I. INDIAN BORING SPONGES OF THE FAMILY CLIONIDAE.

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(Plate i.)

Among the sponges found in excavations in shells and corals by far the best known are those of the family Clionidae. Having recently had occasion to inquire, in connection with other work, into the species that occur in Indian seas (that is to say, the Bay of Bengal with its subordinate gulfs and straits and the Arabian Sea, with which it is convenient to include the Persian Gulf and those parts of the Indian Ocean that lie immediately south and south-west of the Indian Peninsula), I found in our collection so large a proportion of the species known from Oriental waters—as well as several hitherto undescribed—that it seems worth while to bring together in a single paper references to all the former, with such notes as my material suggests, with keys to species and genera and descriptions of new forms.

The specimens examined have included a large part of the collection made by the late Dr. John Anderson in the Mergui Archipelago off the coast of Tenasserim, and described by the late Dr. H. J. Carter in Vol. XXI of the *Journal of the Linnean Society* (Zool). in 1887[1]; as well as examples of sponges extricated from shells and corals from various sources in the general collection of the Indian Museum and specimens specially collected in the Gulf of Manaar and Palk Straits and in lagoons on the east coast of India by Mr. S. W. Kemp, Mr. J. Hornell and myself. I have to thank Messrs. Kemp and Hornell for valuable assistance in this direction.

Fam. CLIONIDAE.

The taxonomy and systematic position of the Clionidae have been considered most fully by Topsent in his papers on the family in vols. V[2] and IX of the *Archives de Zoologie expérimental et général* (1887 and 1891) and I have little to add to the general conclusions there set forth. References to more recent literature are given below in connection with the different species discussed.

Six genera are now recognized by Topsent as constituting the family, namely *Cliona*, Grant, *Clionopsis*, Thiele, *Alectona*,

[1] This paper, with many others originally published in the same Journal, was re-issued by Anderson in 1889 in vol. i of his *Fauna of the Mergui Archipelago.*

Carter, *Thoosa*, Hancock, *Dotona*, Carter and *Cliothosa*, Topsent; but the last seems to me of doubtful validity.

Of these six genera all but *Clionopsis* are known to occur in Oriental waters. *Clionopsis*[1] is at present recorded only from the Pacific Coast of S. America and from an unknown locality probably in the Tropics. *Alectona*[2] and *Dotona*[3] both occur in the Gulf of Manaar, although I have not been so fortunate as to find examples of either. *Cliona* and *Thoosa* are well represented in the Indian marine fauna, while a specimen that would be assigned by Topsent to his genus *Cliothosa* has been found in a shell from the Andamans. I am not satisfied that this last "genus" represents more than a phase of certain species of *Thoosa* (see p. 22, *postea*).

Key to the genera of Clionidae.

I. Microscleres essentially spirasters.
  - A. Macroscleres both amphioxi and styli (usually tylostyli), or either alone; if both present the amphioxi never the larger. Microscleres often variable and sometimes divisible into two groups but never of two quite distinct kinds .. .. *Cliona.*
  - B. Macroscleres amphioxi and tylostyli, of which the former are the larger. Microscleres slender, elongate, zig-zag spirasters and short, stout, irregularly contorted ones .. .. *Clionopsis.*
  - C. Macroscleres reduced to minute simple styli or amphioxi and confined to the external papillae. Microscleres relatively large spiral spirasters and minute straight ones of amphiaster-like form .. .. *Dotona.*

II. Microscleres essentially amphiasters.
  - A. Macroscleres, if present straight or regularly curved amphioxi or tylostyli, occurring in the internal galleries. Typical amphiasters consisting of a cylindrical stem bearing at or near both ends a ring of relatively large bosses and terminating in similar bosses.[4] Other forms

[1] Thiele, *Zool. Jahrb.*, suppl. VI, Vol. III, p. 412 (1905): Topsent, *Bull. Mus. Océanog. Monaco*, No. 120 (1908).

[2] The fullest description, illustrated by numerous figures, is that given by Topsent in his "Etude monographique des Spongiaires de France" (*Arch. Zool. expérim.* VIII, p. 24: 1900). The original description, by Carter, is in *Journ. Roy. Micro. Soc.* II, p. 493 (1879).

[3] Carter, *Ann. Mag. Nat. Hist.* (5) VI, p. 57 (1880): Topsent, "Spongiaires des Açores," *Res. Camp. Sci. Monaco*, XXV, p. 108 (1904).

[4] In *Thoosa laeviaster*, described on p. 22, both lateral and terminal bosses are reduced to smooth conical projections.

of microscleres present also, but never spiny diactinial spicules of relatively large size and of polyactinial origin .. *Thoosa.*

B. [Macroscleres normal tylostyli, occurring as in *Thoosa*. The only microscleres amphiasters consisting of a cylindrical stem bearing at the ends a circle of relatively long horizontal branches which are inflated at the tip or terminate in several minute hooks; the whole spicule smooth and slender .. .. .. *Cliothosa.*]

C. Macroscleres entirely absent; their place taken in the external papillae, but not in the galleries, by relatively large spiny or nodular diactinial spicules some of which reveal their polyactinial origin by being definitely bent or geniculate in the middle, or even by bearing extra rays, complete or rudimentary, in this position. Amphiasters like the typical ones of *Thoosa* but with the lateral bosses far removed from the extremities, which are not always capitate .. .. *Alectona.*

Genus Cliona, Grant.

1826. *Cliona*, Grant, *Edinb. Phil. Journ.* I, p. 78.
1849. ,, Hancock, *Ann. Mag. Sci. Nat.* (2) III, p. 305.
1888. ,, Topsent, *Arch. Zool. expérim.* (2) V², p. 76.
1891. ,, *Id., ibid.*, IX, p. 556.
1900. ,, *Id., ibid.*, (3) VIII, p. 32.
1900. *Dyscliona*, Kirkpatrick, *Ann. Mag. Nat. Hist.* (7) VI, p. 353.
1907. *Cliona*, Topsent, *Arch. Zool. expérim.* (4) VII, p. xvii.

Further references will be found in Topsent's papers, which are essential for a study of the Clionid genera and particularly for that of *Cliona*. In 1891 he arranged the species in six groups as follows :—

Group I. Spicules including tylostyles, diactinial macroscleres and spirasters (microscleres).
Group II. Spicules consisting of tylostyles and diactinial macroscleres only.
Group III. Spicules consisting of tylostyles and microscleres only.
Group IV. Spicules consisting of amphioxi and microscleres only.
Group V. Spicules consisting of tylostyles only.
Group VI. Spicules consisting of amphioxi only.

This grouping is convenient for the purposes of a provisional classification, which is all that is possible until the life-histories of the species are known; but it must be remembered that in at least one species (*Cliona celata*, Grant) phases occur in the life of an individual sponge that would fall respectively into groups I, II and V. The sponge in its younger stage possesses tylostyles, diactinial spicules and microscleres, but as it grows it loses first the diactinial spicules and then, sometimes, the microscleres, so that in its mature form it has only tylostyles. It is possible, and indeed probable, that other species resemble it in this respect, so that groups V and VI may actually consist of species whose earlier stages are unknown and if known would fall into other groups, or even in some cases of species known by other names and assigned to other groups at different phases of development.

Taking the groups as they stand, we find that among the species known from Indian seas all but group VI are represented. Group V, so far as hitherto described species are concerned, has not withstood recent criticism and research[1], but a new species belonging to it is described here on p. 14. In the following key to the species found in the Indian Ocean (including the Red Sea, the Bay of Bengal with its appurtenances and the western part of the Malay Archipelago) I have found it more convenient to make the primary division between species that possess and those that do not possess microscleres. Even so, it is necessary to include *C. celata* under three separate headings in accordance with its three phases of development.

