. James-Clark was right in his interpretation of this form of sponge-cell, and having, by experiments on *Spongilla*, as may be seen in my figures (*l. c.*), showed that, when immersed in a solution of indigo, the sponge-cells with "ear-like points" became more or less filled with it, I, of course, thought that the sponge-cells of *Grantia compressa* might do the same, when it would become satisfactorily evident that the same kind of ciliated sponge-cell existed in both the siliceous and calcareous sponges.

Accordingly, about a fortnight since, I took a branch of *Callithamnion roseum* on which there was a cluster of *Grantia compressa*, and, having placed it, as before, in sea-water on the spot, brought it home, rubbed down a little indigo, also in sea-water, and put the cluster into it.

After about an hour, all the specimens of *Grantia compressa* became of a dark-blue colour; and on cutting out a minute portion of one and tearing it to pieces, still in sea-water, the fragments were thus placed under the microscope, on a glass slide under a glass cover, when, equally to my gratification, I found the collared monociliated cells more or less filled with indigo, and in active vitality (Pl. II. fig. 30).

Next the cluster was placed in clean sea-water, and a stream of indigo was observed to be gradually flowing from the vent of each specimen respectively.

The cluster was then immersed in spirit and water; and after a few hours another minute portion, having been cut out from one of the specimens, was torn to pieces in like manner to the foregoing, and placed under the microscope, when the cell again was distinctly seen, although dead, with its cilium straight and, of course, motionless, the collar partially retracted, and the body more or less filled with indigo (Pl. II. fig. 31).

Thus it was proved that in the siliceous sponges (*Spongilla*) and in the calcareous sponges (*Grantia compressa*) the same form of monociliated sponge-cell exists, which will, in both instances, take in indigo when supplied with it under the circumstances above mentioned.

Further, it follows that, as these cells do take in *crude* material, they are as much the animals of the sponge as the little Ascidians are the animals of the compound Tunicata,—ex. gr. *Botryllus polycyclus* (Pl. II. fig. 41), where the Ascidians are imbedded in circular groups (*b*) in a common tough gelatinous mass (*a*), each Ascidian having an oral orifice on the surface for the reception of food &c. (*c*), and an anal orifice which empties itself interiorly (*d*) into a common cloaca (*e*), finally opening by a circular hole, also on the surface, in the centre of each group (*f*).

Thus satisfied that this monociliated cell existed in both classes of sponges, viz. in *Spongilla* and in *Grantia compressa*, I sought for it also in living specimens of *Grantia ciliata*, *Leuconia nivea*, and *Clathrina sulphurea*, where it was equally well represented.

I then tried the siliceous sponges, viz. *Isodictya simulans*, *Hymeniacidon plumosa*, *Microciona atrosanguinea*, *Cliona celata*, &c., and might have gone further; but the fact of the sponge-cell being only half the size in the siliceous (viz. 1-6000th of an inch in diameter) that it is in the calcareous sponges precluded my seeing any thing more than the cilia. Of all these sponges that I have examined, the common *Isodictya simulans* seems to be the hardiest and best fitted for this purpose; but all that I can state respecting my examination of it amounts only to fancying that I saw the collar round the base of the cilium in profile.

However, as, when my eyes were younger, I had determined it in *Spongilla* in the way mentioned (*l. c.*); that is sufficient to establish its existence in at least one of the siliceous sponges.

As the monociliated cell in *Grantia compressa* somewhat differs from that represented in Prof. James-Clark's figure of it in *Leucosolenia botryoides* (*l. c.* pl. 9. [pl. 6, 'Annals,' vol. i.] fig. 41), it is desirable that I should describe it more particularly; but, before doing so, I would premise that Prof. James-Clark's memoir, although headed "Spongiæ ciliatæ &c.," is chiefly on flagellated Infusoria—four new genera of which, viz. *Bicosœca*, *Codonœca*, *Codosiga*, and *Salpingœca*, including six species, partly freshwater and partly marine, growing separately or in groups on stalks, and all possessing the "collar" characterizing the sponge-cell, he has described and illustrated in detail, before that of *Leucosolenia botryoides*. Hence he not only gives the sponge-cell, but several other minute monociliated and collared monadine organisms almost identical with it, which live respectively in the sea and in fresh water—whereby his observations on the form and habits of the sponge-cell are confirmed by totally independent evidence.

I do not know that any one has published an account of the same kind of monadine infusoria; but now that I am aware of what they are, and have seen them in the sponge, I remember to have frequently seen such organisms as are represented by Prof. James-Clark under the name of *Salpingœca amphoridium* (figs. 37, *a–d*, pl. 9, *l. c.*) on the filaments of *Spirogyra* or *Cladophora* at Bombay, and have them *figured* in several parts of my journal, beginning as far back as "April 15th, 1855" (Pl. II. fig. 42); but at that time my microscopic power was too low to see them properly, and therefore, as often as I met with them, they were so far disregarded. Hence it is probable that when Prof. James-Clark's discoveries become better known (which, like all valuable communications of the kind, may be too far in advance to be recognized in the lifetime of the author) these Infusoria may be often noticed; indeed I hardly despair now of seeing some of them one day myself, especially the freshwater *Codosiga pulcherrima*, which can be "readily recognized under as low a magnifying-power as two hundred diameters" (*l. c.* p. 10).

Returning, then, to *Grantia compressa*, so far as the sponge-cell alone goes, *it* is the same as that of *Leucosolenia botryoides*, viz. globular in form, composed of a plastic exterior, enclosing granuliferous mucus or protoplasm, a nucleus and contracting vesicles, besides, perhaps, other organs at present unknown (Pl. I. fig. 13, *a*), having at one part a non-granular portion, which is extensible (*b*). This part, which we will call the "rostrum," is polymorphic and protrusible, as in *Difflugia*, and frequently assumes different shapes, but especially a cylindrical one rounded at the free end, from the summit of which convexity the cilium (*d*) proceeds, and from around its base a funnel-shaped delicate film like a fringe or frill, which, with Prof. James-Clark, we shall call the "collar" (*c*).

Although the rostrum is not represented in Prof. James-

Clark's figures of the sponge-cell of *Leucosolenia botryoides*, it is figured and described in his *Codosiga pulcherrima* (*l. c.* p. 10, pl. 9. [pl. 5, 'Annals,' 1868, vol. i.] figs. 8, 9, 25, 27, &c.).

Further, it should be stated that both the cell and its appendages are all polymorphic, or, at all events, the latter and non-granular portions of the protoplasm; so that, while the appendages may assume an infinitude of shapes and transformations, the globularity of the cell for the most part remains stationary. (For a description of the different forms of the sponge-cell assumed under polymorphism, and figured in the illustrations, see *infrà*, "Explanation of the Plates," figs. 13–31, inclusively.)

How the *crude* fragments of food are introduced into the sponge-cell is still so far questionable, that, as yet, it has only been *inferred*.

