No. V.—REPORT ON THE HEXACTINELLID SPONGES (TRIAXONIDA) COLLECTED BY H.M.S. "SEALARK" IN THE INDIAN OCEAN.

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(Plates **40—43**.)

Read 17th June, 1915.

The "Sealark" collection contains only three species of Hexactinellid Sponges, but these are all extremely interesting forms, and I venture to hope that the somewhat detailed study that I have been able to make of them may add materially to our knowledge of this remarkable group.

Aulocalyx serialis is a new species of a genus hitherto known only by fragments of the type species (*A. irregularis*) obtained by the "Challenger" expedition and described by Schulze.

Heterorete pulchra is the type species of a new genus related to Dactylocalyx, and remarkable for the entire absence of special dermal and subdermal spicules. Fortunately the material of this species was much better preserved than is usually the case with hexactinellids, so that I am able to give some particulars as to the soft tissues and canal system. This sponge is further interesting on account of the presence in it of a commensal or parasitic hydroid ramifying through the substance of the wall, as well as of numerous Anthozoa attached to the surface.

Sarostegia oculata is a very beautiful and remarkable sponge, first described by Topsent from deep water off the Cape Verde Islands.

The preparation of this Report has been greatly facilitated by a grant from the Trustees of the Percy Sladen Memorial Fund to enable me to pay an assistant. I desire to express my thanks to the Trustees for their generous action, and I wish also to express my indebtedness to Miss Hilda Lucy Deakin, the assistant appointed, by whom most of the microscopical preparations and drawings of skeletal structures have been made, for the skill and care with which she has carried out the work entrusted to her.

The drawings of external forms were made for me by Mr T. P. Collings.

Genus Aulocalyx Schulze [1887].

This genus was founded by F. E. Schulze in 1887 for the reception of several fragmentary specimens obtained by H.M.S. "Challenger" from a depth of 310 fathoms off Marion Island, south-east of the Cape of Good Hope, and between Marion Is. and the Crozets at a depth of 1600 fathoms, and thus practically within the area of the Indian

Ocean. To these specimens the specific name *irregularis* was assigned. Schulze's diagnosis of the genus [1887, p. 380] is as follows:—"A thin-walled cup, much folded, extended into lateral diverticula, and also continued into short laterally projecting tubes. The cup is fixed by a firm irregular base. The connected framework of beams consists of much curved hexacts, partly united by synapticula, partly soldered together. The parenchyma contains loose discohexasters with short or with medium-sized principal rays, bearing S-shaped terminals disposed in perianth-like fashion. Under the skin there are large hexasters in which each of the short principal rays bears six long diverging terminals, which gradually increase in thickness towards the round outer end, and are beset all round with backward bent pointed hooks. The dermalia and gastralia are rough medium-sized oxypentacts."

Schulze placed his new genus in the family Rossellidæ of the then still accepted sub-order Lyssacina. I am not aware that the genus has again been met with excepting by the "Sealark" expedition in the Indian Ocean; but in his report on the Hexactinellida of the Valdivia (p. 180) Schulze [1904] accepts a new arrangement proposed by Ijima [1903], in accordance with which it is placed in the latter's new family Dactylocalycidæ, all the other genera of which are more or less typical dictyonine forms.

1. *Aulocalyx serialis* n. sp.

(Plate **40**, figs. 1—10 *a*.)

The largest and most perfect specimen (R.N. v. 1) has the form of a narrow, obconical goblet, terminating above in a slightly contracted mouth without any sieve-plate (cf. fig. 1). The wall of the goblet is longitudinally folded, and the prominent ridges on the outer surface appear to be made up each of a single row of short tubes fused together. The principal rows of tubes extend longitudinally from the constricted base of the sponge to the margin of the mouth; as they extend upwards the intervals between adjacent rows become wider and new rows appear between them. The tubes have conspicuous external openings and lead right through the wall of the goblet into the central cavity. Their internal openings lie in the bottom of longitudinal depressions of the inner surface. Altogether there are some eight or nine rows of these tubular openings in the wall of the sponge. In this specimen, unfortunately, the base of attachment has been broken off; but two other specimens (R.N. v. 2 and R.N. lxxxi.), which are in other respects much less perfect, show how the body of the sponge gradually contracts below and then expands into a small flattened disc of attachment (cf. fig. 1). The central cavity of the sponge is continued downwards practically as far as the basal disc, and there is no distinct stalk. The sponge is very fragile, the greater part of the body soft and compressible, almost woolly, but gradually becoming much more rigid below, owing to the stronger development of the dictyonal framework. All the soft tissues seem to have disappeared, and the best specimen (R.N. v. 1) contains a considerable quantity of fine white sand, consisting largely of foraminiferan and radiolarian skeletons. The height of the largest specimen, without the basal disc, is about 70 mm., and the greatest width, close to the top of the goblet, 29 mm.

