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[FIFTH SERIES.]

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XL.—*Report on Specimens dredged up from the Gulf of Manaar and presented to the Liverpool Free Museum by Capt. W. H. Cawne Warren.* By H. J. CARTER, F.R.S. &c.

[Plates XVIII. & XIX.]

THE Gulf of Manaar is an inlet of the Indian Ocean, between Ceylon and the southern extremity of India, 150 miles in width at its entrance; and the specimens, which were dredged up by Capt. W. H. Cawne Warren, in 65 fathoms and less, off the town of Negombo, near Colombo, on the coast of Ceylon, and Tuticorin on the coast of India respectively, towards the end of 1878, were presented to the Liverpool Free Museum about a year afterwards, when they were sent to me for examination by Mr. Thomas H. Higgin, F.L.S.

As they all possess a similar facies, it will only be necessary to allude to them hereafter as "from the Gulf of Manaar," without specifying the particular locality more than has already been done.

Altogether they would hardly fill a quart measure; and the largest was not more than three inches in its longest diameter; so that the amount of material is insignificant. But the representatives of species are comparatively enormous, as will be seen hereafter; indeed, if this material is to be taken as typical of what is to be found in the Gulf of Manaar generally, I should think that this little inlet must contain an epitome of

nearly all the marine organisms that exist in the Indian Ocean.

The "specimens" consist of calcareous nodules of different sizes, which may be said to originate, in the first place, in the agglutination of a little sea-bottom by some organism into a transportable mass, which, increasing after the same manner as it is currented about, may finally attain almost unlimited dimensions. They are therefore compounded of all sorts of invertebrate animals, whose embryos, swimming about in every direction, find them, although still free and detached, of sufficient weight and solidity to offer a convenient position for development; and hence the number of species in and about them.

They vary in form and weight in proportion to the amount of loose or solid material in them, some being round, hollow, clathrous, others more solid, but much creviced, and some almost entirely solid; while they may be more or less rugged on the surface from the nature of the organisms of which they are chiefly composed, whether through development *in situ* or subsequent agglutination. Perhaps no family of organisms has entered into their composition or increased their solidity more than the calcareous Algæ (*Melobesiæ*), which, in successively laminated or nulliporoid growths, has rendered these nodules almost solid throughout or covered with short, thick, nulliporiform processes. I am not sufficiently acquainted with the calcareous Algæ to say what the species are; but the common incrusting one hardly differs from our *Melobesia polymorpha*; and this seems also to have produced the nulliporoid growths to which I have alluded. There is also another laminar species with larger cells which are quadrangular; but this does not appear to be so common, while the loose, deciduous, flat, reniform articulations of *Flabellaria opuntia* are agglomerated with every thing, showing that this calcareous alga or coralline, which is very common in the tropics generally, is not less so in the Gulf of Manaar.

As it is upon these agglutinated compounds, as well as in their crevices and the excavated cavities formed by lithodermous sponges in them, that the organisms to be hereafter mentioned have been developed, I shall henceforth allude to the former under the term of "Melobesian nodules."

Next to the part which the *Melobesiæ* have taken in their formation may be mentioned the sessile Foraminifera; and these have, in their turn, been overgrown, in many instances, by Polyzoa, which, too, is a class of which I know so little that I am not able to point out the different species present;

but observing them to be abundant and as beautiful as they are varied in form, while many are evidently not British, I have placed such of them as, in breaking up the nodules for other organisms, were necessarily separated, in a box by themselves, for some one who, desirous of describing the exotic species, may one day be permitted to examine them for this purpose.

For my own part, the Foraminifera and Spongida are as much as I can pretend to undertake; and these, together with a new genus of the Hydractiniidæ and a new species of *Tubipora*, will be found described and illustrated in the following pages.

But although the forms of the Foraminifera that I have mentioned are fully developed, and therefore admit of complete description and illustration, those of the Spongida in several instances are not so. Then it should be remembered that the form of a fully developed sponge is frequently by no means constant, while every fragment of it is almost sure to contain its whole spiculation; and this alone is what is found in many cases on the Melobesian nodules. Hence, the name of a sponge being for the most part derived from the form of its spicules, this enables us to supply it, together with a description of the latter, which is all that is required until a fully developed form is found.

Before commencing these descriptions, however, I would observe that the mountings that I have made of some of the dust that fell off the root-branch of *Euplectella cucumer* (now in the British Museum) which was hooked up by a fisherman in deep water off the Seychelle Islands afford a complete index to the Manaar specimens, with many other forms besides, which may yet exist in the neighbourhood; but I have not met with any traces of gold among the sand obtained from some of the nodules, although the blue sapphire which is found in Ceylon is as evident in them as in the sea-bottom from the Seychelles ('Annals,' 1878, vol. i. p. 102).

Another fact I would also here mention, viz. that throughout my examinations, which have chiefly been conducted under the microscope, and often with high powers, I have never observed a *Coccolith*, *Coccosphere*, or *Rhabdolith*.

The descriptions and illustrations respectively of the new genus of Hydractiniidæ and new species of Tubiporidæ will be found in this part of my communication for convenience of publication &c., rather than on account of proper sequence; this will be corrected in the terminal list of the "Report."

FORAMINIFERA.

Sessile Species.

Genus CARPENTERIA, Gray.

Generic characters. Test conical, sessile; composed of elongated more or less triangular chambers developed successively in a spire, more or less regularly round a hollow axis, towards which they are inclined and into which they open. Chambers foraminated on the surface, and more or less filled in the interior with fragmentary sponge-spicules. Hollow axis prolonged from the summit into a branched fruticose head.

Carpenteria utricularis and *Carpenteria monticularis*.