In the 'Annals' for July 1857 (vol. xx. p. 29, pl. 1. fig. 10) I described and figured what appeared to me to be the process in a sponge-cell of *Spongilla* attached by a pseudopod to the watch-glass, similar to that which I have seen twice, and figured, in *Grantia compressa* (Pl. II. figs. 20, 21); and there (that is, as represented in the figure *l. c.* 10), the particles seemed to be hurled back upon the cell by the cilium, described in my own words at the time as "caught up (by apparently adhering to it, or by a process thrown out by it, as in *Actinophrys sol* (*b*)) and rapidly passed into its interior."

Respecting these observations, Prof. James-Clark states (*l. c.* p. 1),—"Strangely enough, though, as it seems to me now, he [Carter] does not look upon the intussusception of the particles as a genuine process of swallowing, like that which obtains among the ciliated Infusoria." "It is plain, therefore, that he does not believe that the 'sponge-cells' are endowed with a *mouth*; and moreover, if I am not mistaken, he attributes to any part of the 'cell' the faculty of engulfing food."

Now here is the only point at issue between us; and on this depends whether we shall regard the sponge-cells as "Infusoria flagellata," after Prof. James-Clark's view, or as Rhizopoda (like *Amœba*) after my own and that of others.

It should be understood, however, that by any part of the sponge-cell "engulfing food" I mean any pseudopodial prolongation or exserted process of the protoplasm; for it is not improbable that in the Rhizopoda the surface-layer does not cover the *pseudopodium*, but, by its elasticity and yielding nature, allows the transparent and prehensile material of the interior to be protruded for the capture of food &c., and then withdrawn within the rent, which afterwards closes over it; hence the primary globular or rounded form of *Amœba* in the passive state.

Be this as it may, Prof. James-Clark states, respecting the sponge-cell of *Leucosolenia botryoides* (*l. c.* p. 22), that "the mouth is the only organ which has not been actually observed, although its position has been inferred, not only from the otherwise similar structure of the monad of this creature to that of *Codosiga* (§ 6), but because currents of floating particles are constantly whirled in by the flagella and made to impinge upon the area within the collar."

As regards *Codosiga pulcherrima* and *Salpingœca gracilis*, the intelligent author adds (*l. c.* p. 15):—"The *mouth*, we are obliged to presume, as we did in regard to *Codosiga*, lies somewhere about the base of the flagellum. Abundant digestive vacuoles were observed, as well as loose particles of food, in various parts of the body; but at no time were we so fortunate as to see the introception of nutritive material or the ejection of fæcal matter." And of *Salpingœca* it is stated (p. 11), "the position of the *anus*, which, as I have already suggested, may possibly be coincident with the mouth, is easily determined, even to the narrowest limits, as the fæcal matter is discharged in large, highly refractile pellets (fig. 24[a], *d*) close to the base of the flagellum."

Such is the only evidence we possess of the existence of *distinct* oral and anal orifices respectively within the collar of the sponge-cell of *Leucosolenia botryoides*; and so long as the collar of the sponge-cell is present with the cilium, all particles of food may go into and out of the body through the collar; but as every part of the sponge-cell is polymorphic, and may put forth pseudopodia from one part in particular (Pl. II. figs. 22, 23, 24), like *Difflugia*, or from any part of the body (Pl. I. figs. 14, *b* & 16, *a*), like *Amœba*, so it seems to me that we may infer that these pseudopodia may have, under such conditions, the power of introcepting particles of food at any point, which, while the cilium is unretracted and in full motion, may be thrown back upon the body towards its base only, and there introcepted, as I delineated in 1857 (*l. c.*).

This, then, would at one time make the sponge-cell a flagellated infusorium, and at another a rhizopod; but being compounded of the two, it is certainly neither, but an organism *sui generis*—in short, the sponge-cell.

On some occasions, too, the pseudopodial prolongation appears to become a pointed organ of suction like the tentacular prolongations from *Podophrya fixa* and *Acineta*, when it may seize and penetrate the body of another infusorium for the purpose of extracting its nutritive contents. (Indeed it is probably by the intercellular protoplasm, to which I shall allude hereafter, that the Sponges, like the Myxogastres, chiefly excavate and work (how?) their way through hard bodies.) This tentacular form of pseudopodium, which is characteristic of the *Acinetina*, I have also witnessed twice, in two cells of *Grantia compressa*, viz. one where the collar had partly become transformed into a pseudopodial extension and had caught an unciliated monadine cell (Pl. II. fig. 17), and the other where the margin of the collar itself had seized a monociliated one (fig. 18). As these two instances presented themselves during a very short and limited examination of the sponge-cells of *Grantia compressa* in the way above stated, it is not improbable that they are of very frequent occurrence. At the same time it should be remembered that many phenomena of this kind are witnessed under the glass cover, from the Infusoria being brought so closely together, which might not occur so frequently in their natural element, where they are unconfined and have plenty of room to avoid each other.

As an instance of a Rhizopod being able to put forth vibratile cilia at one time, and replace them by pseudopodial tentacles at another, I, long since, described and figured *Podophrya fixa* in the 'Annals' (vol. xv. p. 287, pl. 12. fig. 10).

To this it may be added that Prof. James-Clark in no part states that any of his collared flagellated Infusoria possess a polymorphic power over the whole body like the sponge-cell.

Nevertheless this sagacious observer states (p. 20), regarding "the theory of Carter as to the alliance of Sponges with Rhizopods," "my firm conviction" is "that the true ciliated *Spongiæ* are not *Rhizopoda* in any sense whatever, nor even closely related to them, but are genuine compound *flagellate Protozoa*, and are most intimately allied to such genera as *Monas*, *Bicosœca*, *Codonœca*, *Codosiga*, and *Salpingœca*."

Thus having stated our views respectively on this point, I must leave the reader to judge for himself.

Contracting vesicles and a nucleus are common to all the sponge-cells, and the former common to the protoplasm to which I have just alluded, viz. that which binds them and the whole elements of which the sponge is composed together. The latter is figured and described in one of my earliest papers on *Spongilla* (Annals, Aug. 1849, vol. iv. pp. 86–91, pl. 4. fig. 2), wherein it is stated, at p. 81, that, "when the fleshy mass is examined by the aid of a microscope, it is found to be composed of a number of cells imbedded in and held together by an intercellular substance," and, at p. 91, that "it (this substance) is extended into digital prolongations precisely

similar to those of the protean, which in progression or in polymorphism throws out parts of its cell in this way," and that in it "may be observed hyaline vesicles of different sizes contracting and dilating themselves as in the protean." I quote these portions to show that this intercellular protoplasm was described upwards of twenty years since.

Another phenomenon witnessed by Prof. James-Clark was the duplicative division ("fissigemmation") of *Codosiga pulcherrima* (pl. 9. figs. 13–21, p. 13), which he patiently watched and has as fully delineated and described. To this also I would direct attention, because I have figured a group of stoloniferous sponge-cells from *Grantia compressa* which bear the appearance of having been produced in a similar way (Pl. II. fig. 19).

But the variety of forms which these sponge-cells may assume, from their polymorphic power, is infinite; and, considering the number I have figured from two or three comparatively short examinations (Pls. I. & II. figs. 13–31) it will be easily understood that to attempt to delineate all would be endless.

Another question now arises, as to how and where these sponge-cells are grouped in the sponge-structure.

