VI. SOME SPONGES ASSOCIATED WITH GREGARIOUS MOLLUSCS OF THE FAMILY VERMETIDAE.

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Among the most interesting of the specimens received at the Indian Museum as a result of the work of the trawler "Golden Crown" in the Bay of Bengal are a number of rocky masses consisting of the contorted and worm-like shells of molluscs of the family Vermetidae embedded in sponges. Unfortunately they did not reach us until they had been exposed to the air for some days and were in a dry or putrid condition, and only a few broken fragments were preserved in spirit; but as they offer material for certain observations and speculations of a general as well as a taxonomic nature I have prepared the following notes regarding them.

I.—GENERAL.

The masses received at the Museum can be readily separated into two series, one consisting of shells with strongly serrated external ridges and of sponges of an intense black colour and only of moderate hardness, the other of much smoother shells embedded in sponges that are of stony hardness and either of variegated grey and purple or of some shade of red, orange or yellow.

The masses of the first kind were apparently taken only off Gopalpur in the Ganjam district of Madras at depths between 30 and 38 fathoms. Only three specimens were sent us, but probably more were brought up in the trawl and thrown away. A description of the largest and most perfect specimen preserved (pl. viii, fig. 1) will apply equally well, so far as general characters are concerned, to the others also.

The mass is roughly heart-shaped, measuring 40·8 cm. in length, 40·8 cm. in greatest breadth and 16·6 cm. in depth, and weighing 9 lb. 15 oz. dry. It is possible to distinguish the upper from the basal surface by the fact that the shells open, in a more or less horizontal direction, on the former; the latter is irregular but nearly flat as a whole, there is no sign of it having been attached to any foreign object and the mass appears to be complete in itself, not merely a part of a larger mass. The shells, of which several hundreds are present, appear to radiate outwards from a number of different centres, but each is twisted and contorted in a manner different from its neighbour, although the main course of all is

horizontal rather than vertical. Although they do not actually twine round one another, they are so confused in their twistings that it is impossible to isolate a single shell from the mass; the length of the longer shells, measured along their loose and irregular whorls, would be considerable, if it could be accurately measured.

It is not my intention to give a technical description either of this shell or of the other Vermetidae mentioned in these notes, for they all represent well-known species and are admirably figured by Reeve in vol. xx of his *Conchologia Iconica*. Mr. H. B. Preston has identified the ridged species as *Siliquaria muricata* (Born.), but this species is believed by some authorities to be synonymous with *S. anguina* (Linn.). The mollusc is, in any case, widely distributed in Indo-Pacific seas.

The sponge associated with our specimens of *S. muricata* is identical with a species recently described from the Gulf of Manaar by Dendy under the name *Spongosorites topsenti*. The original specimens were not associated with *Siliquaria* shells, but one of them had grown over calcareous nodules and it is probable that the sponge makes use of any suitable support, living or dead, in its growth. As I have already stated, the colour of the specimens before me is an intense black. These specimens are dry, and there is evidence that they were dark green when fresh. The shells are of a dirty white, so that there is considerable contrast between them and the sponge. The latter fills up the spaces between the shells and covers the greater part of the base of the mass but leaves the distal part of the shells free, as a rule for several inches. As it possesses no definite skeleton, the sponge would not persist for long after its death, for the spicules to which its hardness is due would soon fall apart.

The masses of the second series may be further divided into two groups. At first sight they resemble one another closely as regards structure but are easily distinguished by colour. A closer examination, however, reveals the fact that colour is associated with structural peculiarities, and that we are dealing with different species of shell and with sponges that exhibit certain idiosyncrasies correlated with those of the shells with which they are associated. In those masses in which the sponge is red, yellow or orange, the shell is extremely delicate and fragile, has a lustrous appearance and is at no point tightly coiled, while the sponge is not very massive. In those in which the sponge is grey diversified with purple the molluscs have thicker shells which lack the lustre of those in the other masses and are more tightly coiled, while the sponge is more compact. The shells of the first kind have been identified by Mr. Preston as those of *Spiroglyphus cummingi* (Mörch), a species originally described from the Philippines; those of the second kind he has named *Siliquaria cochlearis*, Mörch, this species having originally been described from Ceylon.

It will be convenient in the following notes to refer to the denser masses as the *Siliquaria*-masses, to the others as the *Spiroglyphus*-masses; but it should be noted that *Siliquaria* and

Spiroglyphus are closely allied groups of species which many authorities recognize only as subgenera.