The former abounds on the Melobesian nodules of the Gulf of Manaar; but of the latter I have only found one specimen.

In 1876 (Ann. vol. xvii. p. 210, pl. xiii. figs. 11-16), I described and illustrated *C. utricularis* under the name of *Polytrema utricularis*, and in 1877 (Ann. vol. xix. p. 211) reverted to the old generic appellation, viz. *Carpenteria*, adding at the same time (*ibid.* pl. xiii. figs. 9-12) a new species, viz. *C. monticularis*; while in 1878 ('Palæontographica,' [3] xxv. 1, Taf. xl. figs. 58-61) Prof. Möbius figured the same *en masse*, under the name of *Carpenteria raphidodendron*.

Genus POLYTREMA.

Gen. char. Test massive, more or less divided at the summit, composed of cells or chambers developed laminarly upon each other, the outer ones foraminated on the surface and opening into the inner ones, whose cavities, communicating with each other, finally terminate at the ends of the branches or laminæ into which the summit may be divided, where they are more or less filled with fragmentary sponge-spicules.

Polytrema miniaceum, De Blainville.

This species, which abounds everywhere in the tropics (but is rare, perhaps, beyond the 35th parallel on each side of the equator), varying in colour from deep red to pink, cinnamon, and pure white, is in its pink colour equally abundant in the Gulf of Manaar, growing apparently indiscriminately on every organism that will bear its weight. Accompanying it is another species, which, although not so frequent, being new I shall designate as *P. cylindricum*, in reference to its form, as will be seen hereafter. Finally, there is a third organism on the

Melobesian nodules, which, being polytrematous (literally), possessing fragmentary sponge-spicules in its interior, and presenting the same red colour as *P. miniaceum*, I at first thought to be another new species; but on further examination it was found to be a reptant *Tubipora* so like *T. musica* that, but for its stoloniferous growth and consequent modifications, together with the presence of the fragmentary sponge-spicules incorporated with its corallum, it might be considered identical. This species I shall designate *Tubipora reptans*; and, although belonging to the Polypifera, it will be described here for convenience, as before noticed, on account of the great resemblance to *Polytrema* just mentioned.

Here also I would take the opportunity of introducing another species of *Polytrema*, which accidentally came into my possession, in a rolled state, having probably been picked up upon some beach; but where, I am ignorant. Imperfect as it is, however, it is remarkable for its size and other characteristics: with a *Polytrema*-like structure and pink colour, it is so much larger and so differently formed from any hitherto published, that it must be considered a new species, which I propose to designate (also in reference to its form) *P. mesentericum*.

These species will now be respectively described, beginning with

Polytrema cylindricum, n. sp. (Pl. XVIII. fig. 1, a-g.)

Erect, cylindrical, consisting of a thick round pillar developed from a slightly expanded base, dichotomously divided at the free end into two short thick branches, which are equal in length and opposite, terminating respectively in an expansion, from the centre of which radiate a number of more or less fragmentary sponge-spicules. Consistence stony. Colour red, cinnamon, or crimson; translucent (Pl. XVIII. fig. 1). Surface of the pillar and branches uniformly divided into gentle convexities, pierced with foramina which are sunk into a sub-reticulated lineation whose interstices vary in prominence with the development of the organism—being most prominent in the oldest parts, and *vice versâ* (fig. 1, e); ends of the branches rendered irregular by the outgrowth of cells, which are otherwise hidden in the pillar and branches, as will appear presently. Cells at the ends of the branches bearing respectively a large aperture, similar in form, position, and margination to that of the cells of *Planorbulina* (fig. 1, c), which they further resemble in the form of their pore-tubulation; divided into two groups by a central rima, presenting a number of apertures, out of which project the fragmentary sponge-spicules

before mentioned, some of which may be seen in the large apertures as well as cavities respectively of the terminal cells themselves (fig. 1, *d*). Internal structure consisting of cells or chambers of different sizes, the largest and most regularly formed of which are arranged cortically (fig. 1, *a*), where their outer wall, corresponding to the "gentle convexities" on the surface, is pierced by the pore-tubules (fig. 1, *f, g g*), whose sunken apertures there are the holes also before mentioned (fig. 1, *e*); opening internally into a cancellated axial structure (fig. 1, *a*), whose cavities, communicating freely with each other, finally terminate in the rima between the groups of free cells at the ends of the branches respectively. Cells generally more or less filled with fragmentary sponge-spicules, especially the free ones at the ends of the branches (fig. 1, *b*). Size of specimens (which are very constant in this as well as in their form) about 1-3rd inch long and 1-12th inch thick; branches 1-16th inch long and a little less in diameter than the pillar.

Hab. Marine, growing on hard objects.

Loc. Gulf of Manaar.

Obs. This is undoubtedly a species of *Polytrema*, as evidenced by its structure, colour, and the presence of fragmentary sponge-spicules at the ends of the branches, in the interior of the cells, and on their way to them respectively through the apertures mentioned. Its size and form appear to be very constant, as above stated, although in one instance there was a tendency to divide in one of the groups of cells at the ends of the branches. What the object of taking in alone so many "fragmentary sponge-spicules" can be with these Foraminifera, when there are so few comparatively incorporated with the substance of the test, I am unable to conceive, especially as the very fact of their being "fragmentary" shows that they must have been drifting objects unaccompanied by any sponge-sarcodæ for nourishment, since "fragmentary spicules" do not, as a rule, exist in a living sponge.

Tubipora reptans, n. sp. (Pl. XVIII. fig. 2, *a-k*.)