Here, again, I must refer the reader to the description and figure of these cells *en groupe* in my paper on "the Ultimate Structure of *Spongilla*" (Annals, July 1857, vol. xx. p. 26, pl. 1. fig. 5), where it will be observed that in this sponge they form *spherical aggregations*, each of which presents a large circular transparent area (aperture?), which is capable of being closed or expanded as required; and to this aggregation I have given the name of "ampullaceous sac." These groups are situated in the areolar cavities, which are accompanied by the excretory canal-system; and the sponge-cells of which they are composed seize the particles of food as they are whirled in through the pores of the investing dermal sarcode, and retain them as long as may be necessary, after which the undigested parts find themselves in the excretory canals.

It is very easy to ascertain the form of the groups, because the monociliated cells of which they are composed are the *only* cells which take in the carmine or indigo, and hence their shape and position are readily recognized with the microscope through the semitransparent substance of the young *Spongilla*.

It must be remembered that in all these instances the parts were viewed *in situ* in the watch-glass where the young *Spongilla* was grown, with the object-glass *under* water and with *no* glass cover.

Although it is easy to determine the form of the groups of sponge-cells in *Spongilla*, it is not so easy to see by what channels the particles of colouring-matter are *immediately* taken into them, or to see how they or the ingesta get from the cells into the excretory canals; for the cilia of the sponge-cells are in the *interior* of the ampullaceous sac, where they may be seen vibrating through the transparent circular area (aperture?). In my latest observations it seemed to me that the particles got into the sponge-cells of the ampullaceous sac through several different channels and holes, perhaps, in the latter, and that the discharged portions passed into the excretory canals through the transparent aperture; but of this I am not certain, and must now leave others to determine it.

The same kind of ampullaceous sac may be seen in many of the marine siliceous sponges, of which perhaps *Isodictya simulans* affords the best example. It has been figured by Schmidt under the name of "Wimperkorb" from *Reniera aqueductus* &c. (Suppl. Spong. Adriat. 1864, p. 13, t. 1. fig. 17); but this author does not allude to my description and figure of it in the 'Annals' for 1857, although the feeding of *Spongilla* with carmine by Lieberkühn and myself is noticed.

Thus the peculiar grouping of the sponge-cells in *Spongilla* and many of the marine sponges has been ascertained.

But in the Calcispongiæ they seem to cover the whole surface of the sarcode which lines the areolar cavities of the parenchyma (Pl. I. fig. 8, and Pl. II. fig. 29), with the exception, of course, of their incurrent and excurrent apertures, the latter of which, where there is no system of excurrent canals, finally open by large orifices *directly* into the cloaca.

So far as structure goes, *Grantia ciliata* does not differ, in the form of its areolar cavities and the absence of the excretory canal-system, from *Cliona celata*, in which, as my figure seems to show, the sponge-cells are still grouped in a spherical form (Pl. II. fig. 38).

It therefore remains for future observation to determine how the sponge-cells are grouped, generally and respectively, both in the siliceous and calcareous sponges.

Cliona corallinoides (Hancock in Ann. Nat. Hist. April 1867, vol. xix. p. 238, pl. 7. fig. 3). Pl. II. figs. 33–37.

Next to the sponge-cells, perhaps the most interesting organ is the dermal sarcode; for this, as I have before shown (Ult. Struct. of *Spongilla*) literally commands the openings on the surface. It can either extemporize them in any part, or close them, as required—a process which, of course, is very slowly effected, on account of the amœboid nature of the sarcode; so that, on death occurring suddenly (that is, where the sarcode has not become putrid and passed into dissolution, and there has been no time for closing by reflex action) these apertures remain. Hence in dried specimens, where the dermal sarcode is not destroyed, they remain visible.

There are two kinds of openings, viz. the pores and the vents—the inhalant and exhalant apertures.

Directing our attention to the former first, we find them averaging about a 1000th of an inch in diameter,—either scattered generally over the dermal sarcode opposite the interstices of the subjacent spicular structure, as in the Esperiadæ, *Halichondria panicea*, Johnston, &c., and the Calcispongiæ; or confined to circular areas in juxtaposition, as in *Raphyrus Griffithsii*, Bk. (*Cliona celata*?), *Raphiophora patera*, Gray, or Neptune's Cup, *Pachymatisma*, &c.; or to circular areas separated from each other and raised on cylindrical heads, as in *Grayella cyathophora*, Cart., *Cliona corallinoides*, Hancock, &c.

Of these the Clionidæ, including *Raphyrus* and *Raphiophora* (see "Mém. sur le Genre *Potérion*," par P. Harting, Soc. des Arts et des Sci. d'Utrecht, 1870, pl. 4. figs. 7 & 12), present examples of a division of the sponge-structure in the pore-areas resembling the tentacular head of a polype; but as this is merely a resemblance, and my object in introducing the subject of the openings in the sarcode of the Spongiadæ is more especially to show this, I shall take *Cliona corallinoides* alone (Pl. II. fig. 33) for description and illustration, as affording the nearest resemblance of this kind that I have met with.

This sponge (like *Raphyrus Griffithsii* and the great Neptune's Cup, together with the diminutive *Grantia ciliata* and its like among the calcareous sponges) possesses *no branched* system of excretory canals like most of the other sponges, but consists merely of an areolar structure (Pl. II. figs. 33 & 36, *a a*) which, burrowing between the layers of univalve and bivalve shells, forms for itself therein similar excavations, which open into each other by efferent (fig. 36, *ccc*) and afferent apertures, finally communicating with the exterior by distinct heads (figs. 33, *a*, *b*, & 36, *b*) here and there, most of which are simple pore-areas (fig. 34), while the rest present a combination of vent and pores (fig. 35) or a single large vent only. *Cliona corallinoides* not only excavates shells, but the sandstone rock too of this locality, where it shelters itself under the florid expansions of *Melobesia lichenoides*, which goes on growing (that is, spreading in all directions), while the

Cliona every here and there makes holes through this crust or thalloid frond for its pore-areæ or vents as required.

Of course, therefore, these "holes" are occupied by a longer or shorter cylindrical prolongation of the sponge (fig. 36, *b*) in proportion to the thickness of the crust, which thus presents as many heads; so that when the shell is dissolved off by acid, these heads project here and there above the general surface of the sponge (Pl. II. fig. 33, *a*, *b*).

It may be assumed that this way of reaching the exterior necessitates a cylindrical extension of this kind; but *Grayella cyathophora*, which is an allied species, possesses it, together *with* a branched system of excretory canals, although freely spreading *over* the surface of the rocky object on which it may be growing.

Each portion, too, in *Cliona corallinoides* has, for the most part, its peculiar spicule. Thus the pin-like, slightly curved, and fusiform one with oval head (fig. 37, *a*) is almost entirely confined to the cylindrical head-like extensions of the sponge, and the tentacle-like prolongations of the pore-area, where their points project outwardly (fig. 35, *f*), while the minute sinuous spinous spicule (*c*, *d*) for the most part fills up the interstices between the latter, and the curved, acerate, spinous spicule (*b*), which is not more than a quarter the length of the pin-like one, is confined to the areolar structure of the interior. These spicules, as they are described, average about 83, 2–3½, and 21 6000ths of an inch in length respectively.

