PLATES IN VOL. IV.

THE ANNALS

AND

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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 Crateriides, 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 Rel. I.

No. 19. JULY 1869.

I.—*A Descriptive Account of four Subspherous Sponges, Arabian and British, with General Observations.* By H. J. Carter, F.R.S. &c.

[Plates I. & II.]

The Subspherous Sponges, like potatoes in appearance, analogous also in form to the Lycoperdons, the large Sphæriæ, and the tuberose Fungi, are not unfrequently present among the exuviæ of the sea-shore, where, after having been freed from their original attachments, and drifting in a living state about the bottom of the sea for awhile, they are at last landed by the waves.

Having specimens of two species, which I found on the south-east coast of Arabia (one of which was gathered alive), and of two others found on the beach at Budleigh-Salterton (also alive), I resolved, for the sake of direct information, to examine them respectively; and bringing to my aid Dr. Johnston's work on the British Sponges (1842), and Dr. Bowerbank's papers on the Spongiadæ, published successively in 1862 and 1864 by the Royal and Ray Societies, I found so much still left untold that I further resolved to draw each of these sponges themselves, and, placing their elementary parts beside them respectively, to write a simple description also of each (that is, confining myself as much as possible to familiar terms in our own language), and to follow the whole by ge-

neral observations showing how far I agree and how far differ from the remarks of my predecessors on this portion of the Spongiadæ.

Two of the species which I have figured and described are new, viz. the Arabian ones; and the other two are common to our own shores, but hitherto very inadequately represented. Each contrasts in most respects strongly with the other, and all four brought together in this way seem to me well fitted to convey a good idea of the principal as well as peculiar features of the subspherous Spongiadæ respectively.

My object has not been to present a mere description which might serve for a handbook, but to give an elaborate account, with illustrations, of four of the most characteristic species of the division, to correct to a certain extent what appear to be the errors of others, and thus to record, to the best of my ability, descriptions and observations which might be relied upon for future classification.

In these descriptions I shall as much as possible avoid the word "tissue;" for such is only shadowed forth in the sarcode of the sponge, and, however much apparent in its fresh state, more or less subsides into a glue-like mass on drying, when tissue in the higher developments for the most part puts forth its most definite, prominent, peculiar, and persistent characters. The tissues and the structures of the sarcode, whatever they may be, are, for the most part, as it were *in embryo*; and we have nothing to do with the naming of objects, in a scientific point of view, until they are unmistakably defined. Hence such terms as ovaria, membrane, œsophagus, pyloric valve, &c., in respect to the sponge, had better for the present be omitted, whatever their application hereafter may prove worth when such parts in the sponge are undeniably identified.

In the following descriptions, also, it must not be expected that I have given the whole history of the British species, their habitat, locale, &c.; this must be sought for in the works to which I have alluded, my desire being chiefly to contrast four prominent species among the subspherous sponges, two of which appear to have been undescribed, and the other two unsatisfactorily illustrated.

The measurements (of course approximative) are chiefly given in the explanations of the plates, to avoid confusion in the text, and units indicating so many 1800ths of an inch or fractions of the same (unless otherwise mentioned) have been employed, by which the relative proportion of the objects in size may be seen at once, and the real size readily computed if necessary; while the illustrations of the sponges themselves,

although drawn after nature as much as the subject would permit, are less for effect than for efficiency, the microscopist often having, in his delineations, to aim at that which an artist would not tolerate nor could supply.

Tethya arabica, mihi.

Pl. I. figs. 1–8, and Pl. II. figs. 19 & 20.

Globular and free, or hemispherical and fixed. Surface soft, hispid, reticulated, with the pores occupying the interstices, and projecting spicules the lines of reticulation, all more or less matted together by the dermal sarcode of the sponge. Large vents in more or less plurality, monticular. Internal structure radiated, rigid, compact, consisting of a corticular, a body-, and a nucleated portion. Corticular portion loose, ill-defined, consisting of tufts of spicules matted together by dermal sarcode. Body formed of sponge-substance supported on bundles of spicules overlapping each other and radiating from the nucleus to the circumference; the whole permeated by the excretory system of canals, which, branching and anastomosing throughout, finally terminate in the vents on the surface of the sponge. Fleshy portion of sponge-substance more or less charged with minute spherical bodies like gemmules. Nucleus globular, consisting of a more compact and dense condition of the spicules and sponge-substance of the body. Spicules of the surface all smooth and pointed, consisting for the most part of groups of bifid, trifid extended, and trifid recurved heads, supported on long delicate shafts respectively, mingled with the pointed ends of the stout spicules of the body. Spicule of the body straight, smooth, fusiform, pointed at each end, or not unfrequently with one end more or less abruptly terminated and round. *Minute*, thread-like, contorted spicules, semicircular and sigmoid, together with minute siliceous globules, abound throughout the sponge, but more particularly in the corticular portion; somewhat larger ones, of a semielliptical form, with single, pointed, incurved ends, and others of a like kind, whose shafts consist of three curves (of which the central is the largest), with trifid ends, webbed together like a waterfowl's foot, and bent inwards, are not uncommon in this sponge. Gemmules (?) numerous, white, spherical, in all sizes of development up to the matured or largest, which consists of a spheroidal cell filled with globules (?) of refractive matter; gemmule white, when viewed by direct light, but by transmitted light seen to be surrounded by an equally spherical transparent portion, or cell, densely charged with extremely minute, bacilliform spicular bodies.

Size variable, that of specimen figured 3 inches in its longest diameter. Colour:—corticular portion grey, body bright orange, nucleus pink.

Hab. South-east coast of Arabia, opposite the north-east end of the island of Masira. Free or fixed to the rocks along the shore.

Obs. I found several specimens of this sponge about the locality mentioned; some were floating or rolling about in the land-wash, and others fixed to the rocks—the latter with, and the former of course without, point of attachment. It is probable that those portions alone float which, having got out of the water for a little time, get some air in them, and that when this is extricated they again sink to the bottom. The sarcodal substance of this sponge is so rigid and contractile that, when alive, it can with difficulty be torn to pieces. Those on the rocks appeared to me to get more rigid in proportion as I tried to get them off, until at last I was obliged to apply my geological hammer and chisel to them. The forcible power of contractility here, as well as in *Tethya lyncurium*, which I shall presently describe, may partly account for the compact character of the sponge-substance after death, and the comparative absence of the excretory system of canals probably arising therefrom, in both these species. *T. arabica* very much resembles *T. cranium* of our own shores; but I found no gemmules in it, like those figured and described by Johnston and Bowerbank respectively as peculiar to the latter species; nor does the surface of the Arabian species agree with that of *T. cranium* figured in Johnston's 'British Sponges.' It appears nevertheless to be the representative of the latter on the south-east coast of Arabia.

In one small portion of the surface which I examined there happened to be several stoutish triradiate spicules, with their rays expanded in the corticular part, like those of *Geodia*—showing, by this occasional occurrence, how such characters may be present in species otherwise distinctly different.

On treatment with iodine, faint traces of starch made their appearance in the globular contents of certain little cells, but not of the gemmules, which turned amber-colour.

When dry, the surface of this sponge presents a glistening asbestiform appearance, from the number of delicate spicules which project beyond the dermal sarcode.

Geodia (*Cydonium*, Gray) *arabica*, mihi. Pl. I. figs. 9–16.

Globular, free or fixed. Surface hard, hispid, covered with a short hirsute dermal sarcode (where the latter is not abraded) densely charged with minute smooth spicules, beneath which

are a number of dimples or pores more or less regularly scattered over the whole sponge, with here and there larger ones, of the same appearance, which seem to be vents. Internal structure subradiated, cavernous, consisting of a cortex and body, but no nucleus. Cortex hard, compact, composed of a thin but firm layer of globular crystalloids, apparently in contact with each other, covered externally by the dermal sarcode mentioned, and internally in communication with the body, the dermal sarcode presenting minute apertures of communication between the exterior and interior of the sponge; and, where abraded, that portion only of this sarcode which is usually stretched across the pore in the form of a diaphragm with central circular aperture some distance below the surface. Body formed of sponge-substance supported on intercrossing stout spicules, which circumferentially run into a zone of radiating ones that support the cortex, and centrically into a denser condition, which is subnuclear; the whole permeated by an excretory system of wide canals, which, branching and anastomosing throughout, communicate to the body a cavernous subradiated structure, finally terminating in the vents on the surface of the sponge. Spicules of the dermal sarcode minute, smooth, slightly curved and pointed at each end. Globular crystalloids of the crust more or less elliptical, somewhat compressed vertically, and presenting an umbilicated depression on the proximal side; found in every part of the sponge, in all stages of development, but chiefly forming the crust. When young, consisting of a minute central point surrounded by a radiated mass of hair-like spicules, which, in advancing towards maturity, become conical externally and, giving place to a clear general crystallization of the centre or body internally, terminate at last on the surface in short, rough, club-shaped eminences and polygonal star-like facets (peculiar to the umbilicated depression and convexity respectively) separated from each other by shallow fissures. Spicules of the body large, smooth, fusiform, slightly curved and pointed at each end. Spicules of the zone supporting the crust all smooth and pointed; provided for the most part with trifid extended, trifid recurved, and triradiate heads, in the proportion of about eight of the two former to one of the latter, which in point of stoutness is more than double their size; all furnished with long pointed shafts, of which the stout triradiate one is by far the shortest, although the thickest. *Minute* stellate spicules found in every part of the structure, but most about the crust, inside and out, consisting of a variable number of smooth (?), straight rays, radiating from a central globule; also some few of a larger kind, in which the rays consist of a number of

short conical processes standing out vertically from a thick globular body. Size variable; that of the specimen figured 3 inches in diameter. Colour: grey on the surface, yellowish interiorly.