Corallum strong, stoloniferous, vermiculate or crooked, not branched, flat, following the form of the surface on which it may be growing, bearing short, erect, cylindrical calyces situated at unequal distances from each other. Colour crimson, translucent (Pl. XVIII. fig. 2). Surface uniformly rough and foraminated, from the holes being sunk in the substance of the coral and the intervals in relief (fig. 2, *h*). Calyx sur-

mounted by an octotentaculated head (fig. 2, *a*), which is almost colourless, especially towards the centre, and from its more tender nature now, in the dried state, sunk into the calycle, while the firmer wall of the latter thus gives it the appearance of having been truncated. Tentacles composed towards the extremities of small, cylindrical, curved and colourless spicules (fig. 2, *f*), becoming larger, longer, and tuberculated towards the base (fig. 2, *g*), where they begin to assume a pink colour, and finally becoming red their tubercles unite with those of the neighbouring spicules, and thus the whole is transformed into the foraminated, fully formed, red, continuous corallum. Calycle charged at the bottom with fragmentary sponge-spicules, which are more or less incorporated with the red substance of the corallum there, and projecting upwards present, when the soft parts above them are removed, an echinated appearance, in which the ends of the spicules are simply branched or otherwise terminated in accordance with their forms respectively (fig. 2, *k*). Stolon compressed vertically (fig. 2, *b*); its wall in structure the same as that of the calycle; its cavity compressed in like manner, so as to be reduced to a minimum, like that in the horizontal plate of *T. musica* (fig. 2, *c*).

Size of specimen described about 6-12ths inch long, upon which there are eight calycles at variable distances from each other below 1-10th inch. Stolon, of which the growing ends are broken off up to the part where their spicules have become consolidated into the fully formed structure of the corallum, about 1-50th inch broad and 1-130th inch high, including the walls above and below, which reduces the vertical thickness of the cavity to 1-450th inch. Calycle about 1-36th inch high and 1-30th inch broad, including the walls; a little larger above than below.

Hab. Marine, on hard bodies.

Loc. Gulf of Manaar.

Obs. As before stated, the striking resemblance of this corallum to the test of *Polytrema miniaceum* in composition, structure, and colour, together with the presence of fragmentary sponge-spicules more or less incorporated with the corallum, led me to regard it at first as a species of this Foraminifer; but subsequent microscopical examination showed that it was almost identical with *Tubipora musica*, as the above description proves. However, I prefer its insertion here, and alluding to this hereafter by name in its proper place, for the purpose of pointing out its several characters in common with *Polytrema*, which otherwise might pass unnoticed.

Polytrema mesentericum, n. sp. (Pl. XVIII. fig. 3, a-h.)

(Rolled specimen.) Test massive, composed of more or less erect, thick, meandering laminae united mesenterically. Consistence stony. Colour pinkish red (Pl. XVIII. fig. 3, 3 a). Surface (*i.e.* vertical sides of lamina) uniformly dimpled and foraminated (fig. 3b, h); margin worn away by attrition (fig. 3, c). Internal structure of lamina consisting of cells or chambers of different sizes, the largest and most regularly formed of which are arranged cortically, where their outer wall is pierced by the pore-tubulation, whose apertures on the surface are the foramina before mentioned (fig. 3, c, d, e e); opening internally into a cancellated axial structure, whose cavities, communicating freely with each other, finally open at the margin in a corresponding position with respect to the cortical chambers (fig. 3, d, g); thus presenting a more compact structure between the layers of the latter, which, in the absence of the real margin now worn away, presents the appearance of a stony polyzoarium of a similar form. Fragments of sponge-spicules incorporated here and there with the substance of the test (fig. 3, d, i). Size of specimen, which is now rounded by attrition, subelliptical and compressed vertically, 3-4th inch by 7-12th inch in its greatest horizontal diameters, and about 1-4th inch thick; lamina 1-16th inch in transverse diameter.

Hab. Marine.

Loc. ?

Obs. Although none of the exposed chambers at present contains any sponge-spicules (probably from their having been washed out), and the structure of the margin is worn away, yet by the presence of fragments of sponge-spicules incorporated with the substance of the test, and the character of the structure of the lamina internally, there can be very little doubt that when in a perfect condition it closely resembled *Polytrema cylindricum* in these respects. Still its peculiar form and size not only claim for it a separate designation, but the latter precedence also of all other species of *Polytrema* that have been publicly noticed. Comparing its form with that of the figure of *Theone*, Lamouroux (Jurassic fossil from Caen), given by De Blainville, Man. d'Actinol. Atlas, pl. lxxvii. fig. 2, one cannot help being struck with their great resemblance. In many respects also it closely resembles the mesenteric forms of several exotic Polyzoaria.

Genus GYPSINA.

Gen. char. Massive, sessile or free, incrusting indefinitely or circumscribed and defined; surface uniformly tessellated

by foraminated interstices variable in form and separated from each other by reticulated lines of translucent shell-substance, which is frequently very prominent and transparent at the angles, forming the ends of a columnar structure in which the cells are united laterally by holes of intercommunication, and above and below by a foraminated plate, like that of the "interstice" on the surface, through which the innermost cell thus indirectly obtains communication with the exterior. No oral aperture. No canal-system.

Such are the characters of this genus, which is founded on the species, *Gypsina melobesioides*, that I described in 1877 ('Annals,' vol. xx. p. 172); but as the facts leading to it were communicated at intervals, and are now confirmed by specimens of each of the species contained in the genus, from the Gulf of Manaar, I will briefly recapitulate what has been stated.