When we examine the heads or free ends of the cylindrical prolongations, they are found to be of different sizes, to present an irregularly round or elliptical margin (fig. 34, *a a a*), and within this a variable number of tentacle-like prolongations of the sponge-structure (*b b b*) charged with the pin-like spicule, and webbed together by the dermal sarcode (*c*), in which there is a variable number of pores (*d*), chiefly situated between the prolongations. In the dried state all this is on a level with the margin of the pore-area, if not a little depressed, with the pointed ends of the pin-like spicules uncovered and bristling in all directions (fig. 35, *f*); but in the living state it rises much above the margin, into a convexity, when the dermal sarcode entirely covers and conceals the spicules.

At this time, inhalant currents may be seen to pass in through the *pore-openings*.

Our illustration presents about thirty of these tentacle-like prolongations, of different lengths (Pl. II. fig. 34, *b b b*), and is nearly a facsimile of the mounted dried one from which it has

been taken, and in which the dermal web-like sarcode (*c*) with its pores (*d*), as delineated, still remain.

Let us now turn our attention to the vent or larger aperture of the dermal sarcode, which here, as well as in *Pachymatisma Johnstonia*, Bk., is more or less constricted or covered (*i. e.* commanded) by a diaphragm of the dermal sarcode, in like manner as the pores, although in the latter both vent and pore-area are themselves solidly fixed by the masonry of the little siliceous balls of which the crust of *Pachymatisma* is composed. By this means (that is, by the dermal sarcode) the vent also may be opened or closed when required, in all the sponges, as I have long since shown in the young *Spongilla* (Ult. Struct. Spong. *l. c.*).

In *Cliona corallinoides* the whole area of the head (figs. 33, *a*, 36, *b*) is not always given up to the vent, but allows the latter to occupy its centre (fig. 35, *e*), while the circumference still presents the tentacle-like prolongations (*b b b*) and pores of the dermal sarcode between them (*d*); so that the head is composed of the two organs, *so far* in combination.

It is a common occurrence for the pores in most sponges to be seen close to the border of the great vent; but as the latter is only the opening at the end of the canal of the excretory system, the pores, although close to its border, do not necessarily communicate *directly* with it, but are in connexion with the areolar parenchyma beneath, which is thus *outside* and surrounds this canal or aperture.

Hence, for convenience, I have taken the same head for illustrating the vent that has been drawn from the pore-area alone (fig. 34), and have placed a large circular aperture in the centre for this purpose (fig. 35, *a*), after which it will not be difficult for the reader to supply the other and, perhaps, more common form, where the vent *alone* occupies the whole of the head (fig. 33, *b*). I have also in this figure inserted the bristling arrangement of the ends of the pin-like spicules as seen in the dried state (fig. 35, *f*), which has been omitted in the former, also for convenience.

Thus, however much like the polype-head the pore-area may be, the tentacle-like prolongations can only be considered to bear a remote resemblance to the tentacles of a polype; and thus also we read in Prof. P. Harting's valuable memoir on *Poterion*, or "Neptune's Cup" (where the pore-area is similar in structure to that of *Cliona corallinoides*, and the internal mass in like manner composed of areolar cavities only, without *canal*-system):—" Peut-être MM. Häckel et Miklucho-Maclay verront-ils dans ces plis rayonnants [in the pore-area] une confirmation de leurs idées sur les affinités des éponges avec les polypes. Quant à moi, je ne crois pas que ces plis puissent être comparés à aucune partie du corps d'une polype, soit aux bras, soit aux plis mésentériaux. C'est une simple analogie de forme, rien de plus." (Mém. pub. par la Soc. des Arts et des Sci. d'Utrecht, pp. 11 & 12, pl. 4. fig. 12 &c.)

As regards homology and adaptation, it is manifest that if the pores are to be considered the homologues of the ends of the gastro-ventricular canals of an *Actinia*, which are said to open on its surface, then their tentacle-like structure cannot be considered homologous with the tentacles round the mouth of the *Actinia* or polype.

Then, as regards the function of the vent and the excretory system of canals generally, it is the rule, and not the exception, for the current to pass outwards, and *vice versâ*. Indeed the structural arrangement in all sponges about the vent proves this; and where the opposite takes place, it seems to me to be occasioned by abnormal conditions, similar, perhaps, to what Dr. Bowerbank has stated to occur on such occasions. ("Ult. Struct. Marine Sponges," Annals, Oct. 1870, vol. vi. p. 331.)

In all sponges which are living and active, the inhalant and exhalant functions of the pores and vents respectively may be easily seen by placing a little colouring-matter in the water which surrounds them, when the process will be found to be almost invariable.

For the development of the seed-like body of *Spongilla* and the spicule, see 'Annals,' 1848, vol. i. p. 305; *ib.* 1849, vol. iv. p. 82 &c.; *ib.* 1857, vol. xx. p. 26; and *ib.* 1859, vol. iii. p. 334, respectively, wherein I am pleased to observe that much has been confirmed by Prof. Häckel's observations on the calcareous sponges, to which I shall presently allude more particularly.

Lastly, I have given an illustration of a group of *Botryllus polycyclus* (Pl. II. fig. 41), to show how the Ascidians of which it is composed have each its separate branchial aperture (*c*), for aëration and nutrition, on the surface of the gelatinous mass (*a*) in which they are imbedded, and its anal orifice (*d*) internally, extended into a common receptacle or cloacal cavity (*e*), which finally also opens externally on the same surface, for the discharge of the fæcal contents of the little community generally (*f*), there being a great many communities of the same kind imbedded in the same flat and spreading, tough, gelatinous or albuminous mass.

Now here we cannot help seeing that the gelatinous mass is at least analogous to the sponge-structure (indeed in the little white incrusting species *Leptoclinum gelatinosum* it is also densely charged with globular radiated calcareous bodies (spicules) similar to some of the siliceous ones of the Geodidæ, and presenting *en masse* such a white colour that it may be easily mistaken for a calcareous sponge),—that the branchial opening in the gelatinous mass, if not homologous with, is certainly analogous to the pore in the Spongiadæ, and the common cloacal cavity and fæcal orifice are respectively analogous to the excretory canal-system and vent, also in the sponges, while the plurality of communities or "systems" correspond to the individual divisions of the sponge termed by Prof. Häckel "persons."

Then, too, there is a network of canals in the gelatinous structure which may be the homologue of the gastroventricular canals in *Actinia* and the cœnosarc of the coral-polypes, especially for supplying nourishment and sustaining the vitality of these parts.

Prof. E. Häckel's *Views.*

It seems to me imperative on all those who would write anything on the Spongiadæ, and especially on the Calcispongiæ, to notice what has lately been put forth by one of the highest authorities on the Protozoa of the present day. I, of course, allude to the paper "On the Organization of Sponges and their Relationship to the Corals," to which is appended a "Prodromus of a System of Calcareous Sponges," by Prof. E. Häckel (Jenaische Zeitschrift, B. v. pp. 207–254; translated by W. S. Dallas, F.L.S., in the 'Annals,' Jan. 1870, vol. v. pp. 1 *et seqq.*).