Of the sixteen species now known from the Indian Ocean at least twelve have been found in the Bay of Bengal or the Gulf of Manaar. Of these, four are of very wide distribution (*C. celata*, *C. vastifica*, *C. carpenteri*, *C. viridis*): *C. carpenteri* is essentially a circumtropical sponge, but the other three are cosmopolitan. Three species have a wide distribution in the Indo-Pacific Region, namely *C. margaritiferae*, *C. mucronata* and *C. orientalis*; while five (*C. annulifera*, *C. indica*, *C. ensifera*, *C. acustella* and *C. warreni*) have been definitely recorded only from the Bay of Bengal and Ceylon. Of the four species not known from these seas, two were originally described, or are only known definitely, from the "Indian Ocean," namely *C. michelini* and *C. millepunctata*, but the original specimen of the latter was doubtfully ascribed to the N. Atlantic. One species (*C. mussae*) has been found only in the Red Sea, and one (*C. patera*) in the western part of the Malay Archipelago.

I have not included *C. gracilis*, Hancock, among the species known from the Indian Ocean, although Topsent (1887, p. 77) has done so; because the latter author's brief description of his specimen from that area ("Spicules en épingle=150μ de long, spic. en zigzag=15–20μ") is totally at variance with Hancock's original diagnosis, which is supported by good figures, and some mistake

[1] See Topsent, *Arch. Zool. expérim.* (3) VIII, p. 78 (1900).

in the identification must have occurred. The *Cliona ? sceptrellifera*, of Carter [1], if he rightly associated the isolated spicules on which it was based, is probably a *Thoosa* or an *Alectona*, but I have been unable to find these spicules in that part of his original material at my disposal.

The names of species on which notes are given are distinguished by an asterisk in the key. I have not seen the following forms:—

C. indica, Topsent, *Arch. Zool. expérim.* (2) IX, p. 574 (1891).

C. michelini, id, ibid., vol. V[2], p. 79 (1887).

C. mussae (Keller), *Zeitschr. wiss. Zool.* III, p. 321 (1891).

C. warreni [2] Carter, *Ann. Mag. Nat. Hist.* (5) VII, p. 370 (1881).

C. millepunctata Hancock, *Ann. Mag. Nat. Hist.* (2) III, p. 341 (1849) ; Topsent, *op. cit.*, 1887, p. 78.

Cliona has a wide bathymetric range. In the Bay of Bengal one species has been found at a depth of over 700 fathoms [3] (*C. annulifera*, p. 9) and another (*C. vastifica*, p. 8) in lagoons of brackish water actually above sea-level. The genus is, however, best represented in comparatively shallow water below low tide. On beds of gregarious sedentary molluscs such as *Ostrea* or *Margaritifera* a single species usually predominates and becomes very abundant, but in the less vigorous parts of coral-reefs several are sometimes found together in a flourishing condition. More than one may also occur in a single shell, either Gastropod or Lamellibranch, that is of suitable size, thickness, etc., but does not belong to a markedly gregarious species.

KEY TO THE SPECIES OF *Cliona* KNOWN FROM THE INDIAN OCEAN.

I. **Species with microscleres.**

A. *Macroscleres both diactinial and tylostyle.*

1. Diactinial spicules smooth, hair-like, fasciculated .. .. *C. celata* (A).*
2. Diactinial spicules granular, spindle-shaped, moderately stout, not fasciculated.
   - *a.* Microscleres sinuate, truncate. *C. vastifica.**
   - *b.* Microscleres straight, spindle-shaped .. .. *C. carpenteri.**
3. Diactinial spicules cylindrical, irregularly spiny .. *C. margaritiferae.**

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[1] *Fauna of Mergui I* (*Journ. Linn. Soc.* (Zool.) XXI: 1887), p. 70. "Spongiaires des Açores," *Rés. Camp. Sci. Monaco*, XXV, p. 108 (1904).

[2] Topsent (*Arch. Zool. expérim.* (3) VIII, p. 54) regards this species as identical with *C. quadrata*, Hancock.

[3] *C. abyssorum*, Carter was taken at the mouth of the English Channel in 500 fathoms (*Ann. Mag. Nat. Hist.* (4) XIV, p. 249, 1874). This is apparently the only other species as yet recorded from depths of like magnitude.

B. All the macroscleres tylostyles.

1. Shaft of macroscleres bearing a single convex ring a short distance below the head .. *C. annulifera.**

2. Shaft of tylostyles normally smooth.

a. Tylostyles definitely of two sorts; one sort normal, the other very short and bearing a sharp subsidiary spine at its point .. .. .. *C. mucronata.**

b. No "mucronate" spicules of this type.

i. Spines on all the microscleres very small and set close together; two groups of zigzag microscleres, one very slender .. *C. indica.*

ii. Spines on microscleres stout, very irregular, often blunt but never widely separated; microscleres not divisible into two groups .. *C. michelini.*

iii. Spines of microscleres relatively long, sharply pointed, normally arranged in a spiral band winding round the spicule.

α. Some of the macroscleres conspicuously but gradually expanded before narrowing to the point; hair-like tylostyles not present. *C. ensifera.**

β. None of the macroscleres of expanded form; hair-like tylostyles, sometimes with spiny heads, often present. *C. viridis.**

iv. Spines of microscleres as in iii, but arranged in a sinuous band outlining one side of the spicule .. .. *C. orientalis.**

C. All the macroscleres amphioxi.

(Microscleres short, straight, approaching the amphiaster type in different degrees) .. .. *C. acustella.**

II. **Species without microscleres.**

Macroscleres both diactinial and tylostyle.

1 Diactinial spicules hair-like, fasciculated .. .. .. *C. celata.* (B).*

2. Diactinial spicules moderately stout, (smooth), spindle-shaped. *C. mussae.*

B. *All the spicules tylostyles.*

1. Sponge forming a gigantic free cup; spicules relatively stout .. *C. patera.**
2. Sponge confined to its excavations or forming a small rounded mass; spicules relatively slender.
   - *a.* Head of spicules spherical .. *C. warreni.*
   - *b.* Head of spicule elliptical .. *C. millepunctata.*
   - *c.* Head of spicule usually trilobed. *C. celata* (C).*

Cliona celata, Grant.

1900. Topsent, *Arch. Zool. expérim.* (3) VIII, p. 32, pl. i, figs. 5, 6–9, pl. ii, fig. 1.
1909. Hentschel, "Tetraxonida" in Michaelsen and Hartmeyer's *Faun. Südwest. Australiens*, p. 386.
1911. Row, *Journ. Linn. Soc.* (Zool.) XXXI, p. 305.

Topsent, in the paper cited after his name (1900), has discussed the structure and synonomy of this species in detail. As he had shown in previous papers, the spiculation undergoes great changes in the life of the individual sponge. At first three kinds of spicules are present—tylostyles, diactinial macroscleres and microscleres of the zigzag spiraster type. The last disappear first, and then, in some cases, the diactinial microscleres, which, even in the young sponge, are much reduced and have the form of hair-like bodies adhering in bundles. There are three specimens from the Bay of Bengal in the collection of the Indian Museum which illustrate three different phases of growth in an interesting manner. One of them is clearly young and retains the full spiculation. It consists of a few galleries, with about half a dozen apertures, in a nodule of calcareous alga dredged by the "Investigator" in 28 fathoms off the coast of Burma.

The other two specimens are both in chank-shells (*Pyrula rappa*, L.) from the east coast of India. One was taken at the town of Madras in shallow water by Prof. K. Rammuni Menon, who has kindly given it to me. The shell was apparently vacant when collected but still retained its horny epidermis. The whole of its subtance is permeated by the sponge, in which only tylostyle spicules remain. The external apertures are, however, small (about 1 mm. in diameter) and the sponge is wholly confined in the thickness of the shell.