Hab. South-east coast of Arabia, opposite the north-east end of the island of Masira. Free at the bottom of the sea, whence it gets landed by the waves.

Obs. I have never found a living specimen of this sponge, or a specimen fixed to the rocks: my descriptions are taken from dried ones found on the sea-shore, whose shape nevertheless indicates their free or floating habit. Pieces of stone and coral, however, may be attached to this sponge almost sufficient to keep it stationary at the bottom of the sea; and in these instances it is observed that the crust is always continuous next to the foreign material, by which we learn that it must therefore have been the dermal sarcode outside the crust which attached them to the surface of the sponge. Of course the same remark applies to the condition under which portions of *G. arabica* would float or sink to the bottom as that on *T. arabica*, viz. the presence or absence of air in it.

This species is closely allied to *Geodia zetlandica* of our shores; and if hereafter it should be found that the dermal spicules of *G. arabica* are of the same kind as those which impart a like hirsute character to *G. zetlandica*, and that this character in the latter should be owing more to their presence than to the "projection of the body-spicules" (which in *G. arabica* are ten times as long as the dermal ones), then it is not improbable that both will have to be regarded as belonging to the same species. Stellate spicules also abound in the dermal sarcode, but they are subsidiary; they are no more numerous there than the stellate spicules which we shall presently see in the dermal sarcode of *Pachymatisma Johnstonia*, where a fusiform, rough, and not the stellate form will be found to be the dermal spicule in particular. Like the latter, whose surface, when fresh, is of a grey colour, from the translucent state of the globular crystalloids and sponge-tissue when soaked in water, it consequently becomes chalky-white when dry; and probably, like *Pachymatisma* also, although subsequently free, is, in the early part of its history, fixed in some submarine locality.

On comparing the size of the pores and their distance apart in *G. arabica* with those in a fresh specimen of *Pachymatisma* (where they appear in other respects to be precisely alike), I find that the former are all much smaller and much nearer together than in the latter. But as they are much smaller and much nearer together in the dried than in the fresh specimens of *Pachymatisma*, I infer that in the fresh state of *G. arabica* they would also have been much larger and much further apart than in the dried specimen. This difference in size and distance therefore arises from contraction; and allowance should be made for it in viewing the illustration, which is, of course, taken from a dried specimen.

On raising a portion of the crust of a specimen of *G. arabica*, and taking out a piece of the subjacent structure (viz. that just inside the trifid heads of the spicules of the zone), I find, by treatment with iodine, that it often contains many decided starch-granules, whose presence seems to indicate that they were developed there, and there in particular, since the part was never so exposed before I opened it, and no portions of the structure taken from other parts of the sponge have, under similar circumstances, presented any trace of an amylaceous deposit; nor have I ever been able to find any starch-granules in a corresponding position of the structure in *Pachymatisma Johnstonia*. The remark is therefore made for what it may prove worth hereafter.

Tethya (*Donatia*, Gray) *lyncurium*, Lam.

Pl. II. figs. 1–6.

Globular, almost spherical, fixed. Surface continuously uneven, wartlike, and rigid, except at the part of attachment, which is, of course, rough and torn; consisting of small, more or less circular lobes, with interangular depressions, the former presenting the broken ends of spicules, and the latter, in the recent state only, the pores and vents respectively of the sponge, which the cortex, owing to its powerfully contractile nature, closes to almost entire obliteration after death. Internal structure radiated, rigid, compact, consisting of a cortex, body, and nucleus. Cortex defined, thick, rigid, consisting of sponge-fibre interlacing at right angles the spicules of the body as the bundles of the latter pass through it, in an expanded form, to the surface; the whole so dense as to assume the appearance of fibro-cartilage; charged with two forms of stellate spicular bodies peculiar to the species. Body consisting of sponge-substance supported on stout bundles of spicules overlapping each other and radiating from the nucleus to the circumference; the whole permeated by the excretory system of canals, which, branching and anastomosing throughout, finally terminate in the vents on the surface of the sponge. Nucleus large, globular, consisting of sponge-fibre and spicules, all intercrossing and interwoven with each other so densely as, like the cortex, to present the appearance of fibro-cartilage. Spi-

cules of the body straight, smooth, fusiform subulate—that is, awl-shaped, with one end round; of different degrees of tenuity, but probably all subulate. Stellate spicules of two kinds, large and small or minute: large stellate spicule smooth, consisting of a clear globule of silex more or less covered with tubercular projections supporting a variable number of conical pointed rays, which are frequently more or less undulated, and sometimes bifurcated, at the extremity; situated chiefly at the union of the cortex with the body: *minute* stellate spicules consisting, in like manner, of a central globule, from which project a variable number of rough subspinous rays; found in abundance throughout the whole structure, particularly in the lines of the afferent or incurrent (?) canals, and the outer part of the cortex. Size of specimen figured about an inch in diameter when fresh. Colour dull sponge- or amber-yellow, most evident in the fleshy substance of the body.

Hab. England, Devon, Budleigh-Salterton beach. Marine, place of growth to me unknown.

Obs. About three years since, several of these were found on the beach at Budleigh-Salterton, having by some means been wrenched from their place of growth and thrown up (I think in the autumn) among other exuviæ. They were brought to me quite fresh on the same day that they were found; but their place of growth is to me as yet unknown. I could discover no gemmules or reproductive bodies in them like those observed in *Tethya arabica*; and the afferent and efferent canals can only be traced by placing a thin vertical section of the cortex (after having been compressed while drying) in balsam, when the minute stellate spicules almost alone mark their course, on account of the homogeneousness of the structure and plastic consistence of its elementary tissues through which they pass, and in which, on this account, they appear to exist as mere canalicular excavations. In short, the fibres of the cortex are so soft, plastic, and delicate, that on drying they all collapse into a common mass, in which individually they become indistinguishable.

It might be observed that the abundance of minute stellate spicules in the afferent canals are for the purpose of straining the water as it passes through them into the body of the sponge; but it must be first proved that they *are* in the afferent or incurrent, and not in the efferent canals, before this opinion can be held; and then it can only be conjectural.

Pachymatisma Johnstonia, Bowerbank. Pl. II. figs. 7–18.

Subglobular, tuberose. Surface hard, or covered with a soft dermal sarcode (where not abraded) densely charged with

minute rough spicules, beneath which are a number of pores more or less regularly scattered over the whole sponge, with here and there larger ones that appear to be vents. Internal structure dense, amorphous, without any appearance of radiation, consisting of a cortex and body only. Cortex hard, compact, composed of a thin but firm layer of globular crystalloids in juxtaposition, covered externally by the dermal sarcode mentioned, and internally in continuous contact with the body; pierced by conical or dimpled depressions called "pores," keeping up communication between the exterior and interior of the sponge through several microscopic apertures in the dermal sarcode opposite to them, when this sarcode has not been abraded, but where this has been the case presenting a diaphragm of it pierced by a circular aperture some distance below the surface*. Body formed of sponge-tissue supported on intercrossing spicules, which circumferentially run into a narrow zone of triradiate ones that support the crust, the whole permeated by the excretory system of canals, which, branching and anastomosing throughout, communicate to the body a cavernous structure, but not the least appearance of radiation; finally terminating in the vents at the surface of the sponge. Spicules of the dermal sarcode minute, fusiform, rough or subspinous. Globular crystalloids of the crust for the most part elliptical, elongate, somewhat compressed vertically, and presenting an umbilicated depression on the proximal side, found abundantly in every stage of development in every part of the sponge, but chiefly in the crust, where they are packed together like masonry, and sometimes equally so round the calibre of some of the excretory canals for nearly an inch of their course inwards. When young, consisting of a minute central point surrounded by a radiating mass of hair-like spicules, which, in advancing towards maturity, become conical externally and, giving place to a clear crystallization of the body internally, terminate on the surface in clavate rough extremities or polygonal star-like facets (according to their position in the umbilical depression or on the convex surface of the crystalloid), separated from each other by superficial fissures. Spicules of the body all smooth and slightly curved, cylindrical or fusiform, with simply rounded or inflated extremities. *Minute* stellate spicules abundantly dispersed in every part of the sponge, and consisting of a variable number of conical subspinous rays, radiating from a more or less conspicuous central point. Size of specimen figured about $1\frac{3}{4}$ inch in

* That this diaphragm is a portion of the dermal sarcode seems probable, from the occasional presence in it of the dermal spicule.

longest diameter when fresh. Colour light grey, becoming darker on contraction of the sponge after death.

Hab. England, Devon, Budleigh-Salterton beach. Marine, place of growth to me unknown.