The skeletal framework (fig. 2) consists of a very lax reticulation of large, smooth hexacts, with very long, slightly curving rays soldered together and joined by synapticula in a most irregular, but often ladder-like, fashion. A characteristic feature of this framework is that it sends out free ends, which project into the gastral cavity in the form of large hooks with very varying degrees of curvature (fig. 3).

The following kinds of separate spicules occur in the sponge :—

(1) Large and small parenchymal hexacts, having straight, slender rays with slightly roughened ends (figs. 4, 5).

(2) Large dermal and gastral pentacts; rays slightly roughened at the ends (fig. 6).

(3) Occasional small pentacts, with knob-like vestige of the sixth ray; rays slightly roughened (fig. 7).

(4) Discohexasters, varying somewhat as regards the curvature and arrangement of the terminal rays, which end in small discs with toothed margins (figs. 8, 9).

(5) Large hexasters with terminal rays ending in small knobs, and provided with rather long, backwardly pointing spines, the most distal of which may arise in a whorl from the terminal knob. These spines are very easily broken off, and this has evidently been the case to a large extent in the specimen figured (fig. 10). It is very difficult to find a specimen of this spicule perfect enough to draw, though a fair number of them occur in my preparations.

The only other species of Aulocalyx hitherto described is Schulze's *A. irregularis*, the type of the genus. To judge from the description and figures given in the "Challenger" report the chief difference between the two lies in the external form. In the "Challenger" species "the general form was that of a broadly expanded cup with complex, much folded or diverticulated wall." The generic diagnosis mentions the occurrence of "short laterally projecting tubes." These are not mentioned in the specific description but the general form is compared to that of *Periphragella elisæ*, the figure of which (Pl. LXXX) shows numerous short tubular projections, with open mouths, scattered irregularly over the outer surface of the cup. Schulze's general figure of the external form of *A. irregularis* (Pl. LX, fig. 1) does not show any distinct lateral tubes, but the specimen was evidently much injured. He gives a separate figure (fig. 2), however, of the macerated skeleton of a lateral tube, which seems to show that these structures are of the same nature as the tubular openings in *A. serialis*. There is no indication, however, that they are arranged in longitudinal rows as in the latter species, and the form of the cup in the two cases appears to be quite different, being very much narrower in *A. serialis*.

Another difference is found in the shape and size of the large, spiny-rayed hexasters or rosettes. Those of *A. serialis* are only about 0·24 mm. in diameter, while those of *A. irregularis* measure about 0·4 mm. Moreover, in the latter the ends of the long terminal rays are "simply convex, or more rarely somewhat knobbed," while in *A. serialis* they are, usually at any rate, distinctly knobbed, with a terminal whorl of backwardly pointing spines coming off from the knob as shown in fig. 10 *a*.

How far the differences between the two forms can be regarded as really specific cannot be decided in the absence of better preserved specimens of *A. irregularis.* The two are evidently closely related and the localities from which they were obtained suggest that intermediate forms may occur at great depths in the intervening area of the Indian Ocean.

Register Nos., Localities, &c. v. 2, 4 (fragment), Saya de Malha, 7.9.1905, C. 20, 3—500 fathoms; LXXXI., Saya de Malha, 8.9.1905, C. 21, 450 fathoms.

Genus Heterorete* n. gen.

The sponge consists of thick-walled, branching, cylindrical tubes, of stony hardness. The main skeleton is a stout dictyonal framework with very irregular meshes, in which slender-rayed hexacts gradually become incorporated by fusion, especially in the inner part of the tube-wall, where the stout dictyonal framework gives place to a much finer network formed by union of the slender-rayed hexacts. The nodes of the reticulation are not provided with spiny warts or with lychnisks. There are no uncinates, no scopulæ nor clavulæ, and no pentacts. There are discohexasters scattered in the parenchyma, especially in the inner portion of the wall. The canal system is complicated by strong folding of the chamber-layer and the flagellate chambers are comparatively small, oval or thimble-shaped.