The third specimen was dredged by Mr. J. Hornell of the Madras Fisheries, whom I have to thank for it, in the Gulf of Manaar near Tuticorin in 6½ fathoms. The shell in this case had evidently been "dead" for some time and its epidermis had wholly disappeared. The apertures made by the sponge are much larger (2 to 3·25 mm. in diameter) and it has begun to grow out over the

inner surface of the shell in the form of a uniform crust, much as in a specimen figured by Topsent (1887, pl. i, fig. 3).

Cliona celata probably occurs in all seas. It was originally described from the British coasts and has since been found at several places on the Atlantic side of North America, in the Red Sea and the adjacent parts of the Indian Ocean, off the south and south-west coasts of Australia, off New Guinea, Ceylon, Singapore, etc. I have examined specimens from several of these localities.

Cliona vastifica, Hancock.

1900. Topsent, *Arch. Zool. expérim.* (3) VIII, p. 56, pl. ii, figs. 3–9.

1909. Hentschel, "Tetraxonida" in Michaelsen and Hartmeyer's *Faun. Südwest Australiens*, p. 387.

This is another cosmopolitan species described at length by Topsent in his "Étude Monographique des Spongiaires de France" (*op. cit. supra*) as well as in his previous papers on the family (1887 and 1891) in the same journal. *Cliona velans*, Hentschel (*op. cit.*, p. 388, fig. 19) from S. W. Australia is evidently very closely related to *C. vastifica*, but is apparently distinguished by its method of growth and by having the heads of the tylostyles imperfectly differentiated.

In the littoral zone of Indian seas *C. vastifica* appears to be by far the commonest species and, as already stated, makes its way well into brackish water. I have found it in that medium in the Chilka Lake in Orissa and the Ganjam district of the Madras Presidency (in shells of *Ostrea* and *Purpura*), in the Adyar River at Madras and in the Ennur Backwater in the same district, in both places in shells of *Ostrea*. In the Persian Gulf it is common in, and apparently destructive to, pearl-shells (*Avicula* and *Margaritifera*); I have seen it in a *Placuna*-shell from Palk Straits (5½ fathoms), in shells of *Oliva* and *Malleus* from the Andamans, of *Voluta* and *Ostrea* from New South Wales. In Indian seas it occurs most frequently in the shells of gregarious sedentary bivalves, to which it probably causes great damage, but only in very shallow water. In European seas it is common; it has been recorded by Topsent and others from many widely separated regions.

Cliona carpenteri, Hancock.

1887. *Cliona carpenteri*, Topsent, *Arch. Zool. expérim.* V² (suppl.), p. 77, pl. vii, fig. 4.

1887 (1889). *Cliona bacillifera*, Carter, *Faun. Mergui Arch.* I: *Journ. Linn. Soc.* (*Zool.*) XXI, p. 76.

This species, as Topsent has pointed out, is easily distinguished from its allies, and in particular from *C. vastifica*, by its straight, spindle-shaped microscleres. Carter's *Cliona bacillifera* from Mergui, of which the type (or a schizotype) is in the Indian

Museum, falls well within the limits of the species as defined by the former author.

C. carpenteri is a tropical sponge distributed all round the globe. Topsent found it more frequently than any other in shells he examined from the Gulf of Mexico, the Pacific coast of Central America, the Gaboon, the Indian Ocean, etc. It does not appear, however, to be common in the Bay of Bengal. In addition to the type-specimen of Carter's species, which is in a dead oyster-shell, I have examined specimens in a shell of *Malleus* from Singapore and in one of *Voluta* from New South Wales.

Cliona margaritiferae, Dendy.

1905. Dendy, "Porifera" in Herdman's *Rep. Ceylon Pearl Oyster Fish.* V, p. 128, pl. v, fig. 9.
1909. Hentschel, "Tetraxonida" in *Faun, Südwest Australiens*, p. 386.

I have included this species (p. 5) among those that possess macroscleres of two kinds, but Dendy evidently regards the larger amphioxi as modified spirasters and points out that there are transitionary forms of spicules between them and the small microscleres. This is true; but there seems to me to be a slight but definite break in the series and it is at any rate more convenient to regard the large spiny amphioxi for the present as the equivalents of the granular amphioxi of such species as *C. vastifica*.

C. margaritiferae was originally described from the shell of the pearl-oyster of the Ceylon banks (*Margaritifera vulgaris*). I have found it in the same shell from the type-locality (*T. Southwell*) and also in a piece of Madreporarian coral from the Palk Straits (off Tondi, 5½ fathom: *J. Hornell*). Hentschel examined specimens in a shell of *Chama*, sp., from Michaelsen and Hartmeyer's Australian collection.

Cliona annulifera, sp. nov.

(Plate i, figs. 1-4.)

A *Cliona* with tylostyle macroscleres and spirasters of the normal type, the former bearing a single convex ring round the shaft; some of the latter unusually large. The gemmules are provided with spirasters of a specialized form.

The only known specimen is in a dead Gastropod shell (*Xenophora pallidula*, Rve.).

General structure. The sponge consists of a series of subspherical or ovoid chambers connected by short horizontal tubules and bearing the papillae on short vertical ones. The chambers form a single horizontal layer. The greatest longitudinal diameter of the larger chambers is about 1·3 mm. and their greatest depth about 0·9 mm. The average length of the connecting tubules (which, of course, represent the thickness of the wall of shell

left between the chambers) is about 0·425 mm. and the diameter 0·119 mm. The papillae as a rule are borne only on the surface nearest the outer surface of the shell. The tubules connecting them with the chambers are longer than the horizontal tubules, but always much shorter than any diameter of the chambers. The chambers are by no means solid, their internal structure being coarsely reticulate. Delicate cellular diaphragms can sometimes be detected at or near one extremity of the connecting tubules.

Papillae. I have been able to find only two kinds of papillae, corresponding to those styled "poriferous" and "mixed" by Topsent (1887). The largest poriferous papillae have a diameter of about 0·225 mm. They are readily distinguished by the

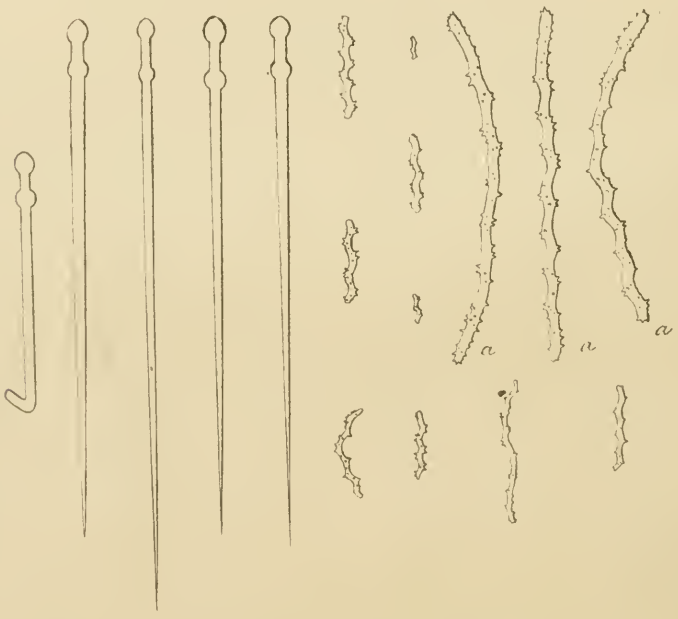


Fig. 1.—Spicules of *cliona annulifera*.
a. Gemmule-spicule.

absence of a central orifice and by the absence or paucity (at any rate when they are contracted) of projecting spicules upon their surface, which is flat and horizontal. It is closed by a minutely perforate membrane on and in which the calcareous particles derived from the shell and carried out through the oscula lie in considerable numbers, being too large to enter the pores. In profile these papillae are flat and table-like, extending beyond their supporting tubules, which are cylindrical, for a considerable distance on either side; the free surface forms an acute angle with the projecting lateral margin. The mixed papillae are about the same size but have a central star-shaped or oval orifice of relatively large diameter. This is surrounded by a number of pori-

ferous lobes through which tylostyle spicules project upwards and outwards (pl. i, figs. 2, 3, 4). In profile these papillae, with their supporting tubule, are trumpet-shaped. Their outer walls (pl. i, fig. 4) are coated with minute calcareous particles considerably smaller than those which lie scattered in the interior of the sponge and on the poriferous papillae. They are covered by a delicate cortex, which protects the calcareous particles against strong acid unless the surface is subjected to its action for a considerable period. The mixed and the poriferous tubules are about equally abundant.