Obs. I found three specimens of this sponge on the beach at Budleigh-Salterton in February last, the largest of which is about 3 inches in diameter. They did not present any pedicle of attachment, and therefore must have been free for some time previously. Sessile they are most probably at one time or other, and soon cement themselves through the dermal sarcode to loose stones or rocks when they are left in contact with them respectively. But they always fortify themselves with their crust first, which thus as constantly intervenes between the body and the foreign ingredient. It is the dermal sarcode which forms the bond of attachment. Two of the specimens were fresh and living when I found them on the beach; but of their original place of growth I am as yet ignorant. Sometimes, probably, such sponges are wrested from their places of attachment by the dredges or trawls of the fishermen as they pass over sandy bottoms, and, when thus loosened and brought to the boat, may not be thrown overboard until some air has got into them, when they float on the surface till this is extricated, but, afterwards sinking, may be drifted at last by under-currents to the shore.

It is to the microscopic apertures in the dermal sarcode covering the pores and their subjacent cavities that Dr. Bowerbank would apply the terms "pores" and "intermarginal cavities" respectively—points to which we will now more particularly direct our attention.

GENERAL OBSERVATIONS.

Pores and Oscules.

To understand these terms, it is necessary to consider them abstractedly. Thus the young *Spongilla* growing from the seed-like body may probably be taken as typical of the whole. It consists of many pores and one oscule. The former admit the particles of food to the sponge; and the undigested portions, having passed through its sarcodal substance (apparently in the same manner and as easily as the undigested particles in *Amœbæ* are passed through its body, viz. without cicatrix), find their way into the excretory system of canals which terminate in the latter or single oscule. And this system, multiplied over and over again as the mass increases in bulk, probably accounts for the great number of pores, together with the plurality of oscules presented by all the larger pieces of sponge.

Before the particles reach the pores, they pass through apertures in a delicate expansion of sarcode which, membrane-like, covers the *Spongilla*, which apertures (about 1-700th of an inch in diameter) are extemporized here and there in this expansion, or closed, as occasion may require. Again, the single oscule, which is supported on a tubular mammillary projection and passes through the sarcodal expansion, can also be closed or opened as required by the sponge.

But these apertures are situated in a substance which is too delicate and evanescent to last long under rough treatment; and hence the term "pores" has been used by naturalists for those superficial cavities which this sarcodal expansion covers in the more solid and durable parts of the sponge, viz. those which are evident to the unassisted eye. Hence the name "Porifera" applied to the class by Dr. Grant, the term "oscule" having only been used for the larger pore which is the opening of the excretory system of canals. "Vent" has also been applied to the latter, which, as regards function, is, of course, more suitable.

Thus Dr. Johnston, in his 'British Sponges,' p. 196, describes the surface of *Geodia zetlandica* as "dimpled in some places, with numerous pores placed pretty closely together, and large enough to be visible with the naked eye,"—to which Dr. Bowerbank (Brit. Sponges, vol. ii. p. 46) objects, stating that "These orifices are not the pores, but they are the intermarginal cavities which receive the minute streams from numerous pores situated immediately above and within a short distance of them; the true pores, perforating the dermal membrane, are too minute to be visible without the assistance of considerable microscopic power." Yet, in describing *Pachymatisma*, only seven pages further on (p. 53), the same author states:—"In the living condition the pores are not visible to the unassisted eye, but in the dried state they are very distinctly seen;" while at p. 110 of vol. i. we read:—"In *Pachymatisma Johnstonia*, Bowerbank, a British sponge closely allied to the genus *Geodia*, we find the dermal membrane perforated by innumerable pores, some as minute as $\frac{1}{1000}$ inch in diameter, while others attained the size of $\frac{1}{230}$ inch."

It is not difficult to see that there is some confusion here: viz. that in the latter quotation "pores" (ranging from $\frac{1}{1000}$ to $\frac{1}{230}$ inch in diameter), which certainly cannot be distinctly seen by the unassisted eye, are stated in the former quotation, although not visible to "the unassisted eye" in the living condition, to be "very distinctly" so in the dried state.

In this dilemma I prefer the prescriptive meaning given to the pores by Dr. Johnston, and as such shall continue to apply

it, leaving the "pores" and "intermarginal cavities" of Dr. Bowerbank for subsequent explanation.

In my description of the "Ultimate Structure of *Spongilla*" (Annals, 1857, vol. xx. p. 21), I have shown that the membrane-like sarcodal expansion in which Dr. Bowerbank's "pores" are situated, is composed, like the rest of the animal, of a congeries of polymorphic sponge-cells, and that thus these "pores" can be extemporized or closed in any part of this structure that occasion may require. Hence Dr. Bowerbank's term of "dermal membrane" does not give an adequate idea of the real nature of this development. Indeed it would be out of place, as it is out of character, to expect in the ever-changing, polymorphic, sarcodal substance of these primitive animals anything to which the term "membrane," as it is used in anatomical description for the higher animals, could be applied; and it was on this account that, in the 'Annals' of 1856, I proposed the term "pellicula" for the surface of sarcodal structures, this having previously been suggested by Mohl for the consolidated surface of material which has no distinct enclosing membrane, and by Dujardin, who likens it to the film which occurs over "flour paste or glue when allowed to cool in the air."

I am aware that I have misapplied the term "membrane" myself, as regards *Spongilla*, in the paper to which I have alluded; but that is no reason why I should repeat it here. In this paper, also, I have used the term "apertures" for the extemporized holes in the sarcodal expansion covering the sponge, and the terms "afferent" and "efferent" for the incurrent and excurrent systems of canals respectively which are hollowed out in the parenchyma of the body, and I shall continue to use these terms under the same signification. It should, however, be remembered that while the efferent canals form a distinctly arboritic system, the afferent ones appear to be only passages of intercommunication between the exterior of the sponge and its areolar or vacuolar cavities, and between the areolar cavities themselves. For the more ultimate structure of the parenchyma in *Spongilla*, see 'Annals,' *l. c.*

From the "pores" (that is to say, my "apertures") let us follow Dr. Bowerbank on to his "intermarginal cavities," which, at p. 101, Brit. Spong. vol. i., are thus described:—"They are in form very like a bell the top of which has been truncated. They are situated in the inner portion of the dermal crust, the large end of the cavity being the distal, and the smaller end the proximal one. The open mouth or distal end of the cavity is not immediately beneath the dermal membrane. There is an intervening stratum of membranes and

sarcode, of about two-fifths the entire thickness of the dermal crust, which is permeated by numerous minute canals, which convey the water inhaled by the pores to the expanded distal extremity of the cavity. The proximal end is closed by a stout membranous valvular diaphragm, which the animal has the power of opening or closing at its pleasure."

Now, the result of my dissection of this structure, both in *Geodia* and *Pachymatisma*, being somewhat different and more elaborate, it will be better to describe it in my own words; and using the term "pores" in the sense of Dr. Johnston, viz. for the dimpled depressions of the surface, it is perfectly evident that they are the orifices of hourglass-shaped openings in the crust, whose constricted portion is situated about midway between the external and internal surfaces of the latter, as proved by their expanded portions on either side requiring to be scraped off for a better observation of the constricted one.

These hourglass-shaped openings are lined throughout with a thin film of sarcode, which, in the constricted portion, still further reduces the diameter of this part by extending itself across it in the form of a diaphragm provided with a central opening which is more or less spiral *inwards*, the outer part of the diaphragm being always *flat*. Moreover the spire, which commences in the aperture of the diaphragm, is sometimes prolonged inwards from it in the form of a spiral tube of four or five turns, which is again constricted in the centre and free at the *inner* extremity—thus dipping as it were into the inner portion of the hourglass cavity. (Pl. II. figs. 11, 12.)

Hence the aperture through the diaphragm is more or less spirally continued on on its inner side.

Inwardly the film of sarcode lining the inner portion of the hourglass opening of the crust is in continuation with that lining the areolar or vacuolar cavities situated at the circumference of the parenchyma of the sponge, into one of which this part of the hourglass opening expands itself; and here, at the commencement of the expansion, may be observed minute apertures, which are more or less scattered all over the surface of the areolar cavity. Some of these appear to be intended to keep up communication between the adjoining areolar cavities, while others, viz. those on the vault or portion next the crust, are the terminations of certain canals coming from the surface of the sponge, to be hereafter mentioned.

Externally the hourglass opening is covered by the dermal sarcode when this is present, which is not always; for it is frequently absent in parts, having probably been rubbed off by the rolling about of the free specimens in the sand at the bottom of the sea; but whether present or absent, the hour-

glass cavity and its diaphragm remain the same in all other respects.

This dermal sarcode presents a great number of minute papillæ scattered more or less over its whole surface, each of which is terminated by an equally minute aperture, the latter frequently more in appearance than reality, since a thin film of sarcode is frequently stretched across it, which, in its turn, may or may not be provided with a central opening, the presence or absence of these openings being probably fortuitous—that is, depending on certain conditions of the sarcode during the death or desiccation of the sponge. (Pl. II. fig. 10.)