When I showed, in March 1877 ('Annals,' vol. xix. p. 215 *et seq.*), that *Tinoporus vesicularis*, Carpenter (Introduction, p. 224, pl. xv. figs. 1-3), had "no generic affinity with De Montfort's *T. baculatus*," I was not aware of the existence of the incrusting species to which I gave the name of *Gypsina melobesioides* (*op. et loc. cit.*); but seeing that the structure of the latter was identical with that of Dr. Carpenter's *Tinoporus vesicularis*, I at once realized the necessity of changing the generic name of the latter also to *Gypsina*, thus making it *G. vesicularis*, Carpenter (*ibid.*). Had Dr. Carpenter, instead of applying De Montfort's name of *Tinoporus* (*T. baculatus* being a *Calcarina*), given it a new name, then this might have been used instead of the one I have proposed.

Further, I observe that the Foraminifer to which I gave the name of "*Polytrema planum*" ('Annals,' 1876, vol. xvii. p. 211, pl. xiii. figs. 18, 19), and which came from the south-west coast of Australia, was a specimen of *Gypsina melobesioides*; hence its name also will have to be suppressed, at the same time that another locality is thus added to those already noticed of *G. melobesioides*, viz. the Mauritius, the West Indies, and, lastly, the Gulf of Manaar.

Gypsina melobesioides, sp. 1877.

There are four specimens of this species among the dredgings from the Gulf of Manaar, two of which nearly cover globular nodules of *Melobesia*, respectively half an inch in diameter, with an incrustation about 1-48th inch thick and twelve cells deep. The other two are also on the surface of similar nodules, but not so extensive. The incrustation spreads itself continuously over whatever irregularities may

be in its way, so as to give the whole the appearance of being frosted with sugar like a bridecake; hence it is very likely, without the aid of a microscope, to be confounded with *Melobesia* as well as the white incrustation of some *Gorgonias*.

Gypsina vesicularis, Carpenter.

Several specimens of this species also occur, in the sessile and free forms respectively. The sessile is hemispheroidal and for the most part the largest, while the free one is spheroidal and much smaller. Frequently the hemispheroidal form is sunk into the flat surface of a Coralline, subtridentate articulation (*Flabellaria opuntia*), where it is covered by a thick sarcodic cuticle; and in this state I have specimens also from the Straits of Carimata, on the west coast of Borneo; while the spheroidal variety, being free, may be found anywhere. The former is well described and illustrated by Dr. Carpenter (Introduction, p. 225 &c., pl. xv. figs. 1-3); and I have illustrated the structure of the latter ('Annals,' 1877, vol. xix. pl. xviii. figs. 18-20).

TESTAMÆBIFORMIA, new group.

Char. Amœbiform, testaceous.

Hitherto almost exclusive attention has been given to the *free* Foraminifera, whose exquisitely varied forms, although in many instances microscopic, have not unnaturally proved as attractive as the frustules of the Diatomaceæ; so that it has become an object of great search among them to find out a new form, although it can hardly be seen by the unassisted eye. This to the specialist is a matter of paramount importance, but to the biologist one of insignificance compared with the less attractive and larger forms, which tend to reveal the life-history and connexions of the class generally.

For some time past I have anticipated the existence of amœbiform Foraminifera, differentiated only by the peculiarity of their respective pseudopodial expansions; but, of course, this cannot be ascertained except by minute and laborious examination of the *living* so-called "*Bathybius*," which probably abounds with them after the manner of freshwater rhizopods, forming a similar slime to that which may often be observed over the bottom of stagnant (*i.e.* still) freshwater pools. I was not, however, prepared to find that some of these ever-changing forms were stereotyped, as it were, by the permanent secretion of a calcareous test, until the *Melobesian* nodules from the Gulf of Manaar came under my notice, when I observed two well-characterized forms to be very abundant in

them, which I will now describe under the generic names *Holocladina* and *Cysteodictyina* respectively, having already above defined the general characters of the group under the term *Testamœbiformia*.

Holocladina pustulifera, n. sp.
(Pl. XVIII. fig. 4, *a-g*.)

Test radiform, polychotomous, free towards the centre, fixed by the terminations of the rootlets at the circumference. Consistence hard. Composition calcareous. Colour white (Pl. XVIII. fig. 4). Surface even, pustuliferous, pustuliform eminences of different sizes scattered over the surface irregularly (fig. 4, *e*), plentifully about the centre, sparsely on the branchlets, in the form of smooth, hemispherical projections, varying in diameter under 1-600th inch, terminating in a slight papillary eminence with a punctum in the centre (fig. 4, *b, c*), sometimes extended into a short conical spine (fig. 4, *d*); ends of the rootlets subpalmate, terminating in amorphous granular projections (fig. 4, *h*), alternating with conical processes, which appear to be perforated at the extremity respectively; and if so, here would be the oral apertures (fig. 4, *g g*). Surface of the test between the pustuliform eminences bearing the appearance of being so minutely micropunctate as to be hardly distinguishable under a high power. Internally, structure of the test-wall, which varies in thickness under 1-50th inch, composed of extremely minute tubules in juxtaposition, perpendicularly descending from the surface to the interior (fig. 4, *f*), which in its dried state is now hollow and without foreign material, but still presenting the remains of the sarcode in the form of a thin yellow layer adherent to the inner surface of the test. Size of most perfect specimen about a quarter of an inch in its longest diameter.

Hab. Marine, in the crevices of Melobesian nodules.

Loc. Gulf of Manaar.

Obs. It is evident from the form of this test that the living animal possessed an amœboid form; but whether both were developed successively (that is, one part after another like the crust on a stream of lava), or the living animal was fully developed before the test was secreted, there is no evidence now to show, beyond the presumption that the former was most likely the case. The absence of all foreign material in the interior, together with its form, distinctly separates it from the genera *Carpenteria* and *Polytrema*, while it chiefly differs from *Aphrosina* (Journ. Roy. Microscop. Soc. 1879, vol. ii. p. 500, pl. xvii. figs. 5-10) in not being multilocular. No oral apertures were satisfactorily seen; but it may fairly be

inferred, as above stated, that each of the conical projections on the terminal branchlets bears one, through which a pseudopodium issues during the living state, in search of that subtle kind of nourishment which the present emptiness of the test indicates to have been the nature of the aliment.