Skeleton.—In the chambers the macroscleres lie scattered, irregularly and somewhat sparsely, parallel to the outer walls. As a rule they are more abundant in the upper than in the lower parts. Occasionally they seem to radiate from the chambers into the connecting tubules, but this arrangement is never of a very regular nature and no trace of it can often be detected. In the vertical tubules the macroscleres form supporting columns, their heads resting in a more or less complete, and more or less regular, ring at the base of the tubule and their points directed upwards. In the case of the mixed papillae the heads are rarely on anything like a uniform level and the points project outwards as well as upwards. The ordinary (*i.e.* the smaller) microscleres lie scattered, somewhat sparsely and almost uniformly, throughout the sponge, but their main axis is always approximately parallel to the outer surface. The gemmules have a special skeleton, which is described below.

Spicules.—The macroscleres are small, slender tylostyles, as a rule quite straight, sharply and gradually pointed at one extremity and bearing a well-differentiated head at the other. The head is most frequently somewhat heart-shaped, but in many cases almost spherical and occasionally with a tendency to be trilobed. It contains as a rule a single minute expansion of the axial tubule of the spicule. There is no distinct contraction of the shaft below the head but, at about 1/10 the distance between it and the point, the shaft is surrounded by a single convex ring. The extent to which this ring is developed varies somewhat, but its presence and position seem to be practically constant features of the species. The average length of the macroscleres is 0·2 mm., the extremes being 0·148 and 0·234 mm.

The microscleres are all slender spirasters of the normal zigzag type, but they differ greatly in size and two groups may be distinguished amongst them in accordance with this character. Those of the small type are, when well developed, from 0·008 mm. to 0·042 mm. in length and have as a rule from 4 to 8 bends, but are sometimes irregularly sinuous. Their spines are arranged in a regular spiral. These spicules lie scattered throughout the sponge.

The larger microscleres (fig. 1A). are as much as 0·126 mm. long, or even longer. They have more numerous and as a rule less well-defined whorls. The spicules of this type are found only on the gemmules.

Gemmules.—Gemmules are abundant in the only specimen examined, most of the chambers containing from one to three (pl. i, fig. 1). They lie at the periphery of the lower part of the chamber and are as a rule somewhat lenticular in shape. The external surface is frequently flattened by pressure against the wall of the excavation. The greatest diameter rarely exceeds 0·56 mm. The internal structure is that of a typical sponge-gemmule, that is to say, each gemmule consists of a mass of cells closely packed together and filled with granules of food-substance. There is a thin horny external coat. The most remarkable feature, however, lies in the spicular coat that occurs on the surface of the gemmule in contact with the sponge, for the spicules of which it consists differ considerable from those of the general choanesome. The spicules have already been described. They lie embedded horizontally in the horny coat on one side of the gemmule only, being completely absent on the side that is in contact with the wall of the excavation.

Locality.—Off the coast of Ceylon: 703 fathoms (*R.I.M.S. "Investigator"*).

Type. No. Z.E.V. 6424/7, *Ind. Mus.*: in spirit.

C. annulifera. is related to *C. viridis* (Schmidt), from which it differs in the form of its megascleres. It is remarkable for the regularity and distinctness of its chambers and especially for the peculiar spiculation of its gemmules, a feature in which it apparently differs from all other known marine sponges. That a deep-sea sponge should possess gemmules at all is a remarkable fact, and one to the signification of which I hope to devote attention in a later paper.

Cliona mucronata, Sollas.

1878. Sollas, *Ann. Mag. Nat. Hist.* (5) I, p. 54, pl. i, figs. 1, 2–7, 9, 10, 15, 17, pl. ii, figs. 1–9.
1887. Topsent, *Arch. Zool. expérim.* (2) V², p. 37.
1897. *Id.*, *Rév. Suisse Zool.* IV, p. 440.

The peculiar short, stout, mucronate tylostyles that form a considerable element in the spiculation of this species are quite characteristic. In the only specimen I have examined, they seem to be grouped together at certain points in the interior of the sponge, but this specimen is very imperfect, having been overwhelmed in its excavations by other sponges. Many of the tylostyles are of the normal type, but very slender.

C. mucronata was originally described from a coral (*Isis*, sp.) of unknown *provenance*. Topsent found it common in corals from the Bay of Amboina, and the only specimen in our collection is in a fragment of dead Madreporarian from the Indian shore of the Gulf of Manaar (Kilakarai: *S. W. Kemp*).

Cliona ensifera, Sollas.

1878. Sollas, *Ann. Mag. Nat. Hist.* (5) I, 61, pl. i, figs. 1, 18; pl. ii, figs. 10–5.

1887 (1889). Carter, *Faun. Mergui*, I, p. 75.
1891. Topsent, *Arch. Zool. expérim.* (2) IX, p. 570.

This species is closely allied to *C. mucronata*, with which it has been found on more than one occasion, including that on which the type-specimens of both species were discovered. Its tylostyles are, like those of *C. mucronata*, of two types, one of which is remarkable for the great expansion of the lower part of the shaft. The tapering of the point is, however, regular and the spicules is never mucronate. The other type of tylostyles is slender and in no way remarkable. The species is apparently more robust in its growth than *C. mucronata*.

C. ensifera, which was originally described as occurring in the coral *Isis* from an unknown locality, is abundant in dead reef-corals from the Mergui and Andaman archipelagoes.

Cliona viridis (Schmidt).

1887 (1889). *Cliona ? stellifera* (in part), Carter, *Faun. Mergui* I, p. 75.
1900. *Cliona viridis*, Topsent, *Arch. Zool. expérim.* (3) VIII, p. 84, pl. ii, figs. 11–14; pl. iii, figs. 2, 3; pl. iv, fig. 2.

Topsent has discussed this species and its synonomy in great detail and further references are unnecessary. It may be noted, however, that Carter's provisional species *Cliona stellifera* was founded on the macroscleres of this *Cliona* and the microscleres of a parasitic *Chondrilla*. I have found the two sponges in close association in his original specimen of dead coral from Mergui.

C. viridis is a cosmopolitan species evidently common in dead coral in the Mergui Archipelago and off the coast of the mainland of Burma. It was originally described from the Mediterranean and is known from the Gulf of Mexico, the Red Sea and many other widely separated localities.

Cliona orientalis, Thiele.

1887 (1889). *Suberites coronarius*, Carter (*nec. id.*, 1882) *Faun. Mergui* I, p. 74, pl. vii, figs. 4, 5.
1900. *Cliona orientalis*, Theile, *Abh. senckhenb. Natur. Gesellsch.* XXV, p. 71, pl. iii, fig. 24.

Thiele pointed out in 1900 (*op. cit.*) that the sponge described by Carter from Mergui under the name of *Suberites coronarius* was not identical with the species the latter had previously described under the same name from the West Indies, but actually a species of *Cliona*. He redescribed it with fresh figures of the spicules and named it *Cliona orientalis*. A re-examination of a part of Carter's Burmese material shows that Thiele was right in both contentions.

C. orientalis is closely allied to *C. viridis*, from which it may be distinguished by the arrangement of the spines on the microscleres. These, instead of running in a spiral round the spicule, are confined to its outline on one side. Carter's figures, although they illustrate this point clearly, are poor and misleading in other respects. The free form of the sponge closely resembles that of *C. viridis*.