The papillary apertures, averaging a little more or less than 1-1000th of an inch in diameter, are chiefly congregated, over the openings of the hourglass-shaped cavities of the crust, into distinct areæ, each of which is more or less convex and presents an appearance like the top of a pepper-box (that is to say, a convexity pierced by the papillary apertures), which area itself is often pursed outwards in the centre also in a papillary form, with an aperture, in the living state, probably, at its termination.

Lastly, the papillary apertures which are immediately over the outer part of the hourglass-shaped opening in the crust lead directly into this cavity, and those at the circumference of the area to minute canals which pass down to the vault of the areolar cavity (into which the inner portion of the hourglass-shaped opening expands itself), through the hourglass opening, but *outside* its sarcodal lining; while the papillary apertures of the crust generally (that is, those altogether outside the areæ) lead to similar canals which traverse the crust opposite to them, and also open within into the vault of the nearest areolar cavity. The two latter sets are the openings of the canals to which I have alluded when describing the inner portion of the hourglass-shaped opening in the crust.

I have not been able to observe any apertures opening into either portion of the hourglass cavity through its sarcodal lining direct; and the minute spicules so abundant in the dermal sarcode are seldom present in it or in its diaphragmatic expansion. These spicules in the dermal sarcode are frequently arranged sponge-like around the papillary apertures—that is to say, after the manner of poles supporting a conical tent.

Thus it will be seen that there are many points of difference between Dr. Bowerbank's and my descriptions, which need not be particularized, as both the latter are given above, *in extenso*; and should ocular demonstration be desired to confirm the statements I have made, this may be obtained by vertical

and horizontal sections of the crust in fresh, half, and wholly dried specimens respectively of *Pachymatisma Johnstonia*, carefully made and manipulated under the microscope, taking the precaution never to reflect the film of sarcode which lines the cavities under examination, as this at once destroys all certainty respecting the apertures which may or may not exist in them in their intact state.

One point, however, I would notice, viz. that I have not had an opportunity of seeing the aperture in the diaphragm open and close as stated by Dr. Bowerbank, which statement must have been an inference, as it refers to a specimen of *Geodia Barretti*, which had been "pickled in strong salt and water" (Phil. Trans. p. 1099).

I have stated that, at this early period of animal development, we should not expect to find tissues of the same kind as those in higher animals, and therefore that Dr. Bowerbank's application of the term "membrane" to the dermal sarcode is not legitimate. But although the whole of the soft substance of the sponge on drying becomes agglutinated into a homogeneous mass like glue, there are frequently many parts of it in the fresh state, and sometimes in the dried (*ex. gr.* the cortex of *Tethya lyncurium* &c.), where tissue-like structure faintly appears.

To deny, therefore, the presence of tissues in the sarcode of the lowest grades of animal life is not theoretically correct, however much it may be desirable to do so for practical purposes.

We cannot see the elements of which water or glass is composed, but inference leads us to the conclusion that the one is formed of particles of matter in an uncrystallized, and the other in a crystallized condition. Indeed, if we could see either in either state, there would be an end of all microscopy.

All we know of things is by comparison, and for practical purposes we discourse of those characters which are most familiar to our senses; still we cannot help seeing in the sarcode of the sponge a looming of tissues which, like objects approaching from a distance, become more evident to us in the coarser, more durable, and more evident developments of the higher animals.

But, to return to Dr. Bowerbank's "true pores," which I have, in my description of the "Ultimate Structure of *Spongilla*" (Annals, 1857, vol. xx. p. 21), designated "apertures" of the investing membrane. These I discovered in 1856, while at Bombay (Annals, Sept. 1856, vol. xviii. p. 242). The manuscript was in the hands of the printer in England in the month of June, and the first part published in the 'Annals' on the

1st of August. Dr. Bowerbank announced his description of those apertures at the meeting of the British Association held on the 30th of August; and on the 1st of September appeared the other part of my paper, to which my note on the subject was appended. Thus, had the whole of my paper been published at once, I should have preceded Dr. Bowerbank in his announcement by just one month. Yet Dr. Bowerbank *very* frequently alludes to his own announcement both in the 'Philosophical Transactions' and in the 'British Sponges,' of 1862 and 1866 respectively, without ever mentioning my name in connexion with it; while my figure and particular account of those apertures, in the 'Annals' of 1857, is still, I believe, the only published illustration of the fact.

If it be assumed that this reticence arose from not reading my papers, then it must be also assumed that Dr. Bowerbank did not read what was published on his own special subject, and, consequently, that what is stated in the 'British Sponges' &c. is mostly upon his own *ipse dixit*: lacking, therefore, authority, it lacks confidence.

It matters little who has discovered these apertures, so long as the fact is made known to the public; but the *suum cuique* should be a sacred obligation among individuals; and nothing that is put before the public loses by additional evidence.

Globular crystalloids.

This term I use for the little siliceous bodies which, closely packed together, form a hard crust on *Geodia* and *Pachymatisma*, whether free or in contact with attached pieces of rock or coral, and also sometimes coat the calibre of the larger excretory canals of the latter for some distance into the parenchyma of the sponge; so that they are evidently accumulated in those parts which are most likely to come into contact with foreign objects. They are imbedded in living sarcode of the sponge, which, acting as a plastic bond of union between them, thus gains access to the surface, where it forms the dermoid layer, charged, as before stated, with minute spicules peculiar to the species.

They are found generally in a more matured form in the crust, especially in *Pachymatisma*, than in the body of the sponge, and, after full development, might be transferred from the latter to the former probably as easily and as naturally as an *Amœba* discharges its undigested material through the surface of its body, viz. without injury. But being chiefly confined to the crust in *Geodia arabica*, while they abound generally in the body of *Pachymatisma Johnstonia*, it becomes

questionable whether the whole of those formed in the crust are not entirely developed there.

Be this as it may, they begin their development, and for some time follow it, very much like the radiated crystallization of minerals, viz. first commencing from a central point, surrounded by radiating hair-like spicules, which finally become consolidated into a globular mass. Here, however, they leave the spheroidal or mineral for the organic form, and become oval, compressed, provided with an umbilical depression in the centre, and a surface of clavate tubercles with more or less flat or conical heads according to their position.

It is remarkable also that, in the vertical section caused by fracture, the body is found to have become a clear crystalline solid globule, still faintly showing the radiated lines of its early structure extending from the centre to the circumference (Pl. I. fig. 12 *a*, & Pl. II. fig. 14 *b*). On no occasion have I been able to detect a central cavity in any stage of their development, either in their natural state or after having been exposed to a red heat, when the axial canals of the long spicules almost invariably become expanded, and indicate, from their charred appearance, the presence of more or less animal matter. At whatever period, even under these circumstances, the crystalloid was broken, whether in its early unconsolidated hair-like or in its subsequent crystalline compact state, the same structure was continuous from the centre to the circumference; there was no appearance of central cavity. Thus, however much they resemble the seed-like bodies of *Spongilla* in appearance, they totally differ from them in their structure and in their nature. The seed-like body of *Spongilla* is incomparably larger, commences as a simple spherical soft cell, looking like a white speck imbedded in the sponge, and finally becomes coated with its horny or siliceous spicular cortical coat, as the case may be. (Annals, 1849, ser. 2. vol. iv. pl. 3. fig 6; and 1859, ser. 3. vol. iii. pl. 8. fig. 3.)

To these globular crystalloids Dr. Bowerbank has applied the term "ovaria," stating that, "In an early stage they appear as a globular body of fusiform acerate spicula, radiating from a central point in the mass" (Phil. Trans. 1862; Brit. Spong. vol. i. p. 141), that in the midst of this central point "a central cavity is produced in which the incipient ova very shortly appear," that the inner and acute terminations of the radiating spicules form "the common inner surface of the cavity of the ovarium, which is now filled with an opaque mass of ova," that "a single conical orifice or foramen has also been produced in a portion of the wall, through which the ova are destined to be ejected," and that this takes place by

the growing again inwards of the spicules, so as to fill up the cavity to their original "central point" of departure.

It is needless to criticise this deliberately detailed statement, which is by no means borne out by the figures intended to illustrate it, whatever the bodies may have been from which these were taken (Brit. Spong. pl. 22. fig. 327, and Phil. Trans.). It must have been as difficult, one would think, to obtain all this information with the microscope as for a closed *siliceous* cavity to form itself in the central point of a radiating mass of spicules, then secrete ova in its interior, then form a hole for their exit, and then close its cavity up again so as to become a compact ball of silex, termed by the author an "adult" or "mature ovarium" (!) (Phil. Trans. *l.c.* p. 815; Brit. Spong. vol. i. p. 143).

Alluding to these globular crystalloids in *Pachymatisma*, Dr. Johnston, with his natural modesty and love of truthfulness, observes:—"The bodies which Dr. Bowerbank has described as the *gemmules* of its crust are, he writes me, very much alike in structure to the granules of the *Geodia*, which he finds also occur in the body of this sponge as well as in the crust. This suggests the query whether the cuticular granules of *Geodia* may not be truly gemmules; but I confess that to me it appears the question should be answered in the negative. Their position, their siliceous and crystalline character, and the mode of their aggregation, seem all opposed to it, and not less so the difference between them and the recognized gemmules of some Halichondriæ." (Hist. Brit. Sponges, p. 202.)