The sponges associated with these shells must be regarded as varieties of a species originally described by Carter from the Gulf of Manaar under the name *Discodermia sceptrellifera* and now assigned to the genus *Racodiscula*. Those that help to form the *Siliquaria*-masses are hereafter described as the types of the new variety *siliquariae* of the species, those associated with the *Spiroglyphus* as the types of the new variety *spiroglyphi*. The two varieties differ not only in colour and compactness but also as regards certain details of spiculation.

The *Spiroglyphus*-masses must have when fresh a very gorgeous appearance, the sponge being red or orange, the shells of a delicate pink and the body of the molluscs yellow. The largest of the specimens (pl. viii, fig. 2), of which a considerable number were obtained, measures about 47·4 cm. by 38·6 cm. by 18 cm. (the last measurement being that of the depth), weighs (dry) nearly 22 lb. and has a regular oval or wreath-shaped form (pl. viii, fig. 2). The smallest, which is very irregular in outline, measures 17·5 cm. by 14·5 cm by 7·5 cm. In the centre of each mass there is usually either a concavity at the base or an empty space extending from the base through to the upper surface. This concavity probably represents that formerly occupied by the object to which the *Spiroglyphus* shells originally attached themselves on quitting their active larval life—in one specimen this object remains in the form of an oyster-shell, in another in that of the shell of a gastropod; for there is evidence that molluscan shells when not occupied by a living animal dissolve rapidly in the Bay of Bengal, even in shallow water. "Dead" shells (to use a conchologist's phrase) from the Bay are usually very "dead," their surface being much corroded; and immediately north of the area on which the *Spiroglyphus*-masses occur, the bottom of the sea is coated with a recent conglomerate formed of partially dissolved shells consolidated with sand-grains into a layer of stony hardness. Most of the *Spiroglyphus*-masses seem from their regular outline to be complete in themselves, but some of the smaller specimens appear to have once formed parts of wreath-shaped masses which have been broken by some accident and have repaired the actual fracture in the course of growth. The collection offers no proof of the existence of masses larger than the larger one of which the measurements are given.

The *Siliquaria*-masses are not so numerous as the *Spiroglyphus*-masses and must have been much less conspicuous objects when fresh. None of our specimens appear to be complete, for all are irregular in form and show evidence of being merely fragments of larger masses. The largest fragments obtained are about half the size of the largest *Spiroglyphus*-masses. While the *Spiroglyphus* shells radiate more or less distinctly from a common centre, run mainly in a horizontal direction and have a very open and irregular spiral, those of *Siliquaria cochlearis* are coiled in almost

regular snail-shell fashion in their oldest portion, and although they become uncoiled and very irregularly spiral in their distal parts, adopt a course much nearer the vertical than that adopted by *Sp. cummingi*. The shell is thicker and stouter than that of the *Spiroglyphus*. The difference in growth between the two shells appears to produce or at any rate to be correlated with structural differences in the sponge associated with them, for there can be no doubt that the same *species* of sponge is associated with both molluscs.

Unfortunately our data as regards the *provénance* of the two species of shell with their associated varieties of sponge are not sufficiently precise for it to be possible to say whether they affected habitats in any way diverse. All that we know is that both species are common in an area that extends in a southerly direction from opposite Gopalpur on the coast of the Ganjam district at least to the neighbourhood of Vizagapatam, and that they are found in depths of between 15 and 30 fathoms.

The sponge *Racodiscula sceptrellifera* belongs to the Tetractinellid grade Lithistida, which is characterized by the possession of much proliferated spicules (primarily of the Tetractinellid type) welded together to form a compact siliceous skeleton. This skeleton, even after the death of the sponge, can be broken up only by the exercise of considerable violence.