In this paper, at p. 11 (translation), we find the following statement:—

"Miklucho has already shown that in a great many sponges the mouth or osculum by no means permits only the outflow, but also the inflow of water. I have repeatedly convinced myself, by my own observations, of the correctness of this assertion. Consequently the mouth in many sponges, just as in the corals, serves for both the reception and expulsion of the water and the nutritive constituents contained in it."

And at p. 6,—"I start with the following general proposition:—The sponges are most nearly allied to the corals of all organisms."

At p. 9:—"I do not, like most authors, regard the characteristic canal-system of sponges as something quite specific and peculiar to this class, an arrangement *sui generis*, but share in the opinion of Leuckart and Miklucho, that it is essentially *homologous with the cœlenteric vascular system* or gastrovascular apparatus of the Corals and Hydromedusæ,—in fact, of all the Acalephæ or nettle-animals. Indeed I am so thoroughly convinced of this homology that I (with Miklucho) designate the largest cavity into which that 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."

As may be perceived from these quotations, Häckel's views of the organization of the Spongiadæ (which also form the basis of his classification of the Calcispongiæ) do not accord with the facts which I have stated. Hence, our premises being different, it is useless to raise any argument against his hypothesis: the *facts* must speak for themselves.

But, as regards the inflow of the water into the osculum or vent, which, as before stated, is only occasional, abnormal, and not the rule but the exception (for even Häckel observes, at p. 10, that it is "generally (but not always!) the case"), no one well acquainted with the habits of the sponge would expect to see any thing but an exhalant current from this orifice.

Relative to this, Häckel adds, at p. 11:—"The difference in the direction of the current of water which is usually admitted in the two classes is a matter of perfect indifference in this close *morphological* comparison. Even if this difference was really constant, general, and thoroughgoing, it would not be capable of invalidating our notion of the homology of the canal-system in the body of the sponge and coral."

The necessitous adaptation, however, of the vent in the sponge to an inflow instead of an outflow of water is only temporary, and, not being constant, seems to me of no value in establishing an homology.

Thus, neither the prehensile extremity of the elephant's trunk nor that of the spider monkey's tail can make these two organs homologous with each other, or with the finger, although all three are used for similar purposes and in a similar way. Again, although a human being may be nourished through the rectum, it does not make the latter homologous with the stomach; neither does the casual inflow of the water through the vent of the sponge make this aperture homologous with the mouth of an *Actinia*; while in all these instances it seems to me more essential to know what their respective functions may be than their homologies, albeit the latter, when based on facts and not fancies, are equally essential as the basis of true classification. It is not difficult to assume that a spider monkey should have a tail, but it is much more useful in natural history to know how it differs from tails in

general. Diversity concerns us more than unity, fact more than theory. It is right to know what the form of a brick is, but it is of more consequence to know what structures a combination of them may produce. A mansion and a monument are not necessarily allied because they are both built of brick, nor is the sponge allied to the coral because both may have originated from the same kind of ovum in a similar way. It is the differentiation of their respective structures afterwards that is of most importance to the naturalist; and it is precisely on this point that Häckel and myself differ. One would make the sponges go along with the corals, and the other in the direction of the compound tunicated animals.

But although our premises being different precludes my arguing against Häckel's hypothesis, there are other points in his interesting paper which do appear to me to be directly assailable.

Thus at p. 8 he states:—"That the essential agreement in the internal organization of sponges and corals, their actual homology, has hitherto been for the most part overlooked is due, among other things, to the fact that the most accurate anatomical investigations of recent times (especially those of Lieberkühn) took their start from the best-known and most common forms of sponges—viz. the freshwater sponge (*Spongilla*), which belongs to the group of the true siliceous sponges, and the common sponge (*Euspongia*), belonging to the group of horny sponges. But these very two forms of sponges differ in many respects considerably from the original and typical structure of the entire class, have been in many ways modified and retromorphosed by adaptation to special conditions of existence, and therefore easily lead to erroneous conceptions, especially as their investigation is comparatively difficult.

"On the other hand, among all the sponges, no group appears better fitted to shed full light upon the typical organization and the true relations of affinity of the whole class than the legion of the Calcispongiæ."

This recalls to mind the old story in Mavor's 'Spelling-Book' of the town in danger, when, the different artisans meeting together for a council of defence, the shoemaker stated that "there was nothing like leather." The same, however, may be stated of what I myself am about to assert, which is, that there is nothing like *Spongilla* for the purpose of studying sponge-development.

As a medallist in the classes of comparative anatomy (under Prof. R. E. Grant) and of human anatomy at University College in 1836–37, as a practical and experimental observer of *Spongilla* in its *living* state, for many years, when it grew in the tanks close to my door at Bombay, and as a practical and experimental observer, for the last two years, on the marine sponges, both siliceous and calcareous, also in their *living* state, I think it might be assumed at least that, both by early education and subsequent opportunities, I ought to be qualified to give an opinion in this matter.

Now, for the most part, all marine sponges (save the *Clionidæ*, which may be in deciduous shells) begin to perish within forty-eight hours after they have been taken from their natural habitat, although their attachment to the piece of rock on which they may be growing remains uninjured; and even if they survive a little this period, they are voraciously devoured by the crustaceans which may be confined with them—just as in all similar and serial microscopical inquiries, whether free or confined, the minute crustaceans are thus the most defeating agents. With the putridity or dissolution of the sponge comes a development of infusoria; and if, under such circumstances, *one* Vibrio is seen to pass across the field, the microscopist may as well give up all further research into the phenomena of the *living* sponge.

On the other hand, if the seed-like body be taken from a living piece of *Spongilla* and placed in a watch-glass with water, it may be kept under a quarter-of-an-inch compound power until the young *Spongilla* issuing from it has gone through all its phases of development from its first appearance to its full completion, which may be seen both elementarily and collectively; while during this time, having a plurality of seed-like bodies growing in different watch-glasses, the experiment of feeding the young *Spongilla* with carmine or indigo, which soon points out, by its colour, the position and grouping of the sponge-cells, together with the passage of the particles in through the pores of the dermal sarcode, thence to the ampullaceous sacs, and then the discharge of the ingesta through the excretory canal-system—all may be deliberately watched under the same microscopic power, with so little difficulty and yet so accurately that there is no merit whatever in recording observations of the whole process. It was in this way that I obtained the data published in my paper "On the Ultimate Structure of *Spongilla*," confirmed by similar observations on large pieces of *Spongilla* taken directly from the tank; and to this paper I must refer the reader for all further information on the subject.

Latterly I have had nothing but the marine sponges to examine and experimentalize on, especially the calcareous ones; and I cannot help thinking that if Prof. Häckel had had the same opportunities that I have had of studying the development of *Spongilla*, he would not have given a preference to the Calcispongiæ for this purpose.