It seems to me that if the globular crystalloids of the crust of *Geodia* are to be considered ovaria, the large stellate bodies of *Tethya lyncurium*, which are similarly situated and very nearly as large (bearing the proportion of 6 to 8), should also have this distinction; but these are called by Dr. Bowerbank "stellate spicula." (Brit. Spong. vol. ii. p. 92.)

Again, in a compound tunicated animal, about the size and shape of half a small pea, which, although probably described before, I have but just noticed on the branches of the fucoid *Cystoseira granulata*, in juxtaposition with *Grantia ciliata*, the mass, which is of the whiteness of snow, is chiefly composed of globular crystalloids of carbonate of lime, presenting conical points all over them, very similar to fig. 13 *a*, Pl. I. This crystalloid, when compared with that of *Geodia arabica*, bears the proportion in diameter of 3 to 8, but, although much smaller and composed of carbonate of lime instead of silex, has exactly the radiated mineralogical structure of the globular crystalloids of *Pachymatisma* and *Geodia arabica* (fig. 12, *a*, Pl. I., and fig. 14, *c*, *b*, Pl. II.).

Now, surely, it cannot be said that these globular crystalloids, firmly packed in between the cells of an Ascidian and bound down by its general tough integument, can be the "ovaria" of this animal.

In short, I can see nothing to account for the opinion that the globular crystalloids of the crust of *Geodia* and *Pachymatisma* (for they are both alike) are "ovaria," excepting the undiscovered presence of any other propagative form in the species, in which case, if the crystalloids were ovaria, they would demonstrate the fact directly. These animals do not propagate by a gemmule here and there, but by tens of thousands; and among all the crystalloids of these two sponges that I have examined in all stages of development, by fire, water, fracture, and acid, I have not been able to find one with anything approaching to a central cavity.

With reference to the Ascidian mentioned, I might also here cursorily state that it is almost as full of starch-granules, dispersed among the crystalloids, as would be an equal amount of potato-substance. The conical projections of the crystalloids, too, have very much the appearance of "dog's tooth" calcspar, as if structurally developed under a combination of animal and mineral influence.

Reproductive Elements.

In an illustrated paper on the identity of the seed-like body of *Spongilla* and the winter-egg of the freshwater Bryozoa (Annals, ser. 3. vol. iii. p. 331, 1859), I have endeavoured to show that the seed-like bodies of *Spongilla* are so nearly allied in their structure and nature to the winter-eggs of the so-called freshwater polypes that, for the present at least, we must regard them as gemmules. This resemblance was pointed out long ago by Meyen (*ap.* Johnston, *op. cit.* p. 154, footnote). They are chiefly formed in the oldest part of the structure (that is, at the base of *Spongilla*), and are eliminated on the disintegration of the mass, which is more or less effected by the winds and the dry weather to which it is exposed after the water has left it adhering to the sides of the tanks and quarry-pits in the island of Bombay, where it so abundantly grows. Subsequently, when the tanks become refilled by "the rains," towards the end of July, the eliminated seed-like bodies may be seen in great numbers, together with the winter-eggs of the freshwater Bryozoa, floating about on the surface of the water, where, after having become thoroughly soaked, they begin to throw out their sponge-like substance, and, adhering to floating objects on, or to rocks beneath, the water, finally grow there into new sponges; while the seed-like bodies still re-

maining at the base of the parent chiefly renovate the old mass—although such is the nature of the sarcode of *Spongilla*, that I think almost any portion of it, on becoming thoroughly soaked, even after drying for a whole hot season, might, under advantageous circumstances, grow into a new individual.

With such properties, then, the seed-like body seems to be more allied to a bud than anything else, and therefore truly to deserve the name of "gemmule."

The "ciliated gemmule," first described by Dr. Grant, and latterly more at length by M. N. Lieberkühn (Annals, 1856, vol. xvii. p. 407) as the "swarm-spore," I have not yet had an opportunity of seeing either in the fresh- or salt-water sponges. But of its existence there can be no doubt; and if it had been particularly sought after, probably it would not have escaped my observation.

I have, however, as will have been seen, described and figured bodies in *Tethya arabica* (fig. 19, Pl. II.) which seem, under the circumstances, to be very much allied to the gemmules of *T. cranium* figured by Dr. Johnston. They are of all sizes below 15-6000ths of an inch in diameter, and situated in the fleshy part of the *Tethya*, chiefly towards its base, where they, by the aid of a common lens, appear in the form of little white specks scattered plentifully throughout this substance. The white speck, however, is not the whole of this body; for when it is viewed through the microscope by transmitted light, it is seen not only to be spherical in itself, but also to be surrounded by a spherical transparent capsule, charged with minute bacillary bodies resembling spicules, but not siliceous, I think, although resisting the solvent power of nitric acid applied to them on the slide. They may be albuminous tubes on which future spicules might be developed, but are too minute for anything but conjecture of this kind. On the other hand, the spherical nucleus or opaque white body itself appears to be composed of albumino-oleaginous matter, in some instances assuming the form of minute globular masses, but for the most part so consolidated by first the drying and then, latterly, the soaking in spirit and water of the sponge for elementary examination, that hardly more can be satisfactorily stated of it than that its contents *appear* to be albumino-oleaginous, and that these had a minute globular structure.

Still there are these bodies scattered in great abundance through the fleshy portion of the sponge; and they seem to get their capsule developed in proportion to their size, so that at an early period they would be nothing but white albuminous spherules.

I have not been able to find anything like them in *Tethya*

lyncurium or in *Pachymatisma Johnstonia*; and of course they could not, if present, be detected in the dried state of *Geodia arabica*; nor has any one ever described such bodies in either of these species; but gemmules have been described and figured in *Tethya cranium* by both Johnston and Bowerbank, and therefore it is interesting to find something of the kind in the Arabian representative of this sponge.

Two kinds of gemmules, with marked difference, have been described and figured by Dr. Bowerbank in *T. cranium* (Brit. Spong. pl. 25. figs. 343, 344); but when he adds (vol. ii. p. 87) that "It is highly probable that this marked difference in structure is sexual, and, from the more highly developed condition of the second or largest form, that it is the female[!] or prolific gemmule," it can only be hoped that Dr. Bowerbank's illustrations are, as usual, much better than his physiological interpretations.

We use the terms "sperm" and "germ-cell" for the male and female elements of the true or impregnative process of generation; but the term "gemmule" stands for "bud," in which no one has yet detected more than a portion of the product evolved from a combination of the male and female elements of generation.

In short, the true or impregnative process of generation in the Sponge has not yet been made public, even if ever discovered. Lieberkühn (*l. c.*) has stated that he has seen cells filled with spermatozoa in *Spongilla*; Prof. Huxley has described and illustrated what he considers to be spermatozoa in an Australian species of *Tethya*; and I have latterly endeavoured to throw more light on the subject by pointing out the probability that in the freshwater Rhizopoda (e.g. *Difflugia*) the nucleus furnishes the *sperm*-, and some other part of the body of *Difflugia* the *germ*-cells, which produce the new generation (Annals, 1865, vol. xv. p. 172). But how far this may be correct in itself, or how far it may apply to the generative process in the sponges, remains still to be discovered, since at present this process is as much a mystery as the generative process was in the stipitate Fungi before Œrsted and Karsten demonstrated that it took place through the union of male and female cells growing out of the mycelium.

I observe, however, that much of the sponge-substance on the surface of *T. arabica* is charged with minute nucleated cells about 2-6000ths of an inch in diameter, frequently grouped together, as if the group had been developed in one cell—and that the substance so charged is especially supported on the rays of the trifid spicule, as shown in fig. 20, Pl. II. Neither could I help being struck with their resemblance to similar nucleated

cells which I have found and described in the chambers of *Operculina arabica*, and which in some specimens of this test in my possession may be seen (for they appear to be the same) on their way out from the introseptal canals, or at the orifices of holes in the spire, covered with a coating of white calcareous matter. What the real nature of those supported on the trifid spicules of *Tethya arabica* may be I must leave future observation to determine.

Spicules.

In describing the spicules, it is very desirable to state whether they are straight or curved, as they maintain this characteristic feature throughout in the species which I have described, whatever their other forms may be. In vain we look for this in the specimens of "specific description" proposed by Dr. Bowerbank (Phil. Trans. 1862, p. 1132) for "adoption by naturalists," and, of course, followed in his individual descriptions.

Now in *Tethya arabica* and *Tethya lyncurium*, as may be observed by the illustrations &c., they are all straight, whereas in *Geodia arabica* and *Pachymatisma Johnstonia* they are all curved, however varied in other respects.

When we look for a figure of the spiculum of the latter in Dr. Bowerbank's illustration of *Pachymatisma* (Phil. Trans. 1862, pl. 72. fig. 6, and Brit. Spong. fig. 353), we find the spicules there not only almost all straight, but for the most part also pointed at each end, instead of being all curved in the shaft and round or inflated at the ends; so that one is tempted to doubt if it be a figure of this sponge.