C. orientalis has been found only in the Mergui Archipelago (in dead coral) and off Ternate in the Malay Archipelago.

Cliona acustella, sp. nov.

This is a species belonging to Topsent's fourth group, having microscleres and amphioxous macroscleres only. The latter, al-

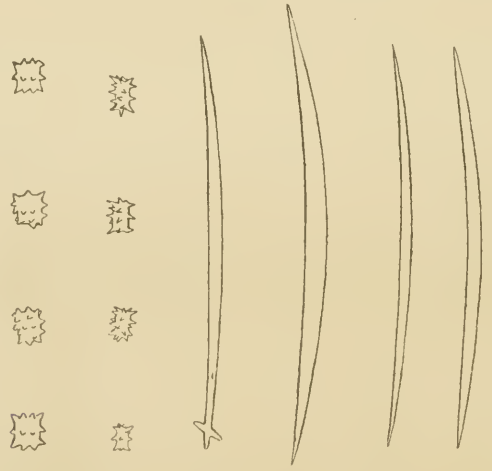


Fig. 2.—Spicules of *Cliona acustella*.

though many of them can be referred to the spiraster type, exhibit a marked tendency to assume a simple amphiaster-like form.

General structure.—Only dried specimens are available for examination, and of these I have been able to extract only minute fragments lacking the external papillae. Chambers excavated apparently by this sponge are, however, abundant in oyster-shells from several adjacent localities. The apertures on the surface of the shell are small and sparsely scattered; their diameter does not exceed 0·4 m. These apertures are connected with the chambers by very short vertical tubules. The chambers are subcircular or polygonal, not more than 3 mm. in diameter and separated only by very narrow partitions of shell. They are arranged in several horizontal layers. The tubules connecting them horizontally and vertically are very slender as well as short.

Spicules.—The macroscleres are smooth, slender, sharply-pointed, somewhat spindle-shaped amphioxi on an average 0·1447

mm. long by 0·008 mm. broad. They are never strongly arched or geniculate. Spicules of this type are fairly abundant.

The microscleres are minute, straight, truncate, cylindrical bodies bearing relatively large spines which often show a tendency to group themselves in three rings (two terminal and one median), but sometimes cover the spicule quite irregularly. Their average length is 0·012 mm. and breadth, with the spines, 0·008 mm.

Distribution.—Apparently common in shells of *Ostrea imbricata* and *O. cuculata* in from 15 to 30 fathoms of water off the coast of Orissa and the Ganjam district of Madras in the Bay of Bengal (*S.S.* '*Golden Crown*').

Type.—No. Z.E.V. 6415/17, *Ind. Mus.*

The microscleres of this species appear at first sight to be in many cases amphiasters rather than spirasters, but actually exhibit (fig. 2) a fairly regular transition between the two types. Some of them are not unlike the small spicules of *Dotona*. The species at present stands alone in the genus so far as its spiculation is concerned, but I have little doubt as to its validity, although the circumstances in which it was found seem at first sight a little suspicious. Large numbers of oyster-shells, all of which were unfortunately cleaned and dried before being examined, were obtained by the trawler 'Golden Crown' off the east coast of India in 1909. The majority of them were found, on recent examination, to be perforated and in many cases partially disintegrated by the burrows of a *Cliona*, of which minute fragments were extracted from broken shells. Spicule-preparations made from other pieces of the same shells contained in some cases only spicules identical with those which occurred in the fragments of sponge extracted, *viz.* smooth amphioxi and microscleres of the type described and figured above. No tylostyles could be found either in the spicule-preparation or in the fragments of sponge. Other fragments of sponge extracted from shells were clearly no part of a Clionid but represented two species of *Eurypon*. Many spicule-preparations contained a mixture of the spicules of the *Cliona* with those of one or other representative of the latter genus. No actual confusion is possible, however, between the two very different genera thus associated.

Cliona patera (Hardwicke).

1822. *Spongia patera*, Hardwicke, *Asiat. Researches* XIV, p. 180, pl. i.
1858. *Poterion neptuni*, Schlegel, *Handleid. Dierkunde* II, p. 542.
1880. *Poterion patera*, Sollas, *Ann. Mag. Nat. Hist.* (5) VI, p. 441.
1908. *Poterion patera*, Vosmaer, *Versl Gew. Verg. Wis-en-Naturk. Afd.* XVII (1), p. 16.
1909. *Cliona patera*, Topsent, *Arch. Zool. expérim.* (4) IX, p. lxix.

Although this large and conspicuous sponge has been known, so far as its external form is concerned, for nearly a century, its true systematic position has only been discovered, by Vosmaer and Topsent, in the last few years. There is a fine series of dried specimens from Singapore, the original locality, in the Indian Museum; but they do not include the type. The species seems to me to be very closely related to *Cliona celata*, from which it differs in its stouter spicules but which it resembles in its general structure and in particular in that of the papillae. So far as these are concerned it agrees more closely with *C. celata* than with *C. viridis*, of which Vosmaer was apparently prepared to regard it as a variety.

Some of our specimens contain at the base both Lamellibranch and Gastropod shells, as well as many small pebbles. The latter, being of hard stone, are intact, as are also some of the shells. Others, however, both of bivalves and of Gastropods, have had ramifying grooves excavated on their surface by the sponge. In one Lamellibranch shell that was partially embedded in it the grooves are entirely confined to the embedded position. At least one Gastropod shell, which was extracted from the centre of the basal portion of a large specimen, is wholly permeated and nearly destroyed by excavations filled with sponge substance. I am convinced by these facts that the excavations in shells found in large specimens of *C. patera* are of a secondary nature, and it seems improbable, in any case, that so large a sponge, if it commenced life in the thickness of any Molluscan shell, should not have completely destroyed that shell before reaching its full size.

So far as I am aware, *C. patera* has as yet been found only in the neighbourhood of Singapore and Java, where it is abundant. If it occurred in the Gulf of Manaar, where several large collections of sponges have been made, so conspicuous an object could hardly have escaped notice. Indeed, its place seems to be taken in the seas round Ceylon and India by the Halichondrine sponge *Petrosia testudinaria* (Lamarck), which bears a considerable superficial resemblance to it, although the "cup" and the "stalk" are not so clearly differentiated.

Genus **Thoosa**, Hancock.

1849. *Thoosa*, Hancock, *Ann. Mag. Nat. Hist.* (2) III, p. 345.
1887. ,, Topsent, *Arch. Zool. expérim.* (2) V², p. 88.
1891. ,, *id.*, *ibid.*, (2) IX, p. 577.
1905. ? *Cliothosa*, *id.*, *Bul. Mus. Hist. Nat. Paris*, XI, p. 95.

This genus is much less well known than *Cliona*. Most of the species, being of tropical origin and having a very inconspicuous appearance externally, have been described from dried specimens extracted from shells or corals, and many of these have been imperfect. Possibly it will ultimately be proved that several quite

distinct genera are included under the name. The genus as at present constituted is remarkable for the great diversity of its microscleres, which always include some form of amphiaster, as well as, in many cases, degenerate forms of euasters. True spirasters seem to be invariably absent.

The typical spicule is characteristic. It consists of a relatively stout cylindrical stem, as a rule quite straight, and of two circles of horizontal branches, which surround the stem at or near its extremities. The stem is quite smooth. In most cases the lateral branches are very short and greatly inflated at their tips, so that they have actually the form of subspherical bosses or prominences. They are never numerous, four to six being the normal number in each ring. In the more highly developed forms the prominences are covered with short spines, and the extremities of the stem are inflated and spiny also. Both the terminal and the lateral prominences may, however, be greatly reduced and take the form of smooth rounded or conical projections.