It is remarkable that Häckel, with the exception of stating at p. 111 that "the simple and extremely significant fact that the reproductive cells are produced, by division of labour, from the nutrient vibratile cells of the entoderm or vegetative germ-lamella applies to the sponges equally with the Acalephs," never once alludes to the *organs of nutrition*, by which the sponge-structure is built up and sustained. Such an omission could never have occurred with an observant, sagacious mind like his, ardent in the pursuit of truth, had he added to his indefatigable researches on the calcareous sponges a study of the development of *Spongilla*, such as I have described, or even had he experimented after a like manner on the *living* calcareous sponges.

Häckel observes, at p. 9, that the calcareous sponges to which he has given the names of *Clistosyca* and *Cophosyca*, which do not possess an excretory opening, are probably to be regarded as retromorphosed forms, related to the others as the Cestode worms to the Trematoda. At p. 10, that "the part played" by the cutaneous pores, which, in the corals, are the peripheral extremities of the cœlenteric vascular system, "is, unfortunately, as good as unknown;" yet with these he homologizes the pores of the sponge. At p. 116, the petaloid arrangement of the vents in *Axinella polypoides*, Sdt. (Spong. Adriatic. 1862, t. vi. f. 4) is regarded by Häckel as antimeral or homologous with the segmental divisions of a coral-polype; and therefore he sets these sponges down as "true Radiata;" while, in the following paragraph, the fringes round the vents in *Osculina polystomella* (2nd Suppl. Spong. Adriat. t. i.) are regarded as "incipient tentacles"—after which Häckel observes that whether this be right or wrong, it is of "less importance," because the tentacles are "almost wanting" in *Antipathes*. But considering that these fringed apertures were neither drawn nor ever seen by Schmidt himself, and that, as I have shown in *Cliona corallinoides*, they belong more to the pore-areas than to the vents, they can hardly be homologized with the tentacles of an *Actinia*.

At p. 116 it is also stated that "the conditions of *stock-formation* or *cormogeny* are exactly the same in the corals and the sponges." True; but the Compound Tunicated animals and the Polyzoa, &c. &c. are grouped together in a similar manner—in "systems."

Among the calcareous sponges which Häckel tells us he found at Naples, and preserved in spirit, we read, at p. 12, were some "microscopically small, but yet perfectly developed (*i. e.* ovigerous)" ones, "in which there are actually no traces of cutaneous pores" (and no spicules; at least none are mentioned in the "classification"). The entire body consisted of an "elongate rounded sac (stomach), with a single opening (mouth) on that extremity of the body which is opposite to the point of attachment." For this sponge Häckel has proposed the name of *Prosycum*. Indeed this is the starting-point or base of his Classification of the Calcispongiæ; and, of course, the absence of cutaneous pores makes its cavity a *stomach*, for there is no evidence of any other means by which nourishment could be obtained.

But is this not slender evidence to go upon, viz. the examination of a microscopic object preserved in spirit? If examined in the living state, might it not, like the young *Spongilla* (for it could hardly be much smaller) have possessed amœboid sponge-cells which might have enclosed particles of food on the outside of the sac, and discharged the ingesta into the so-called stomach, just as in *Clathrina sulphurea*, where the walls of the tubular structure are so thin that its areolar structure, beset with sponge-cells, can hardly be distinguished.

Of course I allude to these points for the purpose of eliciting truth, which no one desires more than Prof. Häckel.

As regards the development of the so-called ovum, it is stated, at p. 12, that the excretory canal commences "by a small central cavity (stomach)," which "extends, and, breaking through at one pole of the longitudinal axis, acquires an aperture, the mouth;" and at p. 114, that the "pores are simple breaches in the parenchyma, which perforate both layers of the body-wall (ectoderm and entoderm)." The first stage represents his *Prosycum*, and the second, where the pores are added, his *Olynthus*. In his *Clistolynthus* the mouth is closed up "by retromorphosis." Where the mouth is closed, the nourishment *must*, of course, come through the *pores*, and not through the so-called stomach.

Such are Häckel's views; and his classification of the Calcareous Sponges is carried out upon them *in extenso*. His theory that the vent of the sponge is the mouth, and the large excretory canal the stomach, is the *principium et fons* of all.

But how can this be maintained, when it has been proved that the greater part of the Sponge consists of flagellated Rhizopoda which take in *crude* material for nutrition, and probably supply the necessary elements of sexual generation?

EXPLANATION OF THE PLATES.

Plate I.

Fig. 1. *Trichogypsia villosa*, n. g. et sp., outline of, natural size.

Fig. 2. The same, magnified two diameters: *a*, vent.

Fig. 3. The same, vent more magnified, to show disposition of oscules opening into it.

Fig. 4. The same, spicule of, linear, slightly sinuous, inæquifusiform, spino-tuberculated at the ends. Size 1-60th of an inch long by 1-1000th broad. Scale 1-24th to 1-6000th of an inch.

Fig. 5. *Leuconia Johnstonii*, n. sp., outline of, natural size.

Fig. 6. The same, magnified 2 diameters: *a*, ciliated vents; *b*, unciliated vents; *c*, large quadriradiate spicule of the surface, relatively magnified.

Fig. 7. The same, diagram of vertical section of upper third or cloacal extremity: *a*, cloaca branching off into *b b*, excretory canals; *c c*, excretory apertures; *d d d d*, parietes of cloaca, consisting chiefly of areolar cells; *e*, ciliated crown of vent; *f*, internal or cloacal arms of great quadriradiate spicule.

For the arrangement of the spicules round the *un*ciliated vent see fig. 40, Pl. II.

Fig. 8. The same, diagram of areolar cells of parietes of cloaca, much magnified, showing large and small apertures in them: *a a*, efferent apertures.

Fig. 9. The same, diagram of a portion of the surface, much magnified, to show the dermal sarcode (*a*), and its pore-openings (*b*).

Fig. 10. The same; *a–f*, all the spicules relatively magnified, viz. on the scale of 1-24th to 1-1800th of an inch: *a*, large quadriradiate spicule of surface; *b b*, curved arms; *c*, internal arm; *d*, straight arm foreshortened, presenting the central canal line; *e*, large, thick, slightly curved, inæquiacerate spicule of the ciliated crown of vent; *f*, thin, straight, cylindrical one of the same; *g*, triradiate, staple spicule of the skeleton, of various sizes, showing the curved and straight arms respectively, the latter (*h*) bearing the trace of the central canal; *i*, small quadriradiate of the interior, front view; *i'*, lateral view, showing the curved arm, which projects into the cloacal cavity and excretory canals, in company with *k*, minute fusiform spicule, and *l*, still more minute quadriradiate spicule with one short arm.

Fig. 11. The same, minute spicules more, but relatively, magnified, on the scale of 1-12th to 1-6000th of an inch: *a*, curved fusiform spinous spicule, for the most part characterized by one extremity presenting the appearance of having been fractured towards the point and reunited in the opposite direction to the general curvature of the shaft; *b*, quadriradiate spicule, showing its short arm &c.

Fig. 12. The same, dark or transparent area (according to the direction of the light) at the union of the four arms of the great quadriradiate spicule of the surface, arising from the presence of the fourth arm, which thus distinguishes at once this species from *Leucosolenia nivea*. Scale 1-24th to 1-1800th of an inch.