It is probable that the masses, with which this paper deals, will be of considerable interest to the geologists of some future epoch, when the bottom of the Bay of Bengal has become dry land, if there be geologists then. This is especially the case as regards those masses in the formation of which *Racodiscula* plays a part, for, "The Lithistids are peculiarly well suited for preservation, owing to the massive, stony character of their skeletons; and their remains occasionally form thick deposits, especially in the Jurassic and Cretaceous." (Zittel's *Text-Book of Palaeontology*, vol. i, p. 47, Engl. ed., 1900.) We have no evidence, however, that the combined growth of the shells and the sponges is producing in Indian seas, reefs at all comparable to those now being formed by Vermetid shells alone off the coast of Florida. These reefs are described by Dall [1] as being of sufficient size for boats to be wrecked upon them at low tide, and as covering very large areas. But it is evident that masses of considerable weight and stability, and possibly larger than any that have as yet been examined, are being produced in enormous numbers off the coast of the Ganjam and Vizagapatam districts of the Madras Presidency. From a practical point of view these masses would interfere seriously with trawling operations off this coast, for the net of the "Golden Crown" was seriously damaged by them on more than one occasion; from a zoological point of view they seem to be characteristic of a definite faunistic area of somewhat limited

[1] *Bull. Mus. Zool. Harvard*, xviii, p. 262 (1889).

extent. Northwards the fauna they represent gives place to one consisting largely of sedentary organisms such as Alcyonaria and Antipatharia fixed to the recent conglomerate to which reference has already been made. Still further northwards, all round the head of the Bay, only those animals can exist which can endure muddy water and can live without a solid surface of attachment. Southwards the *Siliquaria*-beds are replaced, in the more sheltered and probably salter waters of the Gulf of Manaar, by coral reefs.

From a strictly biological point of view it is interesting to notice that neither of the two species of sponges found associated with the three species of Vermetidae is peculiar to these shells or, indeed, to a habitat or manner of life similar to that implied by the mollusc's peculiar method of growth. In two cases out of three, however, the sponge appears to be modified to some extent by the peculiarities of the shell with which it is associated, or at any rate in accordance with these peculiarities.

Several other organisms were found in large or considerable numbers and in some degree associated with the shells and sponges. Dead shells (of which there were a considerable number in some masses) of both *Siliquaria cochlearis* and *Spiroglyphus cummingi* were often inhabited by the peculiar little hermit-crab *Troglopagurus manaarensis*,[1] hitherto only known to frequent holes in corals in the Gulf of Manaar. A small bivalve mollusc (*Arca domingensis* var. *divaricata*) was also found in considerable numbers in dead shells of the two species, anchored to the inner surface by a byssus of horny consistency, while specimens of a larger species of the same genus (*A. adamsiana*) were found in interstices of the sponges and between the shells. Sedentary organisms were not so numerous on the external surface of the masses as might perhaps have been expected, but a considerable number of small monaxon sponges and a few polyzoa occurred in this position and shells of the bivalve *Chama ruppellii* were common.

II.—DESCRIPTION OF THE SPONGES.

The sponges here described belong to two grades of the order Tetraxonida, namely the Lithistida and the Monaxonellida, if we adopt the nomenclature proposed by Prof. Dendy in his account of the sponges in part iii of Prof. Herdman's report on the pearl-fisheries of Ceylon; for two of the three forms found in association with *Siliquaria* shells off the Madras coast represent varieties of a species of *Racodiscula* (Lithistida) originally described by Carter from the Gulf of Manaar, while the third represents a species of *Spongosorites* (Monaxonellida) also described from the Gulf of Manaar, by Prof. Dendy in the report to which reference has just been made.

[1] Dr. J. R. Henderson, the author of the species, has been kind enough to identify specimens.

Racodiscula sceptrellifera (Carter).

Discodermia sceptrellifera, *Carter*, *Ann. Mag. Nat. Hist.* (5), vol. vii, p. 372, pl. xviii, fig. 2 (1881).

Racodiscula sceptrellifera, *von Lendenfeld*, *Das Tierreich*, Lief. 19 (Tetraxonia), p. 132 (1903).

Carter's description of this species was based on a specimen "not only small but imperfectly developed" and partially embedded in a nodule of the calcareous alga *Melobesia*. It is therefore unfortunate that the form he described must be regarded as the *forma typica* of the species. Among the specimens obtained by the "Golden Crown" two other forms may be distinguished, each associated in several or many instances with a particular species of *Siliquaria* or *Spiroglyphus*. Possibly they are mere phases, their peculiarities being due to the direct effects of environment, but it will be convenient to regard them provisionally as varieties of Carter's species, with which I have no doubt they should be associated.

Var. *spiroglyphi*, nov.

(Plate viii, fig. 2; plate ix, figs. 1—15.)