Cystodictyina compressa, n. sp.
(Pl. XVIII. fig. 5, *a-e*.)

Test bladder-like, flat, compressed, interrupted in its continuity by holes of different shapes and sizes, which thus give it a reticulated appearance (Pl. XVIII. fig. 5); spreading flatly over the surface of hard bodies, and thus following their irregularities. Consistence firm, but fragile from its thinness. Composition calcareous. Colour white, yellowish, or lilac. Surface even, uniformly punctate; puncta distinct, in juxtaposition; circumference terminating in short radicleform expansions like those of *Holocladina*, viz. in conical points (fig. 5, *dd*), mixed with an amorphous structure here and there like calcareous sand-grains (fig. 5, *ee*). Internally, test almost too thin for measurement, traversed vertically by tubules in juxtaposition extending inwards from the surface, terminating on the inner side in the midst of their prismatic divisions respectively (fig. 5, *b*). Cavity of the test without foreign material, continuous, and presenting the same kind of dried sarcodic lining as that of *Holocladina*. Size of most perfect specimen about half an inch in its longest diameter, by about a quarter of an inch wide and about 1-160th inch thick. Wall, as before stated, almost too thin for measurement.

Hab. Marine, on the surface of hard bodies and in their crevices.

Loc. Gulf of Manaar.

Obs. This species differs from *Holocladina* in not being branched, but membraniform and lobate, in the greater thinness of the test-wall, the absence of pustuliform eminences on the surface, and the larger size of the pore-tubulation. In other respects the same observations apply to it as to *Holocladina*. The amorphous sand-like development here and there on the processes of the circumference reminds one of the amorphous structure at the ends of some tendrils in the vegetable kingdom, and may serve a similar purpose.

CERATESTINA, n. gen.

Gen. char. Test horny; colour dark amber, translucent.

The composition of the test here brings us one degree nearer than that of the *Testamcebiformia* to the absolutely

naked Foraminifer, to whose conjectured existence I have before alluded; but lest it might be thought that it is merely the chitine without the calcareous material which characterizes this genus, it should be mentioned that, if a specimen of *Ceratestina* and an ordinary calcareous test of a Foraminifer together be exposed to the influence of an acid solution (*ex. gr.* dilute nitric acid), the latter will be dissolved and leave scarcely any residue, while the former remains unaffected, proving that the horny substance of the *Ceratestina* is something more than the chitine which may support the calcareous material; indeed the best way of extricating a *Ceratestina* is to put the calcareous substance containing the specimen into a strong solution of nitric acid, which, all know, is instant destruction to a calcareous test. This kind of Foraminifer, besides occurring in the cavities excavated by lithodermous sponges in the Melobesian nodules of the Gulf of Manaar, is often observed on the *surface* of old coral. In some cases the foraminiferal test is composed in one part of the ordinary calcareous material, and in the other of the horny substance only, which condition is so usually seen in one species that it would appear to be rather natural than accidental. I allude to a species which I have figured and described, conjecturally, as the "embryonic form" of *Carpenteria monticularis* ('Annals,' 1877, vol. xix. p. 213, pl. xiii. fig. 11), but which now, finding it to be a distinct species, I would name "*Carpenteria microscopica*." The chambers of *Carpenteria utricularis* and also the cells of *Polytrema miniaceum* are often lined by a stiff horny layer of considerable thickness; but under what circumstances, I am ignorant, as it does not occur always; this, however, is secondary and must not be confounded with *Ceratestina*, in which the horny structure is primary and permanent.

Ceratestina globularis, n. sp.
(Pl. XIX. fig. 6, a-g.)

Test composed of four or more subglobular chambers developed one after another from a primary or embryonic cell, which is subspheroidal and presents the first bud of the stolonian siphon. Composition horny. Colour dark amber (Pl. XIX. fig. 6). Chambers increasing in size as they are successively developed upon the stolonian siphon (fig. 6, c) proceeding from the embryonic cell, which is the smallest (fig. 6, a); arranged more or less spirally, fitting upon each other, as they are successively developed, by the convex surface of the preceding being received into a lunate one of the following chamber (fig. 6, c), and all tied together on the inner side of

the spire by the stolonie siphon mentioned (fig. 6, *c*). Surface of the chamber smooth, indistinctly microspinose and micropunctate (fig. 6, *e*). Size of the group about 1-36th inch in diameter.

Hab. Marine, in minute cavities of the Melobesian nodules, which have been excavated by lithodomous sponges.

Loc. Gulf of Manaar.

Obs. Besides the specimens which come from the cavities above mentioned in the Melobesian nodules, I possess pieces of old *Stylaster sanguineus* from the South Pacific Ocean bearing several specimens on the surface (fig. 6, *f*). Like the last chamber in the figured specimen from the Gulf of Manaar, which has put forth two stolonie knotted tubular filaments and was in the act of putting forth more (fig. 6, *d d*), some of those on the surface of the *Stylaster* coral are connected with a similar filament. How far the chambers of those from the Gulf of Manaar were originally arranged together in juxtaposition and spirally I am not able to state, further than that their forms indicate it, since to see them satisfactorily it was necessary to dissolve them out of the Melobesian substance with acid and mount them in Canada balsam, during which the chambers became separated.

Ceratestina tessellata, n. sp.
(Pl. XIX. fig. 7, *a-h*.)