Fig. 13. *Grantia compressa*. Sponge-cells relatively magnified, on the scale of 1-12th to 1-6000th of an inch, showing:—*a*, cell containing granular mucus or protoplasm, nucleus, and contracting vesicles; *b*, rostrum; *c*, collar or frill; *d*, cilium—all polymorphic; *e*, another common form; *f*, a form where the whole cell nearly appears to have become transformed into the rostrum; *g*, conical form of the same, where the rostrum presents a pointed elongation in the centre, with flat top; *h*, similar form, showing the contracting vesicle, *i*.

Fig. 14. The same, group of sponge-cells, part of which show the rostrum in different degrees of protrusion, apparently without the collar, but with the cilium; *g*, sponge-cell with rostrum, collar, and cilium retracted, and pseudopodia alone put forth.

Fig. 15. The same, group of sponge-cells showing the rostrum in different degrees of protrusion (*b*), and the collar only seen in *a a*.

Fig. 16. The same, five sponge-cells, of which three present the collar &c., and the other two (*a*) the pseudopodia only.

Plate II.

Fig. 17. *Grantia compressa.* Sponge-cell with collar transformed into tentacular pseudopodia, one of which bears a monad on its point, *a*.

Fig. 18. The same, sponge-cell with monociliated cell (*a*) seized by the margin of the collar.

Fig. 19. The same, group of sponge-cells with collar and cilium respectively, which appear to have undergone duplicative division, on stolons of sarcode.

Fig. 20. The same, sponge-cell with a single pseudopodium extended laterally from the fundus and attached to the glass (*a*), round which it was propelled by the cilium in a circle represented by the arrows, *b*.

Fig. 21. The same, sponge-cell (*a*) similarly attached to a group.

Fig. 22. The same, collar transformed into pseudopodia, cilium remaining.

Fig. 23. *Clathrina sulphurea*, sponge-cell of; rostrum and collar transformed into pseudopodia, cilium remaining.

Fig. 24. *Leuconia nivea*, sponge-cell of; rostrum partly, and collar and cilium wholly, transformed into pseudopodia.

Fig. 25. *Grantia compressa.* Sponge-cell with rostrum, collar, and cilium; presenting pseudopodia at the fundus of the cell.

Fig. 26. *Clathrina sulphurea*, sponge-cell of; rostrum and collar retracted, and cilium also becoming retracted by thickening at the base.

Fig. 27. *Grantia ciliata.* Sponge-cell with rostrum, collar, and cilium; the collar very faint.

Fig. 28. *Leuconia nivea.* Sponge-cell with rostrum, collar, and cilium; the rostrum beaded upon its anterior edge, and the collar very faint.

Fig. 29. *Grantia compressa.* Group of sponge-cells which had assumed a round or elliptical form, with their cilia rapidly vibrating in the interior. Common.

Fig. 30. The same, two living sponge-cells after their bodies had become more or less filled with indigo, presenting rostrum, collar, and cilium in motion.

Fig. 31. The same, specimen of the same after the sponge had been immersed in spirit and water.

Fig. 32. *Grantia ciliata.* Quadriradiate spicule, magnified, on the scale of 1-24th to 1-6000th of an inch, common to the internal surface of the cloaca in most of the calcareous sponges; showing:—*a a*, the two arms, which are generally more or less curved; *b*, the straight arm, which generally presents a trace of axial canal (this is the common form of the *tri*radiate in this sponge &c.); *d*, the fourth arm, which is curved *towards* the orifice of the cloaca *in situ*, and often joins the straight arm at a little distance from its union with the other two.

Fig. 33. *Cliona corallinoides*, Hancock (Ann. Nat. Hist.), portion of, after having been dissolved out of the deciduous shell of *Cardium edule*, and dried; magnified 2 diameters: *a a*, pore-heads; *b*, vent.

Fig. 34. The same, pore-head in the midst of a thalloid expansion of *Melobesia lichenoides*, beneath which the sponge had grown; taken from a dry-mounted specimen; magnified, on the scale of 1-48 to 1-1800th of an inch; natural size about 1-24th of an inch in diameter: *a a a*, border of the pore-area; *b b b*, tentacle-like prolongations of the sponge-structure, bristling, in the dried state, with the pointed ends of the pin-like spicules, and united together by the dermal sarcode, *c*, which fills up all the interstices, with the exception of the pore-openings, *d*.

Fig. 35. The same, pore-area with vent in the centre, combined, but not communicating with each other: *a a a*, border of area; *b b b*, tentacle-like prolongations of the sponge-structure, bristling, in the dried state, with the ends of the pin-like spicules, and united together by the dermal sarcode, *c*, which fills up all the interstices but the pore-openings, *d*, and the vent, *e*; *f*, the pin-like spicules, which are omitted in the foregoing figure for convenience.

Fig. 36. The same, diagram of vertical section of the pore-head and a portion of the areolar structure of the body, magnified, to show the absence of the excretory canal-system, whose function is supplied by the large efferent apertures, *c c c*, in the areolar cavities, *a a*; *b*, pore-head.

Fig. 37. The same; all the different spicules relatively magnified, on the scale of 1-24th to 1-6000th of an inch: *a*, pin-like spicule of the pore-head; *b*, spinous curved acerate spicule of the areolar structure; *c*, minute tortuous spined spicules of the pore-area; *d*, the same, more magnified.

Fig. 38. *Cliona celata*; ampullaceous sac of sponge-cells, showing the cilia vibrating internally ("Wimperkorb" of Schmidt); showing also the relative size of the sponge-cells compared with those of *Grantia compressa* in fig. 29, which are magnified to the same scale, viz. 1-12th to 1-6000th of an inch.

Fig. 39. The same, reproductive or ovi-cell, to show its relative size when compared with the sponge-cells in fig. 38: *a*, nucleus.

Fig. 40. *Leuconia Johnstonii.* Unciliated mouth of cloaca, much magnified, to show arrangement of the arms of the great quadriradiate spicules of the surface: *a*, vent; *b b b*, quadriradiate spicules; *c c*, their fourth arm projecting into the cloaca.

Fig. 41. *Botryllus polycyclus.* Fragment of gelatinous mass showing a group of Ascidians, magnified; arranged round a common cloaca: *a*, integument; *b*, Ascidians; *c*, branchial orifice; *d*, anal orifice; *e*, common cloacal chamber; *f*, its vent.

Fig. 42. Bell-shaped colourless infusorium, common on *Cladophora* in the freshwater tanks of Bombay. Cell about 1-7466th of an inch in diameter; total length about 1-1600th of an inch. Sessile, separate, in groups. Copied from a drawing in my journal, made in March 1857; to compare with Prof. James-Clark's figures of *Salpingœca amphoridium* (*l. c.* pl. 9. fig. 37).