Again, when we turn to the two figures of *Geodia Barretti* in the Phil. Trans. (pl. 72. fig. 5, and pl. 32. fig. 2), the latter of which is repeated in the Brit. Spong. fig. 354, we find fig. 2 three times as large as fig. 5, and the "radii of the patento-ternate" spicules in fig. 301 (Brit. Spong.) still larger; yet they are all set down as "×50 linear." Which is the true representation? Generally speaking, these illustrations are beautifully executed; but of their truthfulness are we to say, after having only examined one or two of them, *ex uno disce omnes*?

Had Dr. Bowerbank drawn these figures himself, these mistakes could hardly have occurred; neither ought they to have come before the public so untruthful under any circumstances.

But the plan throughout pursued by Dr. Bowerbank, in his description of the Spongiadæ, can never suffice for the subject. Mere magnified views of the elementary parts alone of objects

described in new terms, for the most part borrowed from the Greek, instead of from the language of the country, which would supply nearly all that is necessary, must ever prove more or less enigmatical, and therefore correspondingly tiresome and impracticable.

We shall never get a satisfactory idea of the Spongiadæ until the species have been simply but truthfully figured side by side with their elementary parts, and as simply described. Association, with both, will then supply what the latter certainly fails to do separately.

It was with this view that I sent home to Dr. Bowerbank nearly all the collection I made on the south-east coast of Arabia, thinking that he was about to accomplish this great work, which requires a master mind of no ordinary ability to produce, and the confidence of a bold publisher to print. But my collection, with many others, are locked up in Dr. Bowerbank's El Dorado, which, like his papers published successively by the Royal and Ray Societies, contain many good things, if one could only get at them.

Classification.

A glance at my figures will show that *Tethya lyncurium* differs so much from *T. arabica* that it cannot rightly be placed in the same genus with the latter; while *T. arabica* is so nearly allied to *T. cranium* that these two also must of necessity come together. Hence Dr. J. E. Gray, in his arrangement (Proc. Zool. Soc. Lond. May 9, 1867), has very properly made a separate genus, under the name "*Donatia*," for *T. lyncurium*. His third or "club-shaped" spicule is but a modification of the subulate or awl-shaped form common to the species.

Again, for sponges of the type of *Tethya cranium* he has assigned the term "Tethya;" and here my *T. arabica* must of course come. Thus *Donatia* and *Tethya* form the first genera respectively of his first and second divisions of the Tethyadæ. Dr. Bowerbank places both under the genus *Tethya*.

Under Dr. Gray's *Tethya* should also come my *T. dactyloidea*, described and figured in the 'Annals' for January last (p. 15), which, I regret to state, lacks minute detail, from my having parted with the specimen.

The genus *Pachymatisma* naturally appears first in Dr. Gray's family of Geodiadæ; and my *G. arabica*, being closely allied to *G. zetlandica*, under his third genus, viz. that termed "Cydonium."

With Dr. Gray's love for the subject, together with his great

ability, long experience, and the advantages afforded by the British Museum for reference both to specimens and publications, we could not have a better authority in point of classification; but, of course, this must depend very much upon the assertions of others, which, if incorrect, reflect dishonour upon those with whom they originated, and not upon the author of the classification.

In offering the few remarks above mentioned, I do not pretend to comment on the subject generally; and should it hereafter be found that my *Tethya arabica* and *Geodia arabica* are one and the same respectively with the *T. cranium* and *G. zetlandica* of our own shores, which, on more careful examination of the latter, I do not think unlikely to be the case, it will be so far fortunate that the species have been thus reduced, and my names obliterated, feeling as I do conscious of the but too melancholy conclusion expressed by Raspail, at the end of the preface to his 'Dict. de Termes des Sciences Naturelles,' that "La science ne marche que par la nouveauté des faits; et la nouveauté des mots, ou la rend stationnaire ou bien la fait rétrograder."

EXPLANATION OF PLATES I. & II.

N.B. All the figures in these plates are more or less diagrammatic, for convenience of illustration, except the drawings of the four Sponges themselves, which are delineated after nature.

The measurements (of course, approximate) are given in units indicating so many 1800ths of an inch, or in fractions of these, unless otherwise stated, by which the relative proportions in size of the objects can be seen directly, and the real ones readily ascertained by computation, if desired.

Plate I.

Fig. 1. *Tethya arabica*, n. sp., natural size, showing the hispid state of the surface and three large vents.

Fig. 2. The same, section to show internal structure: *a*, matted sponge-substance of surface supported on the distal portions of four kinds of spicules terminating respectively in single-pointed, bifid and trifid extended, and trifid recurved extremities; *b*, sponge-substance of body supported on bundles of spicules overlapping each other, which radiate from the centre to the circumference, and present between them the truncated canals of the efferent or excretory system; *c*, nucleus, consisting of densely matted sponge-fibre interwoven with intercrossing spicules.

Fig. 3. The same, portion of surface magnified, showing reticular arrangement of the lines of spicules with pores in the interstices. Seen only in the fresh or undried state.

Fig. 4. The same, forms of the distal extremities of the spicules of the surface, respectively, all smooth and straight: *a*, stout, fusiform, pointed at both ends, 250 long by $2\frac{1}{2}$ broad (that is, 250-1800ths long by $2\frac{1}{2}$-1800ths of an inch broad); occasionally pointed only at the distal and rounded at the other end, awl-shaped: *b*, *d*, slender, bifid and trifid respectively; shaft pointed, 460 long by 1 broad; rays 6 long by $\frac{1}{2}$ broad, all pointed: *c*, slender, trifid recurved, shaft pointed, 320 long by $\frac{3}{4}$ broad; rays 6 long by $\frac{1}{2}$ broad, all pointed.

Fig. 5. The same, characteristic spicule of the body; straight, smooth, fusiform, pointed at each end, 250 long by $2\frac{1}{2}$ broad: *a*, occasional spicule, fusiform awl-shaped, round at one extremity, pointed at the other, or rounded more or less at both ends. These two spicules also enter into the composition of the crust.

Fig. 6. The same; very minute spicules and siliceous globules, most numerous in the matted structure of the crust; the former like bits of thread, sigmoid and semicircular respectively, more or less contorted; largest sigmoid form 1-2000th inch long by 1-24000th inch broad; siliceous globule 1-6000th inch in diameter.

Fig. 7. The same; occasional spicules somewhat larger than the last, found in the sarcode generally: *a*, shaft semielliptical, incurved and pointed hook-like at the extremities, more or less contorted; largest 10-6000ths inch long: *b*, direct, half-lateral, and lateral views respectively of a similar but more complicated hooked form; shaft consisting of three curves, of which the central is the largest; extremities trifid, rays expanded and webbed together like a waterfowl's foot, incurved in the opposite direction to the external curvatures of the shaft, which are the reverse of the central one; 6-6000ths inch long.

The latter is an intricate form, but easily understood by drawing the curves &c. in accordance with the description.

Fig. 8. The same, real lengths of the spicules respectively: *a*, bifid and trifid extended; *b*, trifid recurved; *c*, body-spicule. (See figs. 4 and 5 respectively.

Fig. 19 (Pl. II.). The same, form of gemmule (?), showing nuclear, opaque, or white portion, enclosed in a transparent capsule charged with extremely minute, bacillary, pointed, spiculiform bodies; 4-1800ths inch in diameter; bacillary body 1-6000th inch long.

Fig. 20 (Pl. II.). The same, trifid spicule of surface, bearing sponge-substance charged with nucleolated cells; largest cells about 1-3000th inch in diameter.

Fig. 9. *Geodia* (*Cydonium*, Gray) *arabica*, n. sp. (Pl. I.), natural size; dried specimen, found on the sea-shore, probably after having been much exposed to friction in the waves, as no dermal sarcode remained upon it; showing surface *uncovered* by dermal sarcode, dimpled over with little pores, and here and there larger ones, probably the vents (oscules) or terminations of the efferent canals. All much smaller than during the living state, the reduction in size having been produced by contraction in drying.

Fig. 10. The same, section to show internal structure (taken from another specimen): *a*, crust composed of globular crystalloids, covered with dermal sarcode charged with minute spicules; *b*, zone of trifid spicules of different forms supporting the crust; *c*, sponge-substance of the body supported on stout curved fusiform spicules arranged more or less in a direction radiating from the centre, presenting the truncated canals of the efferent or excretory system; *d*, central portion more compact than the rest.

Fig. 11. The same, portion of surface more magnified: *a*, part of crust, showing pores uncovered by dermal sarcode; *b*, portion covered with dermal sarcode charged with minute, smooth, curved fusiform spicules, pointed at each end; *c*, form of dermal spicule more magnified, size 18 to 25 long by ½ broad. (To compare in size with body-spicule (fig. 15), which is ten times as long.)

For more details of the dermal sarcode and pores, see illustrations of *Pachymatisma Johnstonia*, Pl. II.

Fig. 12. The same, globular crystalloid of the crust, oval obtuse, compressed in the axis of the umbilicated central depression: *a*, vertical section, showing:—the crystalline nature of the body, traversed by faint lines radiating from the centre; the umbilicated depression below; also the margin, formed of the clavate tubercles of the surface. Size, 8 long by 7 broad and 5 thick.