Test lobular, adenoid, connected with a crooked, knotted, stolonie filamentous tube. Consistence horny. Colour dark amber (Pl. XIX. fig. 7, *a, b*). Developed upon a stolonie tubular filament in a globular form (fig. 7, *c*), which, becoming multiplied as the mass increases in size, passes into a lobulated group whose walls are traversed by straight unbranched lines of fibre intersecting each other at various angles, and thus giving the surface a meridonated or tessellated appearance (fig. 7, *d*), not rising above the level of the outer surface, but sending inwards processes which in the living state may have supported delicate partitions, and thus have rendered the interior multilocular (fig. 7, *f*). External surface of the wall smooth, with the exception of microscopic points which are sparsely scattered over it (fig. 7, *h*). Stolonie tubular filaments, which are often knotted (that is, bearing several successive dilatations and here and there conical processes indicative of budding development), hollow, and characterized throughout by the tessellated fibrous structure above described, only in a less visible degree (fig. 7, *g*). Size of largest group or specimen 1-25th by 1-45th inch in its greatest dimensions.

Hab. Marine, in cavities of the Melobesian nodules, which have been excavated by lithodomous sponges.

Loc. Gulf of Manaar.

Obs. In composition, colour, and position, together with the micropointed surface and its connexion with the crooked, knotted, filamentous, stolonie tubulation, this organism resembles *Ceratestina globularis* more than any thing else that I know of; but there is no visible appearance of punctures in the wall. The knotted form of the stolonie tubulation reminds one of the successive moniliform chambers in the so-called Placopsiline Lituolida—equally so in form, although not in consistence, of the creeping tubulation of the Saprolegniæ and Myxomycetic fungi, to which in nature the Foraminifera very nearly approach. In consistence, however, they are more like the penetrating developments of the kerataceous sponges, but in structure totally different; for the fibre in the latter is not only infinitely branched, but, in all instances that I am aware of, cactiform—that is, puckered up into little monicles on the surface, which is thus rendered most uneven.

One cannot help here associating the amber colour of *Ceratestina* with the bright brown, or red cinnamon colour of most of the Lituolida, which appears to be thus modified by admixture of the chitine in the latter with the white mineral substance of which the test is otherwise composed.

Subsessile Species of Foraminifera.

Genus *ROTALIA*, D'Orbigny.

The genus *Rotalia*, sometimes parasitic, but, according to Williamson, "usually free," is under the former condition characterized by being flat on one side, by which it adheres to the object on which it may be fixed, and convex on the other; but although many of the latter may be easily detached without injury, still there is one in particular, viz. *Rotalia spiculotesta* ('Annals,' 1877, vol. xx. p. 470, pl. xvi. figs. 1-3), which is so thin and delicate, and so firmly fixed to the object on which it may be growing, that it may be fairly inferred that it remains in this position for the whole period of its existence. As I have found several specimens of this species on the Melobesian nodules of the Gulf of Manaar, and hitherto have only had one to describe from, viz. that to which I have alluded (*op. et loc. cit.*), although Mr. H. B. Brady has obtained three from the Red Sea, whereby he has been able to ascertain that the composition of the spiculiform bodies in the test is calcareous, still it is desirable that I should state, by way of confirmation, what

the Manaar specimens have revealed respecting this beautiful little organism.

Rotalia spiculotesta, sp. 1877.

To the description of this species given in the 'Annals' of 1877 (*l. c.*), and the intimation of Mr. H. B. Brady that he had obtained three specimens out of "dredgings" from the Red Sea, whereby he had been able to ascertain that the spiculiform bodies of the test were calcareous, I have little to add. In the first place, then, it is evident that the number of specimens about the small amount of material from the Gulf of Manaar indicates that it is very plentiful there; they (six) are all about the same size as that which I originally described; and if any difference exists between the two, it is simply that the spiculiform bodies in the Gulf-of-Manaar specimens are more quadrangular or oblong than elliptical, while they are the reverse in that to which I have alluded, viz. that which came from the South Pacific Ocean; they are respectively fixed upon the surface of the Melobesian nodules; and, with so much material, I have been able to mount a fragment of the test in Canada balsam for examination of the spicules under a higher power, whereupon they seem to me to be solid and the granular matter between them to consist of microscopic bodies of the same form, although of different sizes. I have also been able to confirm Mr. Brady's observation that they are calcareous, inasmuch as they dissolve entirely, with effervescence, in dilute nitric acid.

Although all the specimens to which I have alluded appear to contain nothing but the spiculiform bodies in their tests, I have met with some smaller (? young) specimens of the same Foraminifer about the Melobesian nodules, which, when mounted in balsam, show that their tests are at this period composed of a heterogeneous assemblage of microscopic bodies (? calcareous sand), in the midst of which one or more of the genuine spicular ones form prominent features, from their large size and isolated condition. Thus it may be that sometimes the test is composed of foreign material as well as bodies produced by the animal itself—a condition among the testaceous freshwater Rhizopoda to which Dr. G. C. Wallich has alluded in his valuable paper "on Structural Variation among the Diffugian Rhizopods" ('Annals,' 1864, vol. xiii. p. 233 &c.).

Free Species of Foraminifera.

As it is not my object to give a list of all the free forms of Foraminifera that occur about the Melobesian nodules, it will

be restricted to those only whose size renders them most conspicuous, none of which sensibly exceed an eighth of an inch in diameter; and these belong to D'Orbigny's genus *Amphistegina*, for a more intimate acquaintance with which I must refer the reader to Profs. Parker and Jones's account (*apud* Carpenter, 'Introduction,' p. 242).

AMPHISTEGINA, D'Orbigny.