Sponge of a deep orange or bright red colour when fresh, yellow when dry, coating and filling the interstices between shells of *Spiroglyphus cummingi* (Mörch), often massive, but without definite form, very hard; the surface smooth, with scattered oscula of oval form and varying from 2 × 2·5 mm. to 3 × 4 mm. in dried specimens; pores sieve-like, scattered, minute, each aperture measuring about 0·33 × 0·5 mm. The main efferent channels run as a rule obliquely. The surface of the sponge, immediately under the dermal layer, is scored with narrow channels which enter the efferent canals close to the oscula. The lining of the latter is a collenchyma which is sometimes as much as 3 mm. thick and consists of numerous nuclei embedded without visible cell-limits in a gelatinous substance. This substance is not destroyed even by hot nitric acid, at any rate without prolonged boiling. Slender fibres can be detected in parts of the collenchyma, running vertically. (My material is not sufficiently well preserved to render a detailed description of the soft parts possible.)

Skeleton and Spicules.—The skeleton consists of stout desmas (pl. ix, figs. 8—14) of the typical form firmly welded together by means of the proliferations at the ends of the branches. The shafts are smooth or nearly so. Where the sponge is in contact with the shells with which it is associated the tips are flattened and splayed out in a horizontal plane. Towards the external part of the sponge, where growth is evidently most active, many of the desmas afford a transition, more apparent than real, to the phyllotriaene dermal spicules (pl. ix, figs. 8, 9; see also Carter, *op. cit.*, pl. xviii, fig. 2e). Their shafts are more slender, their terminal proliferations less developed than in other desmas, and often

one cladus is less well developed than the other three. They can always be distinguished, however, from true phyllotriaenes by the fact that in the former this cladus, although apparently vertical in direction and often only a little proliferated at the tip, has never the regular pointed form of the vertical spike of the phyllotriaene. I have no doubt that these "intermediate" desmas are simply young spicules that have not yet become firmly united with their fellows. The true phyllotriaenes are entirely confined to the external surface, on which they form a single reticulate layer, the branches of different spicules overlapping at the extremities and the spike pointing vertically downwards. The subdermal channels lie directly under this layer and the spikes project into their lumen. I have not found any of the discoidal forms figured by Carter, *op. cit.*, pl. xviii, figs. 2a, 2b; but spicules agreeing with his figs. 2c and 2d are abundant in my preparations (pl. ix, figs. 4—7). Possibly the discoidal spicules are only found in young or stunted sponges. The most noteworthy difference between Carter's specimens and those of this variety is the apparent absence in the former of the slender rhabdi that form a conspicuous feature in the latter. These rhabdi vary greatly in length but are always very slender, the longest measuring 0·9 mm. × 0·007 mm. They are not inflated in the middle or at the ends and their tips are bluntly pointed, but one end is often stouter than the other. The longer specimens are sinuous and hair-like. These rhabdi lie in a more or less vertical position in the interstices of the skeleton, and more especially in the walls of the efferent canals, sometimes forming loose strands in the latter situation. They do not project on the surface of the sponge. The microscleres (pl. ix, fig. 15) are somewhat irregular amphiasters with a circle of spines round the shaft; but the spines are often asymmetrical in form and disposition. The spicules measure about 0·01 mm. in length and 0·006 mm. in greatest breadth. The amphiasters are found chiefly in the dermal layer, in which they are densely scattered.

Habitat.—Off the coast of the Ganjam and Vizagapatam districts of the Madras Presidency in 15 to 30 fathoms: associated with *Spiroglyphus cummingi* (Mörch).

Var. *siliquariae*, nov.

(Plate ix, figs. 16—18.)

Sponge denser and more massive than that of var. *spiroglyphi*, of a dull grey colour diversified with large spots which are of a deep purple colour and have irregular but well-defined outlines; oscula larger, main efferent canals wider and more vertical.

Spicules and Skeleton.—The desmas, phyllotriaenes and amphiasters agree almost exactly with those of the var. *spiroglyphi*, except that the desmas are a little stouter; but the rhabdi are very few or altogether absent. The sponge has the habit of collecting spicules from other sponges that grow in its vicinity, and I

have found in different preparations of a considerable number of specimens, single spicules or small groups of spicules belonging to seven different types, the commonest of which consists of amphioxi that have clearly been derived from the skeletons of monaxons growing on the surface of the Lithistid. In several instances I have found the sponge from which they clearly originated. These adventitious spicules are scattered, together with small grains of sand, in the collenchyma of the efferent canals and in the outer parts of the sponge. In one preparation I found several rhabdi like those of the var. *spiroglyphi*. They apparently formed a small vertical strand in the collenchyma of an efferent canal, but it is impossible to be quite sure that they were not adventitious. The external surface has been rubbed off most of my specimens of the var. *siliquariae*, and with it the phyllotriaenes and amphiasters have disappeared, but I have found them both in one preparation, having the same forms and arrangement as in var *spiroglyphi*, except that the amphiasters were perhaps a little shorter and more regular in shape.