Another form of amphiaster that is often, though not invariably, present also consists of a smooth cylindrical stem surrounded at the ends by a ring of horizontal branches. Both the stem (as a rule) and the branches (always) are, however, more slender and the latter are much produced. The extremities of neither are regularly spiny, but each branch terminates either in a minute inflation or in several small hook-like spines.

A third form of microscleres that often occurs has been shown to be a degenerate oxyaster, although in its common form it has little resemblance to that type of spicule. As a rule it consists merely of two slender, more or less strongly curved spines attached to a minute centrum and having the appearance of the horns of some Ruminant attached to a fragment of the skull, or that of a sea-gull in flight as seen from a distance, or rather as conventionally represented in pictures. Occasionally more than two spines are present, and the spicule may assume a star-like form. Other microscleres, which resembles toxa but probably have the same origin, also occur in some species.

Yet another type of aster is often found. It has the form of a flat, spiny plate or a spiny cylinder and is referred to by Topsent as a pseudosteraster. I have not come across this form of spicule myself in the specimens I have examined.

The macroscleres, if present, are either amphioxi or tylostyles, but they are often absent.

The distribution of *Thoosa* is essentially tropical, but several of the species are as yet recorded only from specimens of unknown history. They appear to occur mainly in shells of solid structure or reef-corals from shallow water, but one species described here (*T. investigatoris*, p. 18), was found in a thin Gastropod shell from a depth of over 700 fathoms.

The following species have been recorded, or are here recorded for the first time, from the seas of British India and Ceylon:—

Thoosa radiata, Topsent.
T. socialis, Carter.
T. armata, Topsent.
T. hancocci, Topsent.
Thoosa, investigatoris, nov.
T. fischeri, Topsent.
T. laeviaster, nov.

Of these I have not seen *T. socialis* [1] and *T. fischeri*,[2] both of which are only known from Ceylon.

It does not seem advisable at present to attempt to draw up a key to the Indian species. One to all those known in 1891 is given by Topsent on pp. 585-586 of his paper cited after that date on p. 16, and no new species have been published since. Two are described in this paper.

Thoosa investigatoris, sp. nov.

(Plate i, figs. 5, 6).

This is a species with megascleres in the form of pin-like tylostyles and with three types of amphiasters as microscleres, *viz.* (1)

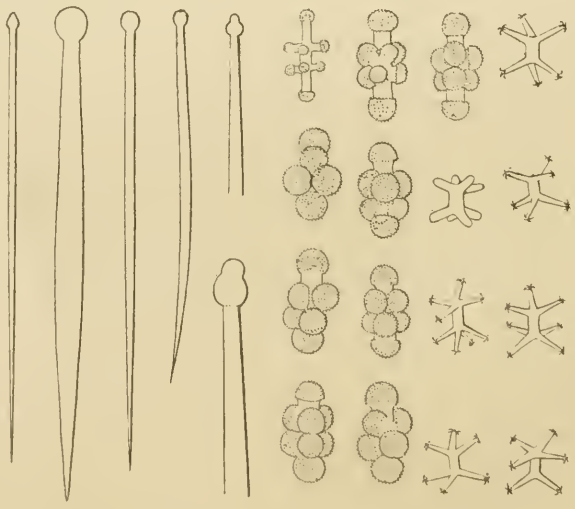


Fig. 3.—Spicules of *Thoosa investigatoris*.

nodular amphiasters typical of the genus, (2) smooth amphiasters with horizontal branches ending in a circle of hooklets, and (3) much stouter smooth amphiasters without hooks or spines of any kind.

General structure.—The sponge consists of a number of tubules which anastomose in one plane and swell out at intervals into not very clearly differentiated chambers of a flattened form and of irregullar outline. The whole structure is fragile and delicate, offering in this respect a strong contrast to *Cliona annulifera*,

[1] Carter, 1880, p. 56 (*v.* p. 2, footnote 3). [2] Topsent, 1891, p. 582 (*v.* p. 16).

which was taken at the same station. The papillae are borne on very short pedicels, as a rule only on what may be called the upper surface of the sponge; occasionally they are also found on the lower surface. I have not been able to detect cellular diaphragms.

Papillae.—Two kinds of papillae have been observed, one of which is apparently inhalent, while the other is probably of a mixed nature. The latter is considerably larger than the former; its diameter is on an average, in normal circumstances, about 1 mm., whereas that of the smaller papillae is only about 0·4 mm. In both cases the vertical walls are straight and the actual papilla does not expand much beyond them. The exhalent apertures are circular and are protected, as is explained below under the heading "Skeleton", by a peculiar arrangement of spicules.

Spicules.—The macroscleres are tylostyles with well differentiated heads usually spherical in form and frequently containing a single large vacuole. The stem is usually curved and spindle-shaped, tapering considerably towards both extremities and considerably swollen in the middle. More slender tylostyles occur in which the stem is much less swollen, but there are also intermediate forms. The shape of the head is not constant, for, especially in the more slender macroscleres, it is sometimes trilobed and sometimes flattened above; occasionally it is even acorn-shaped or quite asymmetrical. In the stouter tylostyles the total length is on an average about 0·34 mm., the greatest thickness of the shaft about 0·02 mm. and that of the head slightly less.

The nodular amphiasters have both the lateral and the terminal nodules or bosses relatively large, nearly spherical and covered densely with minute straight spines. They are joined to the stem, which they often conceal almost completely, by very short smooth pedicels. The average length of the spicule of this type is about 0·0369 mm. and the greatest breadth across the lateral nodules 0·0164 mm.

The smooth amphiasters with terminal hooks on the lateral branches are of the habitual form. Their stem is rather stout and the lateral branches taper straightly towards the tip, which usually bears about six hooklets. The greatest length of the spicule is on an average about 0·0164 mm. and the greatest breadth from tip to tip of the branches 0·0246 mm.

The third type of amphiaster, which is very scarce, is about the same size as the second, which it resembles considerably, but the branches are stouter and bear no terminal hooklets, nor are they inflated at the tips.

Skeleton.—The spicules are arranged to form a skeletal structure in a somewhat more regular manner than is the case in most species of Clionidae.

In the horizontal tubules the macroscleres lie parallel to the surface and in a large proportion of cases point in the same direction. They exhibit, in quite a definite manner, evidence of fasciculation, although in this part of the sponge they do not appear to

be bound together by any horny substance. At certain points, probably where the aperture for a new papilla is about to be excavated, a stout chitinoid covering is secreted over the sponge and the macroscleres adopt a convergent arrangement and are densely massed together. At such places the nodular microscleres are sometimes present in large numbers and form a layer several spicules thick over the protecting mass. The papillae are protected by a dense ring of vertical macroscleres fortified with chitinoid substance and arranged concentrically in several or many circles with the heads resting at the base of the very short vertical tubule. Within this ring, in the case of exhalent orifices, there is an arrangement of convergent macroscleres with their tips meeting almost horizontally and their heads set in a broad spiral of about 1½ turns. Presumably the tips can be separated in the living sponge by rotation of the heads. The whole arrangement is strikingly reminiscent of the diaphragm in the stage of a compound microscope. The smooth amphiasters are scattered in the flesh of the tubules and chambers. Neither they nor the nodular amphiasters play any part in the protection of the external papillae.

Gemmules.—I have found several gemmules in the specimen examined. They are spherical masses of cells of the usual type, but have no horny protective membrane. Each is about 0·374 mm. in diameter. Each gemmule occupies a separate chamber which it fills completely. There is a slender strand of cells connecting it with the active part of the sponge.

Type.—No. Z.E.V. 6430/7, *Ind. Mus*, in spirit: in a dead Gastropod shell.

Locality.—Off Ceylon: 703 fathoms (*R.I.M.S.* '*Investigator*').