On the borders of the Indian Ocean there are several species of these nummuline forms; and although they may vary slightly in their structural features here and there, for some of the "borders" are very wide apart (*ex. gr.* the Gulf of Aden and the south-west corner of Australia), still the genus extends to all of them; and therefore the Gulf of Manaar is not without its representatives, among which is the well-known *A. mammillata* of D'Orbigny. There is also another compressed globose form, unless it be the thick part of a *Heterostegina* worn down to this, with the same kind of structure as *Heterostegina*, and a third, which is the largest of all, wherein the chambers are extremely numerous and regular, closely approximated, awl-shaped, and much recurved, with a thick nummuline marginal cord between the whorls.

Calcarina calcar, var. *hispid*a, n. var.

The same remarks respecting the varietal differences apply to *Calcarina calcar*, which is found in the Red Sea, at the Mauritius, and, under the form of *Trioporus baculatus*, in Polynesia, while it is also abundant in the Gulf of Manaar, but here under the hispid form mentioned. This hispid state bears the same relation to *Calcarina calcar* as the hispid form of *Calcarina Spengleri* bears to the latter species in Polynesia, well shown in Dr. Carpenter's representation ('Introduction,' pl. xiv. fig. 6). All, not averaging more than 1-24th inch in diameter, are much smaller than *C. Spengleri*, while it is not unusual to find the hispid form of the latter, like that of the former, sunk into the flat surface of an articulation of *Flabellaria opuntia* side by side with *Gypsina vesicularis*.

Alveolina sinuosa, n. sp. seu var.

The genus *Alveolina* also occurs on the borders of the Indian Ocean generally; but whether that from the south-west coast of Australia has been named or not I cannot say. Suffice it to state, then, that if so, *A. sinuosa* must be considered a variety; for I can see very little difference between it and that which occurs on the coast of Australia, as well as the

others that I have found about the Melobesian nodules of the Gulf of Manaar, beyond its larger size and sinuous form, it being a quarter of an inch long by 1-24th inch in its greatest transverse diameter.

Hydroid Zoophyte.

Family **Hydractiniidæ**, Hincks.

HYDRADENDRIUM, n. gen.

Gen. char. Polypary dendriform; stem solid, with the exception of a small medullary canal, thickly spined.

Hydradendrium spinosum, n. sp.

(Pl. XIX. fig. 8, *a-g*.)

Polypary dendriform, slender; stem erect, branched; branches alternate, about 1-24th inch apart, irregular in length and disposition around the stem, extending upwards and outwards from the fixed to the free end, becoming shorter towards the latter; sometimes subdivided, but generally giving off on each side a regular series of branchlets, arranged alternately and plumosely, from which again spring sparsely a third set, chiefly on one side. Consistence horny. Colour dark amber, translucent (Pl. XIX. fig. 8). Stem and branches smooth, except where interrupted by the presence of spines; the latter also smooth and directed upwards and outwards, in longitudinal lines, wherein they are arranged alternately in adjoining rows, the rows increasing in number with the size of the stem; spine round, conical, slightly curved upwards, varying in size from a slight indication at the growing ends of the branches respectively to 1-200th inch in length where fully developed (fig. 8, *b-f*). Stem solid, with the exception of an axial canal which traverses continuously every part of the structure, and contains the sarcode upon which the whole has been developed; hence at the extremities of the branches the latter is thicker in proportion to the horny material than at any other part (fig. 8, *c, d*), composed of concentric layers through which branches radiate from the axial canal to the branches themselves and to the spines respectively (fig. 8, *c*), terminating in the latter a little distance from the point, which is therefore imperforate and itself formed by concentric layers on the branch of sarcode first emanating from the medullary or axial canal (fig. 8, *e*). Diameter of largest fragment of stem found 1-90th inch, that of the axial canal in the same 1-600th inch. Cenosarc covering the surface of the skeleton, but not now elementarily distinguishable, on account of the specimen having been dried. Spine often bifid, but where

developed from the cœnosarc extending over foreign substances enlarged, dichotomously branched one or more times, and thus rendered dendriform (fig. 8, *a, g*). Largest and most perfect specimen, which is that figured, about 2 inches long and $1\frac{3}{4}$ inch in its broadest part; stem of the same at the lower end, which has been broken off, 1-60th inch in diameter.

Hab. Marine, growing on hard objects.

Loc. Gulf of Manaar, in 65 fathoms, N. lat. $7^{\circ} 18'$. Western coast of Ceylon.

Obs. It may seem premature to some to establish a new genus of Hydractiniidæ on the mere skeleton of a Hydroid Zoophyte; but the characters of the family are so peculiar that, to those acquainted with the species which have been described, there is little risk of error in this respect. The generic distinction, however, is founded on the solidity of the structure, which in all other instances hitherto noticed is formed of reticulated fibre, like that of *Hydractinia echinata*. From the number of fragments of *Hydradendrium spinosum* among the Manaar dredgings, it would appear to be very plentiful in this locality. Under the microscope, when fully divested of the cœnosarc, the regularity of the spination and clear amber-colour of the whole stem, make it a beautiful object. In development, of course, the skeleton is formed upon the embryonic sarcode, which thus becomes separated from the cœnosarc of the exterior, although it is probable that subsequently the latter, which must have sprung from the former too, in the first instance, adds the greater portion of the horny material in layers, like the sarcode of the sponges to their structures both horny and siliceous. That the cœnosarc can do this is proved by the forest of dendriform spines which it develops from its surface when extending from the stem to other bodies, as shown in the illustrations (fig. 8, *a & g*).

EXPLANATION OF THE PLATES.

PLATE XVIII.

Fig. 1. *Polytrema cylindricum*, n. sp., *in situ*, showing the sponge-spicules projecting from the apertures in the ends of the branches respectively: *a*, horizontal section, to show the cortical and medullary cell-structure (magnified 2 diameters); *b*, form of cell about the ends of the branches, broken open; *c*, aperture with sponge-spicules on their way to the interior; *d*, the same in the interior; *e*, portion of surface of pillar, to show the arrangement of pores &c.; *f*, fragment of outer wall of cortical cell, cut horizontally to show the sunken pore-tubules; *g g*, tubules. (All on scale of 1-48th to 1-1800th inch.)