Lying loose in the efferent channels near the osculum of a dried specimen of this variety I found several little siliceous bodies (pl. ix, fig. 18) that are probably the skeletons of embryo sponges. They are formed of closely welded spicules resembling the desmas of the adult sponge but smaller and more slender. Each body has the form of a figure of eight somewhat attenuated, and measures between 2 and 3 mm. in length; the proportions differ in different specimens, but one of the loops is usually rather larger than the other One surface is flat, the other distinctly convex. Each loop contains three relatively large apertures, one on the convex surface, a corresponding but smaller aperture on the flat surface, and one (still smaller) at the free extremity. The last is surrounded by projecting cladi of desmas. There is no channel, so far as can be seen from a bare skeleton, between the two loops.

Habitat.—Off the coast of Ganjam and Vizagapatam in 15—30 fathoms; associated with *Siliquaria cochlearis*, Mörch.

It is unfortunate that the data supplied with the specimens of these two varieties are not sufficiently precise to enable me to state whether their peculiarities are correlated with any difference in habitat or environment. The colour of the two is of course strikingly different, while the absence or paucity of rhabdi in the var. *siliquariae* enables sections or other preparations of this form to be distinguished at a glance from those of the var. *spiroglyphi*. The former variety, therefore, seems to agree as regards spiculation (except in the absence of discoidal phyllotriaenes) with the typical form of the species, but to differ both from it and from the var. *spiroglyphi* in colour. It differs from both in its more massive structure. Colour is perhaps a more important character as regards the forms of *R. sceptrellifera* than it is in most sponges, for in the case of all the specimens examined I have found it to some extent persistent. In the var. *siliquariae*, however, the purple patches are probably due to the sporulation of some

micro-organism, for they are produced by enormous numbers of minute morula-like masses contained in the soft parts of the sponge.

Spongosorites topsenti, Dendy.

(Plate viii, fig. 1.)

S. topsenti, *Dendy in Herdman's Report on the Pearl Oyster Fisheries of Ceylon*, pt. iii, p. 182, pl. xii, fig. 1.

Sponges of this species were found associated with *Siliquaria muricata* off the coast of Ganjam near Gopalpur in from 30 to 38 fathoms. They agree well as regards structure with Dendy's description of the type specimens from the Gulf of Manaar, one of which had grown partially round calcareous nodules; but certain differences may be noted as regards external form and colour, although these differences are perhaps due to the fact that my specimens are dry. Their surface is smooth, except where the sponge forms a thin layer over the spinose shells of the *Siliquaria*, and except for a few scattered and irregular cones less than 5 mm. high. I have not observed the vents. Externally the sponge is of an intense black colour, but the inner parts are dark green, which was probably the colour of the fresh sponge.

EXPLANATION OF PLATE VIII.

FIG. 1.—Mass formed of shells of *Siliquaria muricata* (Born.) and the sponge *Spongosorites topsenti*, Dendy, viewed from above. (Scale about $\frac{2}{7}$.)

,, 2.—Mass formed of shells of *Spiroglyphus cummingi*, Mörch, and the sponge *Racodiscula sceptrellifera* var. *spiroglyphi* nov., viewed from below. (Scale about $\frac{2}{6}$.)

In both figures the lower end of the mass is obscured to a slight extent.