This genus evidently falls into Ijima's family Dactylocalycidæ. It perhaps comes nearest to Dactylocalyx itself, but is remarkable for the complete absence of pentacts and, indeed, of special dermal or subdermal spicules of any kind.

2. *Heterorete pulchra* n. sp.

(Plate **41**, figs. 11—18.)

This species is represented in the collection by one good-sized fragment and a few small pieces evidently belonging to the same specimen. The sponge consists of irregularly branching tubes (fig. 11), about 8 mm. in diameter, and with walls about 2 mm. in thickness, so that there is a wide lumen of about 4 mm. diameter. There is some evidence of anastomosis between adjacent tubes, but this cannot be regarded as definitely established. Both inner and outer surfaces of the tubes are marked with numerous small, thickly-scattered pits, representing the openings of the exhalant and inhalant canals. The texture is rigid and stony, but brittle; the colour in spirit (with the soft tissues preserved) is opaque yellowish white, in the macerated condition it is glassy and transparent. Numerous minute Anthozoa (? Zoanthids) are attached to the outer surface of the tubes, but at wide intervals and apparently without any connection with one another. Apparently they have no effect on the growth of the sponge, which does not seem to respond in any way to their presence.

The main skeleton (figs. 12, 17) is a stout dictyonal framework of cylindrical trabeculæ, with irregular meshes. The bars are somewhat stouter and the meshes smaller at the dermal surface, where also short, conical processes are given off from the trabeculæ towards the dermal membrane, which they help to support. The whole of the dictyonal framework

* This name is proposed in allusion to the two kinds of skeletal net-work.

thus constituted is roughened with small conical spines, but these are more strongly developed on the subdermal trabeculæ than deeper down.

At various points rather small, spiny-rayed hexacts are seen to be undergoing incorporation in the general framework by fusion of their rays with the trabeculæ. To what degree the framework really grows by this incorporation of originally separate hexacts it is impossible to say, but the following observations rather suggest that it extends centripetally in this manner.

For some little distance beneath the gastral surface, in the region occupied by the inner trabecular layer of soft tissues, the main dictyonal framework is absent and its place is taken by scattered hexacts quite irregularly arranged. These hexacts (figs. 12, 17, *hex.*) are far more numerous here than anywhere else in the sponge, and it is at the junction of this layer with the chamber-bearing layer that the incorporation of hexacts in the dictyonal framework is chiefly seen (figs. 12, 18).

Possibly growth of the main skeleton also takes place by the formation and subsequent fusion of outgrowths from the trabeculæ themselves, as in *Sarostegia oculata*, but it is often difficult to distinguish between such outgrowths and the projecting rays of partially incorporated hexacts.

The hexacts of the subgastral layer also frequently unite with one another by fusion of rays, and thus tend to form a very irregular dictyonal framework with much smaller meshes and more slender trabeculæ than those of the main skeleton (fig. 12, *hex.*).

Sometimes even discohexasters may be incorporated in the skeletal framework, giving rise to very curious appearances (fig. 13).

The parenchymal spicules are as follows :—

(1) Spiny-rayed hexacts (figs. 12, *hex.*, 14); with rays straight or slightly curved, and varying a good deal in length and thickness ; sometimes sharply pointed at the ends and sometimes more or less clubbed. These spicules occur chiefly in the subgastral layer, where they are united together by fusion of rays into an irregular, loose network, while the outer ones are also united in the same manner with the inner portion of the main dictyonal framework. It is difficult to find a single hexact lying entirely free in the parenchyma.

(2) Oxyhexasters (fig. 15); with long, slender, sharp-pointed rays. These appear to be extremely rare and are perhaps not a normal constituent of the spiculation.

(3) Discohexasters (fig. 16); with slender, curved rays terminating in toothed discs and varying much in length in different specimens. There are usually about five terminal rays to each principal. These spicules are very abundant in the subgastral portion of the sponge wall. Occasionally they become incorporated in the skeletal framework (fig. 13).

This sponge is sufficiently well preserved to enable me to give some account of the structure of the soft parts (figs. 17, 18). A very delicate dermal membrane (*d.m.*) is stretched over the outer surface of the main skeletal framework. This framework is interrupted at frequent intervals by the rather wide inhalant canals (*i.c.*). The dermal membrane still extends over the outer ends of these canals in some cases as a thin net pierced by the inhalant pores, but for the most part it is absent from the openings in question, perhaps owing to abrasion or shrinkage. Beneath the dermal membrane comes a very thin external trabecular layer (*o.t.l.*), followed immediately by the chamber layer, which occupies by far the greater part of the thickness of the sponge wall. Then, on the inside of the chamber layer, comes a fairly thick subgastral or inner trabecular layer (*i.t.l.*), bounded internally by a thin gastral membrane (*g.m.*).