For the development and further illustration of this body, see that of *Pachymatisma*, Pl. II.

Fig. 13. The same, *minute* stellate crystalloid with which the structure generally is more or less charged, particularly towards the circumference, 1 to 6-6000ths inch in diameter: *a*, not unfrequent form, 3 to 11-6000ths inch in diameter.

Fig. 14. The same, forms of distal ends of the spicules of the zone (fig. 10 *b*) which supports the crust, respectively; all smooth and pointed; proportionally magnified: *a*, robust, triradiate; shaft straight, 265 long by 7 broad; rays more or less slightly undulated, 15 long by 6 broad: *b*, end view of head, to show triradiate form, shaft truncated: *c*, trifid extended, less robust; shaft straight, 420 long by 3 broad; ray 5 long by 1 broad: *d*, trifid recurved, shaft much the same as the last, straight, 370 long by 2 broad; ray 5 long by 1 broad (these spicules are arranged in groups; and there are about five to eight of the more slender forms, *c* and *d*, to one of the robust, *a*): *e e*, occasional forms.

Fig. 15. The same, characteristic spicule of the body; stout, curved, smooth, fusiform, pointed at each end; size 205 long by 4 broad.

Fig. 16. The same, real lengths of the spicules respectively: *a*, trifid extended; *b*, trifid recurved; *c*, triradiate; *d*, body-spicules. (See figs. 14 and 15 respectively.)

Plate II.

Fig. 1. *Tethya* (*Donatia*, Gray) *lyncurium*, Lam., natural size: *a*, view of exterior, showing lobate or warted surface; *b*, vertical section, showing the cortical portion pierced by the expanded bundles of spicules, which, radiating from the centre or nucleus, terminate by broken extremities on the surface.

Fig. 2. The same, portion of the surface more magnified, showing by the dotted points the broken ends of the spicules as they traverse the wart-like lobes, and the depressions in the interangular spaces where the pores and vents are respectively situated.

Fig. 3. The same, vertical section, more magnified, showing:—*a*, cortical portion formed of sponge-fibre horizontally interwoven with the expanded ends of the bundles of spicules radiating from the centre—the whole so dense as to assume the appearance and consistence of cartilage; *b*, sponge-substance of the body supported on the radiating bundles of spicules, which overlap each other and present between them the truncated canals of the

efferent or excretory system; *c*, nucleus, consisting of densely interwoven sponge-fibre and spicules, resembling the cortical portion in appearance and composition.

Fig. 4. The same, characteristic spicule of the sponge generally; straight, smooth, more or less fusiform, awl-shaped; seldom if ever pointed at both ends, although frequently much attenuated; shorter and more abruptly terminated on one side than on the other, the enlarged end round, sometimes inflated. Size, 70 to 120 long by ½ to 2 broad: *a*, largest, real length.

The distal ends of those spicules which, projecting beyond the cortical portion, appear to be always broken off, probably do not differ from the one just described, as no other form of long spicule than this is to be found in any other part of the sponge.

Fig. 5. The same, large stellate crystalloid, more or less scattered throughout the structure, but most numerous at the point of contact between the cortical and body portions; rays more or less in number, often undulated, and sometimes bifid at the extremities. Total diameter 1 to 6; central globule or body of largest 2 in diameter; ray 2 long; body and rays all smooth, clear, and crystalline.

Fig. 6. The same, *minute* stellate crystalloid, relatively magnified, to compare with the foregoing; 2 to 4-6000ths inch in diameter: *a*, more magnified view; *b*, ray still more magnified, to show its rough spinous surface.

Fig. 7. *Pachymatisma Johnstonia*, Bowerbank (Pl. II.), natural size of specimen: *a*, view of the exterior, showing pores and large vents; *b*, section through the centre, showing thickness of crust and cut portions of the efferent or excretory system of canals. Structure amorphous, massive; centre undistinguishable.

Fig. 8. The same, section of interior, more magnified, to show the character of the efferent system of canals.

Fig. 9. The same, portion of surface more magnified: *a*, part of crust uncovered by dermal sarcode, showing the pores only; pores 1-24th inch in diameter and about 1-12th inch apart, but slightly variable both in size and proximity: *b*, portion covered with dermal sarcode, charged with the minute, rough, fusiform spicules peculiar to the species; pores beneath faintly, if at all, seen in the fresh state.

Fig. 10. The same, portion of the surface covered by the dermal sarcode, greatly magnified, showing the papillary apertures of the afferent or incurrent canals dispersed over it generally, but more particularly over the area covering the pore, which is situated in the centre, averaging about 1-32nd part of an inch in diameter; papillary aperture about 1-900th inch in diameter, but slightly variable in size.

Fig. 11. The same, pore greatly magnified, surrounded by the globular crystalloids of the crust, showing:—*a*, the diaphragmatic extension of the sarcodal lining, and *b*, its central opening; the former very variable, 10 to 25 in diameter, and the latter more constant, averaging 6 in diameter.

Fig. 12. The same, vertical section of pore, showing hourglass-shaped cavity covered in externally with dermal sarcode and opening below into one of the areolar cavities at the circumference of the sponge: *a*, external chamber of hourglass cavity; *b*, internal chamber, opening into areolar cavity; *c*, dermal sarcode surmounted by papillary apertures; *d*, diaphragm of pore; *e*, spiral opening in the same, more or less extended, but in this instance

carried inwards for four or five coils in a tubular form, constricted in the middle.

Fig. 13. The same, magnified view of dermal spicule, 2 to 5-6000ths long by 1-6000th inch broad: *a*, more magnified view, to show rough, subspinous or tuberculous character.

Fig. 14. The same: *a*, globular crystalloid of the crust, elliptical, compressed in the direction of the axis of the umbilicated depression in the centre: *b*, vertical fracture, showing the clear crystalline nature of the body, traversed by faint lines radiating from the centre, the umbilicated depression below, also the margin formed of the clavate tubercles of the surface; size 8 long by 4 broad and 6 thick: *c*, early form, showing hairlike appearance of spicules radiating from the centre; size 2-6000ths inch in diameter: *d*, more advanced stage, portion of surface to show the conical form assumed by the ends of the now half-coherent, hairlike, radiating spicules: *e*, fully developed state, portion of surface to show its star-like facetted form.

Fig. 15. The same, *minute* stellate spicule, more or less scattered throughout the whole structure; rays variable in number, subspinous; total diameter of largest forms 12-6000ths inch; central globule 1 to 2-6000ths inch in diameter; ray 6 to 12-6000ths inch long: *a*, more magnified view of the ray, to show its spinous character.

Fig. 16. The same, triradiate spicule supporting the crust, shaft and rays all pointed: *a*, terminal view of same, with shaft truncated; *b*, another form, with rays and shaft all rounded or inflated at extremities. This spicule in *Pachymatisma* is subject to great variation in every respect.

Fig. 17. The same, characteristic spicules of the body: *a*, more slender form; *b*, real length. These are all curved, smooth, more or less cylindrical or fusiform, with round or inflated extremities, seldom if ever pointed; longest about 85 by 2. They are also subject to great variation based upon the form given.

Fig. 18. The same, extreme varieties of spicules: *a*, early stage of globular crystalloid, with spicule projecting from umbilicated depression; *b*, elliptical form of long spicule; *c*, club-shaped form; *d*, hourglass form.

For the description of figs. 19 and 20, see Explanation to Pl. I.

[I could have wished that the lines of the spicules in figs. 15 and 17 of Plates I. and II. respectively had been more even. But *I* am content; for the hand which did them is now paralysed in death, although others, without this explanation, might be dissatisfied, from want of association. They were the last efforts of the long and useful career of one who has heretofore etched my drawings, as well as, probably, those of many others, with an ability and accuracy which, as in the present instance, with the exceptions mentioned, left nothing to be reasonably desired.]

II.—*Note on an Alciopid, a Parasite of* Cydippe densa, *Forskål.* By Edward René Claparède, Professor of Comparative Anatomy in the Academy of Geneva, *and* Paul Panceri, Professor of Comparative Anatomy in the Royal University of Naples*.

[Plate V.]

The authors, having made in the month of March last observations on the same subject, which agree and are mutually complementary, have determined to publish them in conjunction, and prior to other works, in order to make known sooner the first and perhaps the only observations that have been made on the metamorphosis of the *Alciopæ*†, and to illustrate this case of endoparasitism, singular among the Annelida‡.

Among the many deep-sea animals which the currents bring into the Gulf of Naples, and which delight as well the resident naturalists as those who resort to these shores from distant countries, one of the numerous and elegant forms of the Beroids is a Pleurobranch, corresponding, as we think, to the *Cydippe densa* of Forskål, better described by Gegenbaur under the more recent name of *C. hormiphora*§. In some individuals of this species, obtained at different periods, there were visible within the gelatinous mass, and also towards the outer surface of the body, some white corpuscles, which at first sight we took for those larvæ of *Distoma*, with the tail armed, which have been described by G. Müller‖ as *Cercaria setifera*, and subsequently by Graeffe as *C. thaumantiatis*¶,

* Translated and kindly communicated by A. H. Haliday, A.M., from the 'Memorie della Società Italiana di Scienze naturali,' tomo iii. No. 4. Milan, 1867.