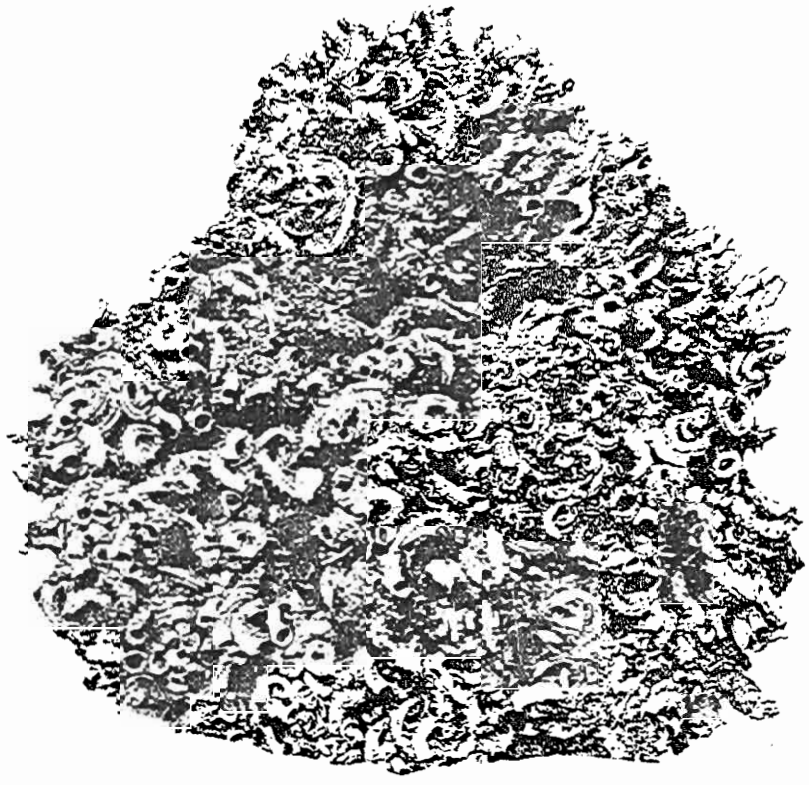
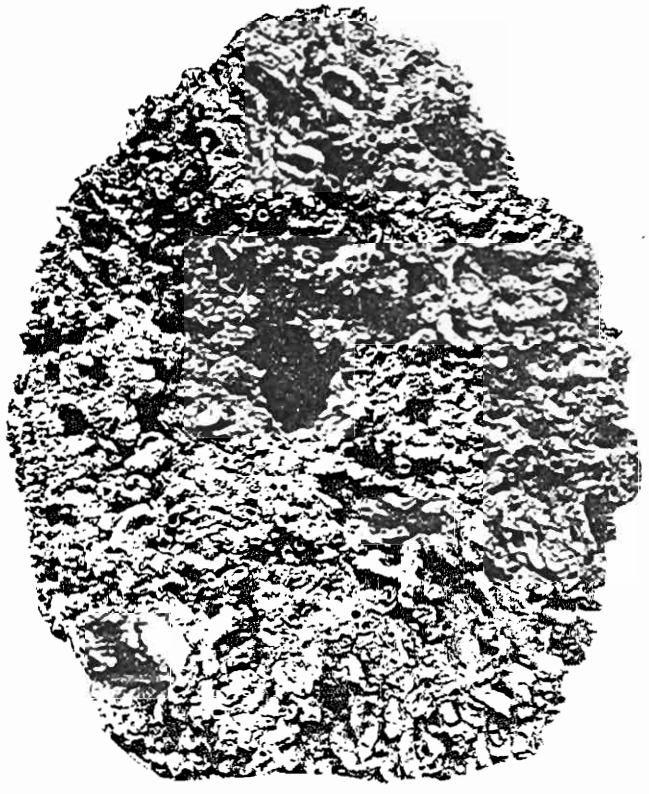


Photo. by A. C. Chowdhury.

1.

SILIQUARIA MURICATA Born.
with Spongosorites topsenti Dendy.



2.

SPIROGLYPHUS CUMMINGI Mörch.
with Racodiscula sceptrellifera Carter, var. spiroglyphi, nov.

Photo.-Engraved & printed at the Offices of the Survey of India, Calcutta, 1911

EXPLANATION OF PLATE IX.

FIGS. 1—15.—*Racodiscula sceptrelliſera*, Carter, var. *spiroglyphi*, nov.—

Figs. 1—7.—Phyllotriaenes, × 75.

,, 8—11.—Desmas, × 75.

,, 12, 13.—Fragments of the skeleton (lateral view), × 75.

,, 14.—Fragment of the skeleton in contact with a shell (surface view), × 75.