The wide inhalant canals run inwards approximately at right angles from the dermal surface and extend throughout the greater part of the thickness of the sponge wall. They branch more or less and interdigitate with similar exhalant canals, also branched and also extending through the greater part of the thickness of the wall, which open by wide apertures on the gastral surface (whether the gastral membrane ever extends over these apertures as a delicate net I am unable to say definitely, but I think it highly probable that it sometimes does). Owing to the obliquity and irregularity of their direction a transverse section of the sponge wall (fig. 17) shows the inhalant and exhalant canals sometimes cut across and sometimes cut lengthwise.

The flagellate chambers (*f.c.*) are very small for a hexactinellid sponge, only just about as large as those of a typical Leucandra, such as *L. phillipensis* [Dendy 1893], and much smaller than those of *L. australiensis* [Dendy 1893]. Indeed the whole canal system very closely resembles that of a Leucandra, except that the trabecular layers are represented in the latter by more continuous mesoglœal tissue. The large exhalant and inhalant canals may be regarded as formed by folding of the chamber-bearing layer, and it is probable that in reality there is only a single, much folded layer of chambers. Such appears to be the case at any rate in many places (*e.g.* in part of the section represented in fig. 17), but usually the arrangement has become greatly confused.

The chambers come close up to the surfaces of both inhalant and exhalant canals, but the actual surface in both is probably formed by a very thin, net-like trabecular layer. Most of the chambers communicate with the large exhalant canals, but some of them open into the irregular spaces in the subgastral trabecular layer (fig. 18).

The chambers themselves (figs. 17, 18, *f.c.*) are oval or thimble-shaped. I have measured them up to 0·2 mm. in length, but usually they appear a good deal shorter than this. The collared cells are very small and indistinct and it is impossible to make out any satisfactory histological details. Such histology as I have been able to observe is represented in fig. 18.

In addition to the numerous small Anthozoa attached to the outer surface, the sponge wall is penetrated in various directions by the branching stolons of a hydroid colony. The hydranths (fig. 17, *hyd.*) are elongatedly club-shaped, with few tentacles (two or three?) arranged in a single whorl springing from a short distance beneath the mouth. They are only sparsely scattered at long intervals on the hydrorhiza and appear to be capable of protrusion sometimes from the outer and sometimes from the inner surface of the sponge wall, though all now in a state of complete retraction. There is no distinct horny perisarc, though sometimes a very thin layer can be discerned which may represent the last vestige of such a structure. The hydranths occupy definite tubular cavities which run inwards from the surface of the sponge and appear to be lined by a continuation of the dermal or gastral membrane as the case may be. This hydroid is probably closely related to *Amphibrachium euplectellæ*, described by Schulze [1880] as occurring in the soft tissues of

Euplectella aspergillum. The latter species, however, has only two tentacles to each hydranth, while our form certainly seems to have at least three in some cases. Moreover the tentacles in Schulze's species are much longer than in ours, assuming both to be retracted to approximately the same extent. Schulze also speaks of a delicate, annulated perisarc tube in his species.

It seems probable therefore that the commensal hydroid of Heterorete belongs to a distinct species from that of Euplectella and, provisionally at any rate, it may be named *Amphibrachium infestans.*

Register No. and Locality. CXV., Salomon, 3.7.1905, C. 120—150 fathoms.

Genus Sarostegia Topsent [1904].

The sponge forms a coral-like colony of stony hardness, the more or less cylindrical, tubular or solid branches ramifying chiefly in one plane and sometimes anastomosing. The rather close dictyonal framework of the skeleton is made up of stout trabeculæ. The separate spicules consist of (1) dermal and gastral hexacts, in which one ray is frequently more or less completely reduced, (2) spinose hexacts, which tend to become incorporated with the dictyonal framework, (3) dermal sarulæ, (4) uncinates, (5) oxyhexasters, (6) discohexasters.

This well-characterised genus was founded by Topsent in 1904 for a remarkable sponge obtained by the "Princess Alice" and the "Talisman" in deep water off the Cape Verde Islands, and named *Sarostegia oculata.*

In the same year Schulze [1904] proposed the genus Ramella for fragments of a similar sponge collected by the "Valdivia" expedition near the Cape Verde Islands and Sumatra respectively. There can be little doubt that the specimen from the Cape Verde Islands at least is both generically and specifically identical with Topsent's.