† An Alciope larva seems to have been seen by Leuckart (Arch. f. Naturg. xxi. 1855); but, to judge from the figure, we are inclined to think it may have been a young animal in the act of reproducing the posterior extremity of the body.

‡ As ectoparasitic or sedentary Annelida may be considered (besides a great number of *Hirudinea*) the *Stylaria* and the *Chætogaster* of *Lymnæus* and other Naids, as also the Amphinomid discovered by Fritz Müller in the cavity of the shell of *Lepas anatifera*, and referred to by him in his essay 'Für Darwin,' 1864, pp. 29, 30; to which we have now to add the *Myzostomum* of *Comatula*, according to what Mecznikow has published concerning its development and its position among the Annelida (Zeitschr. f. wissensch. Zoologie, Bd. xvi. 1866).

§ Studien üb. Organisat. u. Systematik der Ctenophoren (Arch. f. Naturg. Bd. xxii. 1856). [= *Cydippe plumosa*, Sars, = *Hormiphora plumosa*, Agassiz.—*Note by* Tr.]

‖ Ueber eine eigenth. Wurmlarve (Arch. f. Anatomie u. Physiologie, 1850, p. 497).

¶ Beobacht. üb. Radiat. u. Würmer in Nizza (Denkschr. der Schweiz. Naturf. Gesellschaft, Bd. xvii. 1858).

For further details about these larvæ, see Claparède, Beobacht. üb.

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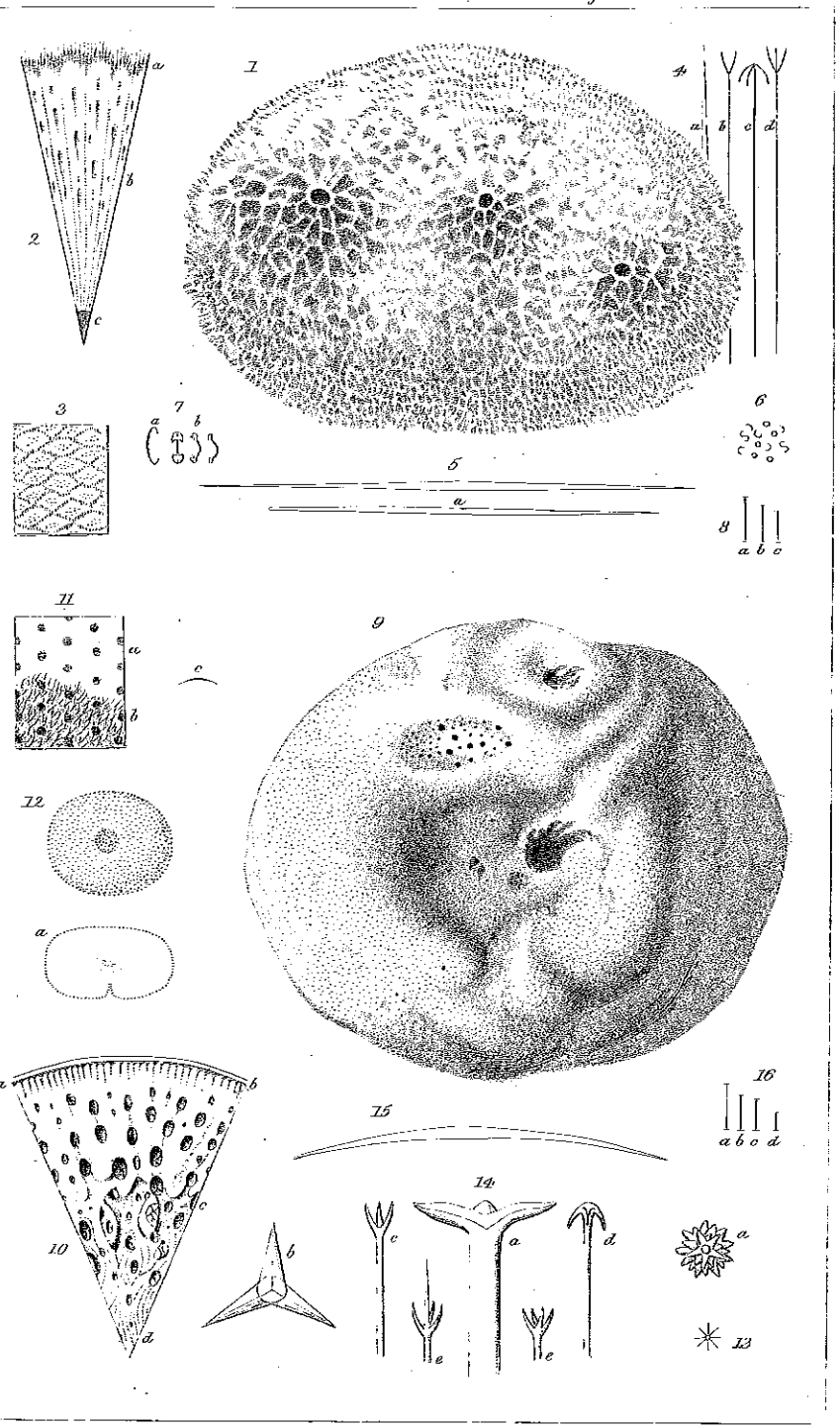

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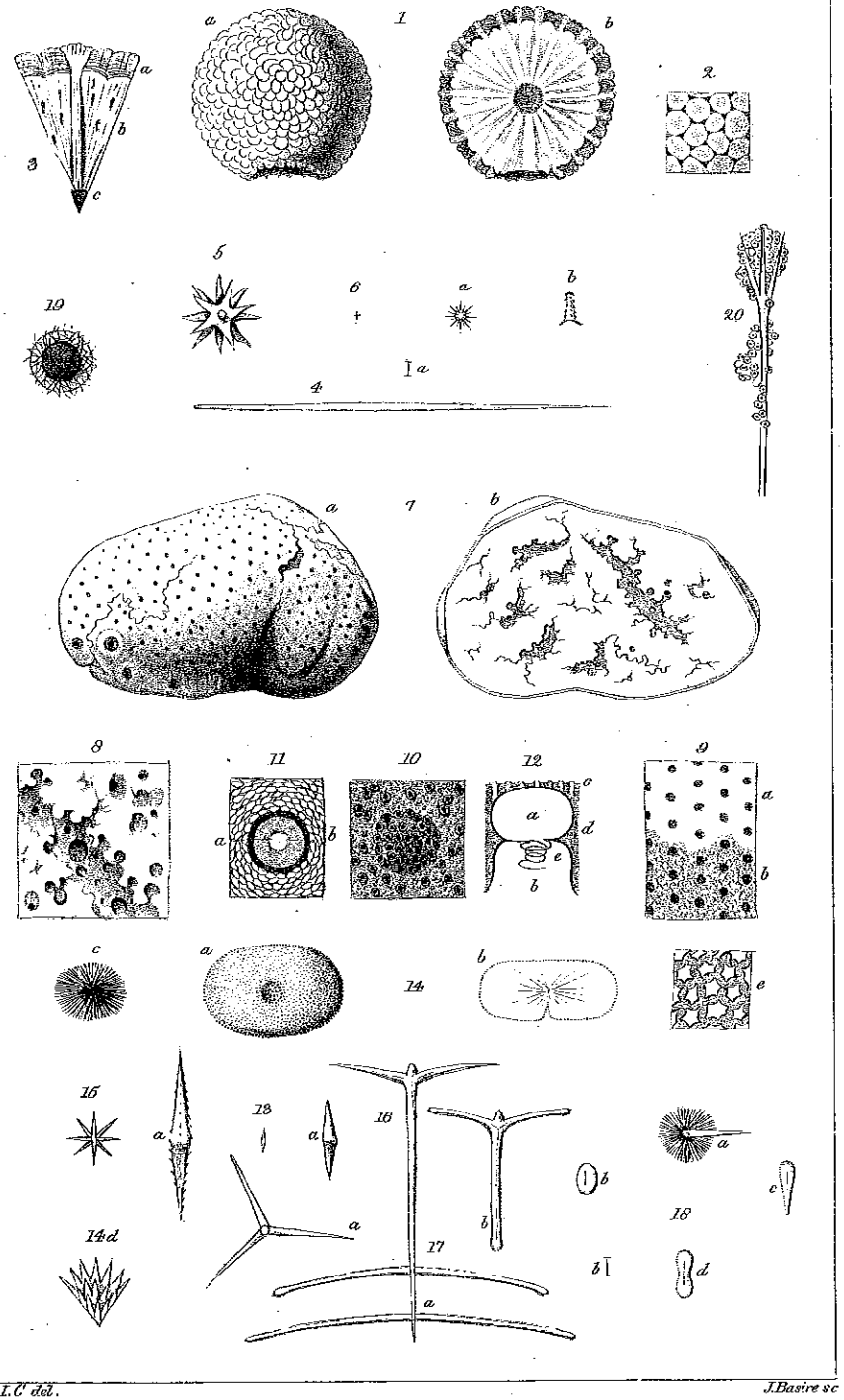

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