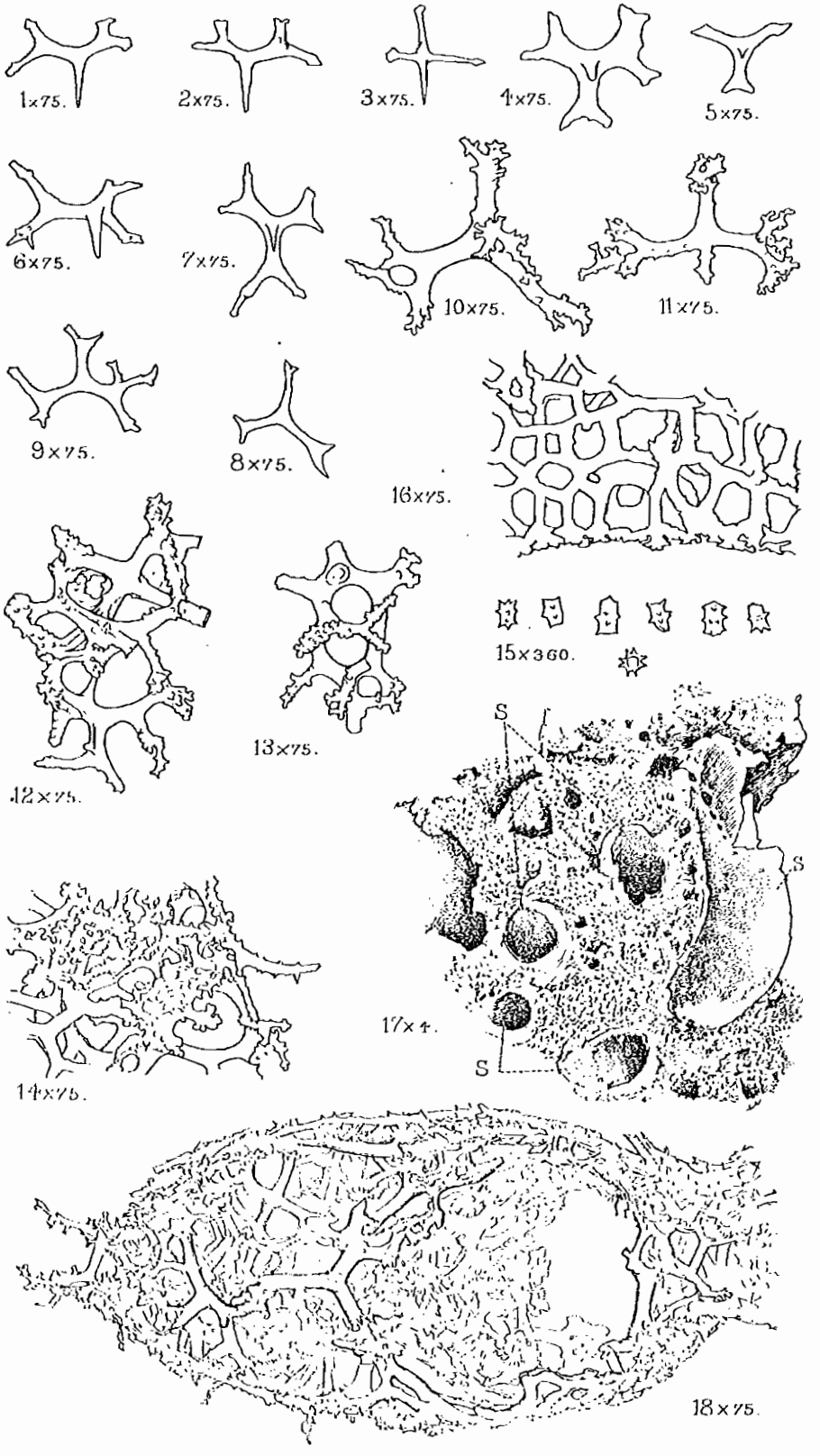
,, 15.—Microscleres (amphiasters), × 360.

FIGS. 16—18.—*Racodiscula sceptrelliſera*, Carter, var. *siliquariae*, nov.—

Fig. 16.—Vertical section of a fragment of the skeleton in contact with a shell, × 75. (To show how the cladi of the desmas become splayed out horizontally in such positions.)

,, 17.—Vertical section of a fragment of the dried sponge with enclosed shells from near the surface of a mass, × 4.

,, 18.—Half of (?) embryonic skeleton from efferent channel of the sponge, × 75.



A. C. Chowdhury, del. et lith.