The form of the nodular microscleres is characteristic, in particular in the large size of the lateral and terminal bosses; otherwise they resemble those of *T. socialis*, Carter. The species is evidently related to *T. armata*, which, however, has the spicules of this type with the bosses perfectly smooth as well as relatively smaller.

A noteworthy feature of *T. investigatoris* is its power of secreting a horny covering for its growing-points when they come in contact with foreign bodies. I hope to show in a subsequent paper that it protects itself in this manner against aggression on the part of a sponge of the genus *Coppatias* that is parasitic in its burrows. At most of the points at which new galleries are being formed in the shell no such covering can be detected, but at some, probably where the sponge is in contact with the outer layers of the shell, and is about to form a new exhalent or inhalent papilla, there is a thick one. It is only where such a covering occurs that the nodular amphioxi are found, and if the covering is very thick, a number of these spicules can usually be discovered in which the spines on the nodules seem to be completely worn away and the nodules themselves even to some extent destroyed. Such spicules lie in or on the outer or distal part of the covering. These facts would

suggest that spicules of this peculiar type play an important part in the perforation of the compact outer layers of the shells in which the sponge constructs its burrows.

Thoosa armata, Topsent.

1887. Topsent, *Arch. Zool. expérim.* (2) V², p. 81, pl. vii, fig. 9.
1891. *Id.*, *ibid.* IX, p. 579.
1904. *Id.*, "Spongiaires des Açores" *Res. Camp. Sci. Monaco*, fasc. XXI, p. 106, pl. xi, fig. 5.

In preparations of *Cliona vastifica* from a shell of *Malleus* from the Andaman Is., I find, mingled with the spicules of that species, others of three types that agree well with those of *Thoosa armata* as described and figured by Topsent. They are nodular amphiasters, reduced oxyasters consisting of a pair of long horn-like spines arising from a minute centrum, and smooth, sharply pointed amphioxi. The spicules of other types figured by Topsent I have not found in this very imperfect specimen.

As to the smooth amphioxi, they certainly do not belong to the *Cliona* and no trace of any other sponge but the *Cliona* and the *Thoosa* is present in some of my preparations. Topsent in his original description of *T. armata* described amphioxi of the kind as an essential element in the spiculation of the species, but did not find them in the specimen from the Azores he described in 1904. In my specimen, in parts of which they seem to be definitely associated to form a skeletal structure, they are on an average 0·09 mm. long and 0·002 mm. broad at the thickest part. They are thus rather larger than in Topsent's original example.

Thoosa armata was described from a dried sponge in an oyster-shell from the Gaboon (West Africa), and has also been found in a dead coral in the Azores. It has not hitherto been known from the Indian Ocean. The extraordinary larva was described and figured by Topsent (*op. cit.*) in 1904.

Thoosa hancocci, Topsent.

1887. Topsent, *Arch. Zool. expérim.* (2) V², p. 80, pl. vii, fig. 12.
1891. *Id.*, *ibid.*, IX, pp. 577, 580.
1898. Lindgren, *Zool. Jahrb.* (Syst. Abth.) XI, p. 320.
1905. Topsent, *Bull. Mus. Hist. Nat. Paris*, XI, p. 94.

Topsent and Lindgren have described this species as having spicules of three types, (*a*) tylostyles, (*b*) nodular amphiasters, and (*c*) slender amphiasters—Lindgren calls them spirasters—with lateral branches terminating in minute hooks. Topsent (*op. cit.*, 1905) has also described a closely similar species without spicules of the last type (*c*), and founded for its reception the new genus *Cliothosa*. The only known species of this supposed genus (*C. seurati*, Topsent) only differs from *T. hancocci*, apart from the

supposed generic character, in having the head of the tylostyle oval (instead of usually spherical) and with a group of minute vacuoles in its centre.

In the collection of the Indian Museum there are two shells from the Andamans, one of a *Tridacna* and one of a *Malleus*,[1] that contain the burrows of a Clionid which agrees well with Topsent's description of *T. hancocci* so far as the general structure and the colour are concerned. In the *Tridacna*-shell the papillae of the sponge have been destroyed, but they are well preserved in that of the *Malleus*. In neither specimen have I been able to find a single nodular amphiaster, although there has been no difficulty in removing the papillae for microscopic examination from one of them. The slender amphiasters are abundant in both specimens, scattered in the galleries of the sponge, and the majority of the tylostyles in the galleries have spherical heads, but those in the papillae are variable in shape. In no single spicule can I detect a group of vacuoles in this part.

The question naturally arises, Is *Cliothosa* a distinct genus or merely a phase of *Thoosa*? In considering this question the facts known in reference to other species of the family must be noted. In the first place, it is known that *Cliona celata*[2] may lose two types of spicules in the course of its latter development and that *Thoosa armata*[3] does the same at an earlier stage. Secondly, we know that the nodular amphiasters are sometimes scarce in *T. hancocci* itself and, apparently, may be either confined to the papillae[4] or scattered throughout the sponge.[5] Thirdly, in the type-specimens of *T. investigatoris* (*antea*, p. 18) and *T. laeviaster* (p. 23, *postea*) these spicules were not found in the fully formed papillae but in what were apparently papillae in the process of formation. Furthermore, in the case of the former species, they sometimes exhibited distinct traces of wear in that position. All these facts seem to me to point to the possibility of there being a stage, perhaps but seldom attained, in the life-cycle of *Thoosa* at which the characteristic spicules of the genus disappear and the sponge gains nominal generic distinction under the title *Cliothosa*. If I am right, there can, I think, be no doubt that at least one of my specimens from the Andamans has reached this stage.

Thoosa hancocci was originally described from a *Tridacna*-shell from the Indian Ocean. It is apparently common in coral from shallow water in the neighbourhood of Java and was taken by Prof. Stanley Gardiner, also in coral, in the Maldives (*fide* Topsent, 1905, p. 94).

Thoosa laeviaster, sp. nov.

Spicules and fragments of the sponge of this species were found in the piece of dead coral referred to by Carter, whose

[1] One valve of the individual in the other valve of which *Thoosa armata* was found intermingled with *Cliona vastifica*.

[2] Topsent, 1900, p. 42, etc.

[3] Topsent, 1904, p. 111: see synonomy of *T. armata*, p. 21.

[4] Topsent, 1905, p. 94. [5] Lindgren, 1898, p. 321.

notice they apparently escaped, in his account of the sponges of the Mergui Archipelago: *Fauna of the Mergui Archipelago* I, p. 75. It is remarkable in the form of its nodular amphiasters, the "nodules" of which are reduced to short, slender, blunt or pointed branches totally devoid of spines. Reduced spirasters of the type common in the genus are also present, while the macroscleres are smooth amphioxi.

General structure.—Nothing is known of the general structure except that the sponge consists, in part at any rate, of slender apparently cylindrical branches ramifying in dead coral.

Papillae.—The papillae, of which several imperfect examples were extracted, are evidently very small, probably not more than 0·3 mm. in diameter. They are protected by dense masses of upright macroscleres.

Spicules.—The macroscleres are small, slender, smooth, sharply pointed, spindle-shaped amphioxi; a large proportion of them are definitely geniculate in the middle. The average length is 0·08 mm. and the average breadth in the middle 0·003 mm.

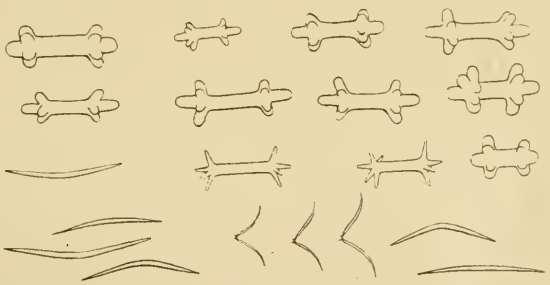


FIG. 4.—Spicules of *Thoosa laeviaster*.