Fig. 2. *Tubipora reptans*, n. sp., *in situ*, showing the calyces and their

stolon (magnified 2 diameters). *a*, calycle, with portion of stolon cut off to show the vertically compressed form of the latter and cavity respectively; *b*, vertical section of stolon; *c*, compressed cavity; *d*, lateral view of tentaculated head when restored to position (ideal); *e*, end view of same sunk into the calycle: all relatively magnified on the scale of 1-144th to 1-1800th inch. *f*, form of young spicule; *g*, matured form (diagrams). *h*, fragment of the corallum, to show pore-openings between the calcareous tubipora-spicules, now otherwise consolidated; *i*, fragment of siliceous sponge-spicule imbedded in the same: scale 1-48th to 1-1800th inch. *k*, sponge-spicules imbedded in the corallum at the bottom of the calycle, as seen on looking down through the end of the latter (diagram).

Fig. 3. *Polytremia mesentericum*, n. sp., nat. size of specimen. *a*, portion of mesenteriform lamina, to show—*b*, pore-surface on the sides and, *c*, cortical and medullary cell-structure in the horizontal section: magnified 2 diameters. *d*, horizontal section of fragment, more magnified, to show—*e*, pore-tubules, *f*, cortical cells, and *g*, medullary cell-structure; *h*, fragment of surface, to show pore-openings (diagrams).

Fig. 4. *Holocladina pustulifera*, n. sp., suspended across a crevice in the Melobesian nodule, into which the ends of the branches are for the most part inserted, therefore represented as cut off (magnified about 16 diameters). *a*, average natural size. *b*, end view of large pustuliform eminence; *c*, the same, lateral view; *d*, the same, with summit extended into a spinous form: scale 1-24th to 1-1800th inch. *e*, end of branchlet, much magnified, to show the distribution and unequal size of the pustuliform eminences, also *f*, the structure and thickness of the test, *g*, the conical, and *h*, the amorphous terminations respectively (diagrams).

Fig. 5. *Cystodictyina compressa*, n. sp., in contact with the surface of the Melobesian nodule, represented as cut off at each end where the continuation of the circumference was not seen (magnified about 16 diameters). *a*, average natural size; *b*, fragment of surface, much magnified, to show the prismatic structure of the pore-tubulation; *c*, end of circumferential lobule, much magnified, to show thinness of test and punctate surface, also *d*, conical, and *e*, amorphous terminations respectively (diagrams).

PLATE XIX.

Fig. 6. *Ceratestina globularis*, n. sp. *a*, embryonic or primary cell; *b*, terminal cell or chamber; *c*, connecting stolon; *d*, crooked and knotted stolon tubulations put forth by the last chamber; *e*, microspinous processes on the surface of the chamber; *f*, groups of *Ceratestina* on the surface of old *Stylaster sanguineus* from the S. Pacific Ocean; *g*, aperture of terminal cell: scale 1-24th to 1-1800th inch.

Fig. 7. *Ceratestina tessellata*, n. sp. *a*, globuliferous or adenoid portion; *b*, stolon tubes: magnified about 16 diameters. *c*, commencement of the growth of a globuliferous portion on a stolon tube; *d*, globuliferous portion, much magnified, to show meridianate or crossing lines of fibre in the horny wall, producing the tessellated appearance; *e*, stolon portion; *f*, internal processes; *g*, end of stolon, more magnified, to show that it also

presents the tessellated appearance; *h*, tesseral division, much magnified, to show microspinous processes (diagrams).

Fig. 8. Hydradendrium spinosum, n. gen. et sp., natural size of specimen. *a*, growth of dendriform spines (see *g*); *b*, portion of stem, much magnified, to show rows of spines, viewed laterally; *c*, horizontal section of stem and spines, to show that the stem is composed of concentric laminae developed on *d*, the axial canal, from which *pari passu* are developed the spines: scale 1-48th to 1-1800th inch. *e*, spine, much more magnified, to show that it also is composed of concentric laminae, but solid and imperforate towards the free end; *f*, end of branch, to show commencement of spinal development on the medullary sarcode: scale 1-24th to 1-1800th inch. *g*, dendriform growth of spines produced by the coenosarc (see *a*): scale 1-48th to 1-1800th inch.

[To be continued]

XLI.—*On a Collection of Crustacea from the Malaysian Region*.—Part IV. Penæidea, Stomatopoda, Isopoda, Suctoriosa, and Xiphosura. By EDWARD J. MIERS, F.L.S., F.Z.S.

[Plate XV.]

[Concluded from p. 384.]

PENÆIDEA.

Penæus avirostris, Dana.

W. Borneo.

I refer to this species two female specimens of *Penæus* in the collection. They agree with Dana's description in the form of the rostrum, fifth ambulatory legs, &c. In both the rostrum is prolonged backward into a somewhat indistinct median dorsal carina, which, however, is obsolete near the posterior margin. The rostrum, in the only perfect specimen, is 7-toothed above.

This species was not represented in the Museum collection when I wrote my analytical table of the species of *Penæus* (P. Z. S. 1878, p. 306); and the examination of the foregoing examples shows that it should be classed (in that synopsis) in the neighbourhood of *P. monoceros* and *P. Dobsoni*, on account of the distinct dorsal ridge of the carapace.

Penæus sculptilis, Heller.

W. Borneo (a female).

This specimen agrees very well with the description and figure of Heller, based on examples from Java. Like the