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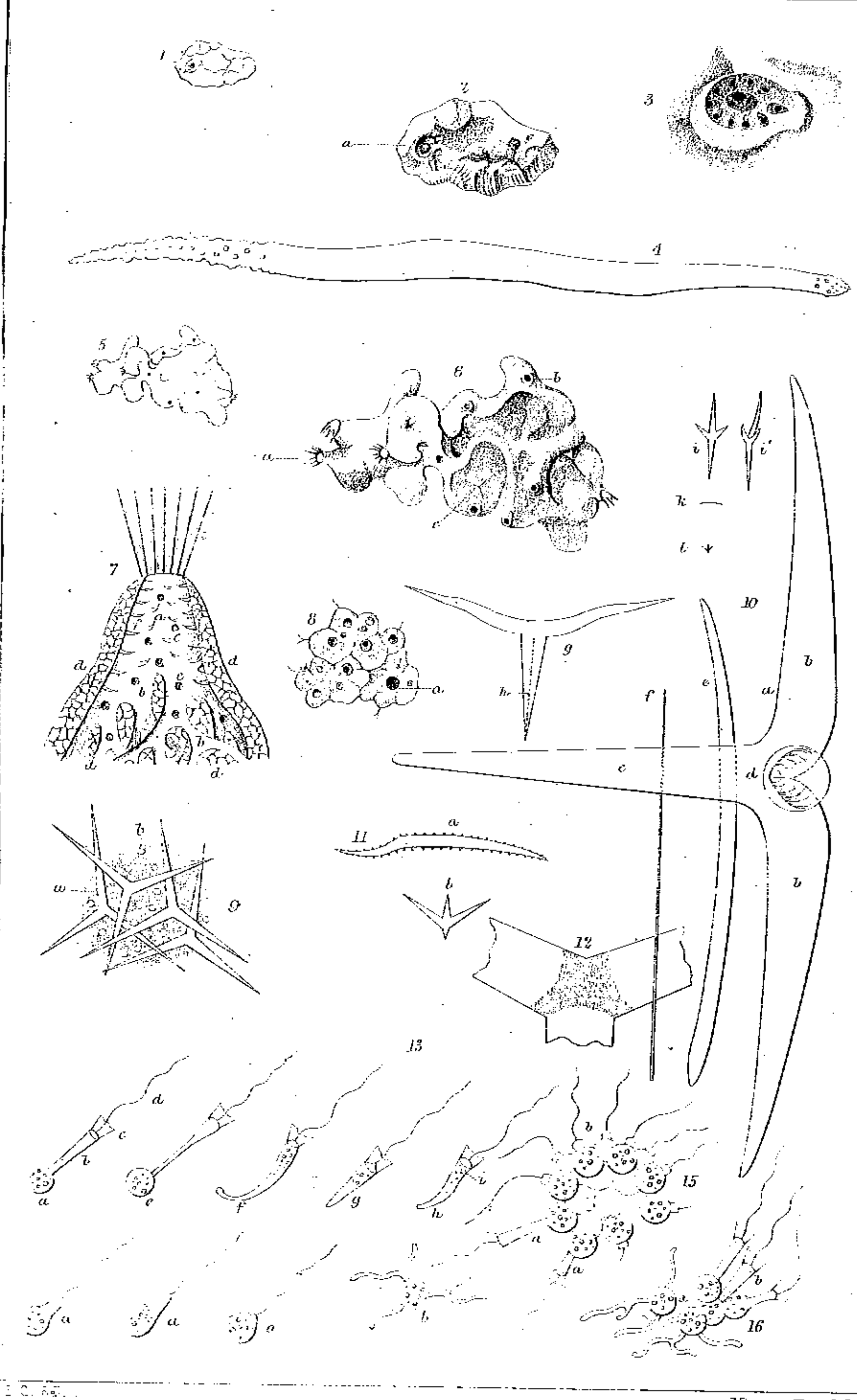

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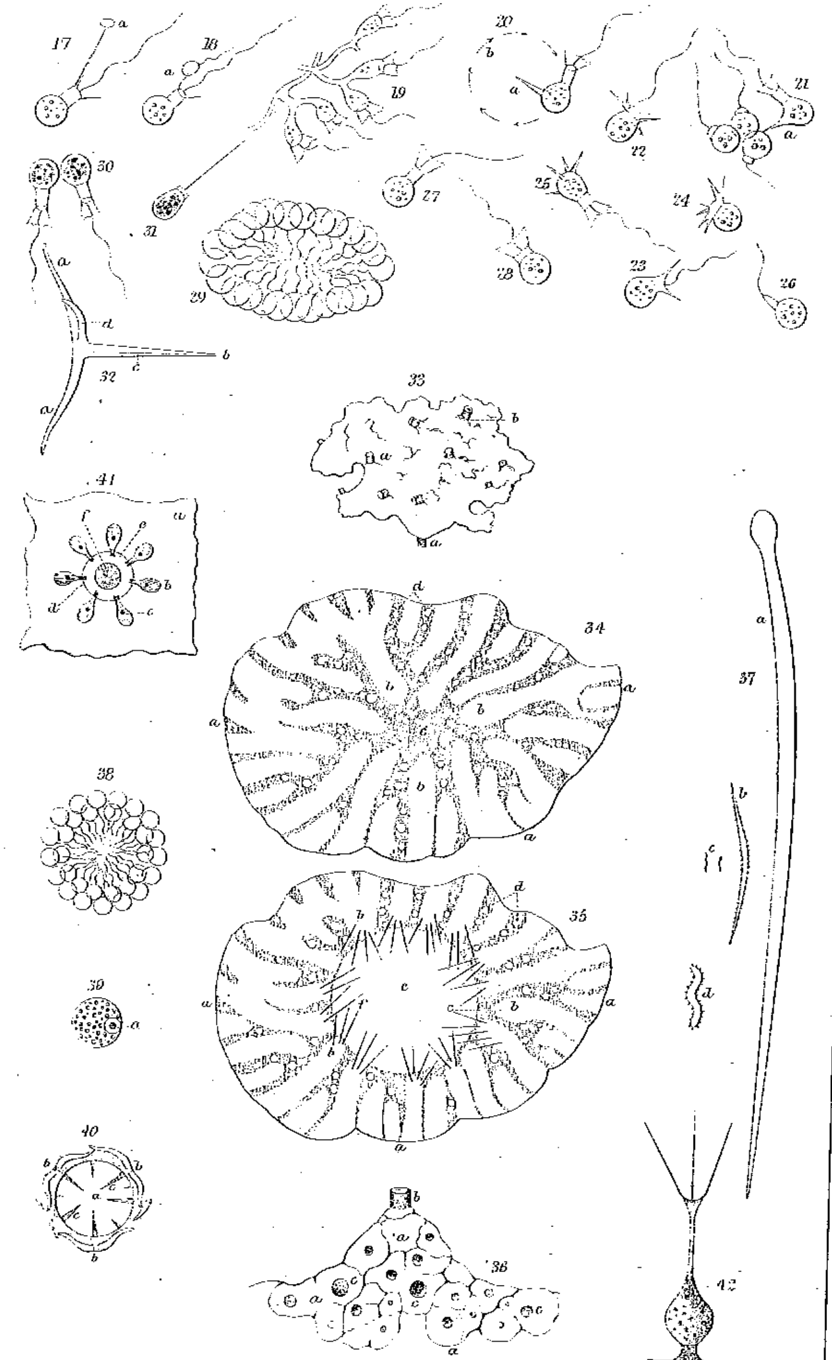

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