Only two types of microscleres can be distinguished; (*a*) smooth, rather slender amphiasters surrounded at some little distance from each extremity by a circle of several (normally 4) horizontal branches, which are also smooth and relatively slender. These are usually blunt but sometimes pointed; they are always stouter at the base than at the tips. The length of each branch is usually equal to the distance of its base from the nearest extremity of the shaft, which terminates in the same manner as the branches, and the distance apart of the two circles is considerably greater. The average length of the spicule of this type is from about 0·041 to 0·08 mm.; the average thickness of the shaft from about 0·0065 to 0·013 mm. and the breadth from tip to tip across the branches from 0·0246 to 0·0328 mm., but all these measurements are variable. (*b*) The second type of microsclere is a reduced oxyaster consisting of a pair of relatively long and slender curved horn-like spines attached close together to a minute centrum.

Skeleton.—From the fragment of sponge extracted from the coral it is evident that the macroscleres are arranged much as in

T. investigatoris. The reduced oxyasters are scattered in the main body of the sponge, while the amphiasters are collected in small groups and associated with films of horny substance in the interior. They also appear, therefore, to have been arranged in the same manner as their homologues in *T. investigatoris.*

Type.—A microscopic preparation mounted in Canada balsam. No. Z.E.V. 6639/7. *Ind. Mus.*

Locality.—King Id., Mergui Archipelago; in dead coral (*J. Anderson*).

The form of the amphiaster is unlike that of any other species in the genus, for the " nodules " of these spicules, even when they are smooth as in *Thoosa armata*, are usually short, stout and rounded. It is clear, however, that their form in *T. laeviaster* does not depart very widely from the generic type and is really nearer that of the normal amphiaster of *T. radiata* (Topsent, 1887, pl. vii, fig. 11) than that of the homologous spicule of *T. armata.*

EXPLANATION OF PLATE I.

FIGS. 1, 2, 3, 4. *Cliona annulifera*, sp. nov.

1.—Part of type specimen extricated from the shell in which the sponge had burrowed, viewed from below as an opaque object, × *ca.* 30. *g.* = gemmule: *s.* = space from which shell-substance has been removed.

2.—A single chamber mounted, without staining, in Canada balsam and viewed from one side by transmitted light, × *ca.* 57. *i.p.* = inhalent papilla: *m. p.* = mixed papilla: *G.*=gemmule.

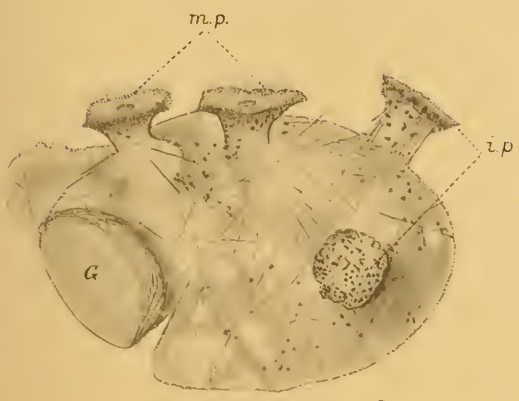
3.—Another chamber stained with borax carmine and similarly mounted, seen from above by transmitted light, × *ca.* 57. Lettering as in figs. 1 and 2.

4.—A mixed papilla, viewed obliquely from one side as a solid object, more highly magnified. *c.* = calcareous granules.

,, 5, 6. *Thoosa investigatoris*, sp. nov.

5.—Part of type-specimen extricated from the shell in which the sponge had burrowed, viewed from above by transmitted light, × *ca.* 35. *e.p.* = exhalent papilla: *h.r.* = horny ring surrounding papilla: *n.g.* = commencement of a new gallery: *s.* = space from which shell-substance has been removed.

6.—Another part of the same sponge only partially extricated, viewed obliquely by transmitted light, and more highly magnified. *i.p.* = inhalent papilla: S.= fragment of shell.



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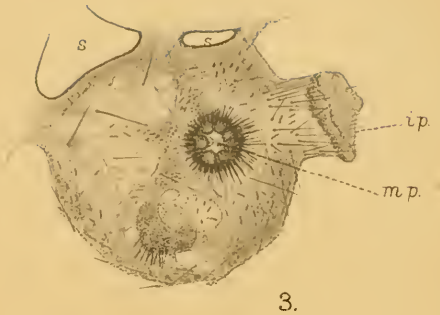

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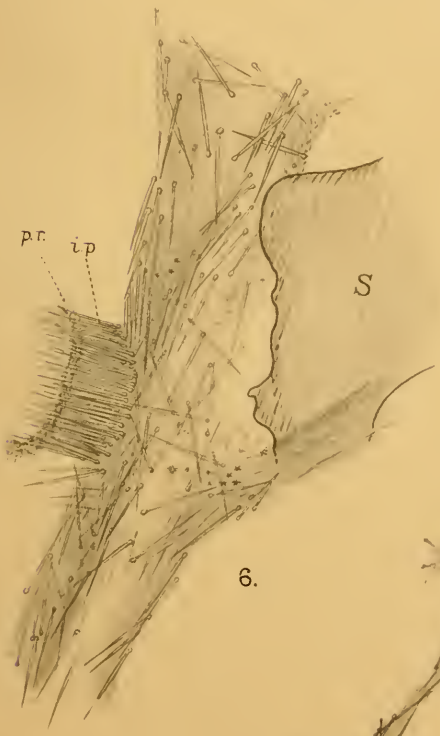

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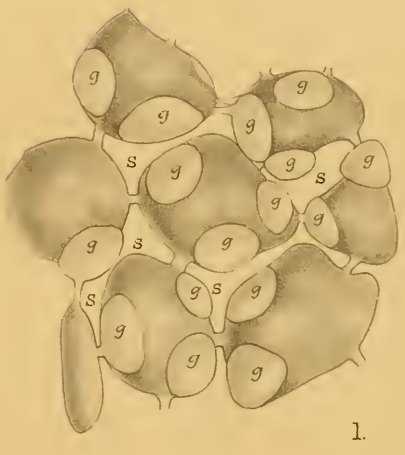
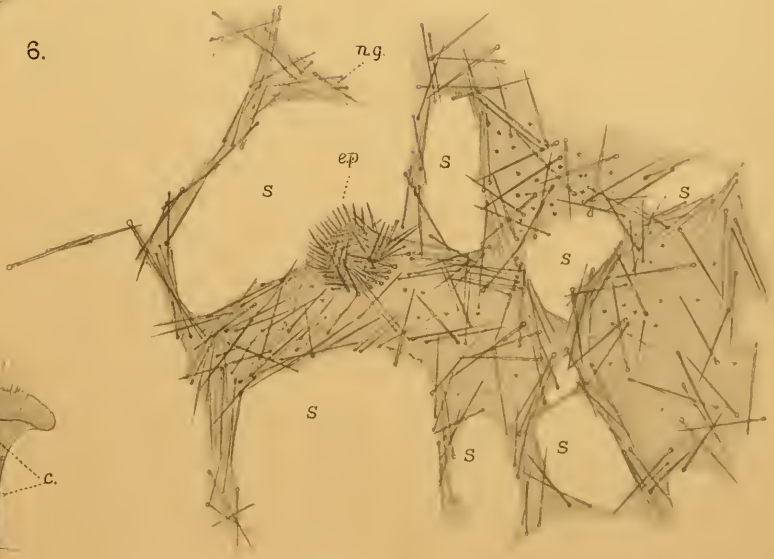


1.



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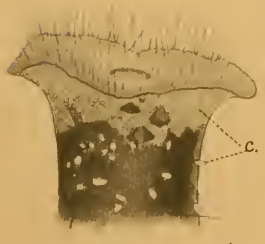

4.

A.C.Chowdhary, del.

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Figs. 1–4. Cliona annulifera. Figs. 5. 6. Thoosa investigatoris.