Curiously enough, in the same year again, H. V. Wilson [1904, p. 84] proposed a genus, Sclerothamnopsis, for some fragments collected by the "Albatross" expedition in the Eastern Pacific, which may very well be generically identical with Topsent's and Schulze's specimens. In neither of these two latter cases, however, was the material sufficiently well preserved to afford the basis of a satisfactory generic diagnosis. In the "Valdivia" material the only separate spicules found were the uncinates. In the "Albatross" fragments the following are described, although in the generic diagnosis it is stated that the free spicules are not known with certainty :—

(1) Spinose hexacts (similar spicules occur in the "Sealark" material).

(2) Slender, smooth oxydiacts, always broken (probably broken uncinates, which, in the "Sealark" material, may have the spines very feebly developed, so that they resemble smooth oxydiacts).

(3) Oxyhexasters (similar spicules occur in the "Sealark" material).

(4) Pinnules of peculiar form, with the distal ray enormously swollen and beset with very short spines. Wilson remarks that these pinnules are very few in number but so peculiar that it seems likely that they belong to the sponge. On the other hand, in the

same work he figures practically identical pinnules for *Eurete erectum*, and I am strongly inclined to the opinion that they occur only as foreign bodies in Sclerothamnopsis.

(5) Scopulæ, few in number and also very likely foreign.

Neither pinnules nor scopulæ occur in the specimens of Sarostegia examined by Topsent and myself, but, in place thereof, the peculiar dermal spicules which Topsent termed "sarules" and which I propose to call "sarulæ."

On the whole there seems to be a strong probability that Wilson's Sclerothamnopsis is generically identical with Topsent's Sarostegia and Schulze's Ramella. If so, the genus is a very widely distributed one, occurring in the Atlantic, the Pacific and the Indian Oceans.

Under these circumstances the question of priority naturally arises, and we have to determine whether the genus is to be known as Sarostegia, Ramella or Sclerothamnopsis.

The date of publication of Topsent's paper is May 1904, that of Wilson's July 1904. Schulze's report on the "Valdivia" Hexactinellids is marked "Eingegangen den 16 Dezember 1903," but it was not published till some time in 1904; I have been unable to obtain further information as to the exact date.

Clearly Sclerothamnopsis may be eliminated, unless it should prove necessary to retain it on account of some generic peculiarity of the "Albatross" specimens, which seems improbable. As between the other two names I choose Sarostegia, on the ground that Schulze's genus Ramella, based upon very imperfect material, in which the characteristic spicules were entirely wanting, was quite insufficiently diagnosed.

Topsent placed *Sarostegia* in the family Farreidæ. This family was merged by Schulze [1904] in the Euretidæ, in which he also included his Ramella. The reason for the union of the two families was the breaking down of the distinction between "Scopularia" and "Clavularia" by the discovery of the genus Claviscopulia, described by Schulze in the "Amerikanische Hexactinelliden" [1899, p. 76 &c.]. *Claviscopulia intermedia*, the type species of the genus, in addition to clavulæ, possesses also spicules of a peculiar kind intermediate between clavulæ and scopulæ. These spicules, which Topsent terms "sarules," have the distal extremity club-shaped and beset with long spines, so that the whole comes to resemble somewhat a besom. It is very interesting to observe that sarules (or sarulæ) occur also in Sarostegia, although of a somewhat different form from those of Claviscopulia.

In his diagnosis of the family Euretidæ, Schulze [1904, p. 177] says that the coherent supporting framework is composed of dictyonal hexacts, which for the most part are united in a regular manner by the enclosure of the parallel apposed rays in layers of silica, so as to form a scaffolding with predominantly rectangular meshes. This is probably the primary arrangement of the framework in Sarostegia, but it is much obscured, at any rate in the "Sealark" specimen, by the formation of secondary trabeculæ subdividing the primary meshes into triangular areas.

3. *Sarostegia oculata* Topsent.

(Plates **42** and **43**, figs. 19—36.)

Sarostegia oculata Topsent [1904].
Ramella tubulosa Schulze [1904].
? *Sclerothamnopsis compressa* Wilson [1904].

Topsent's account of this beautiful species is not very detailed. The figures of external form are very fragmentary and only one kind of spicule, the sarula, is figured. It seems desirable, therefore, to give a complete account, with illustrations, of the "Sealark" material.

A large number of pieces were obtained, apparently in a single haul of the dredge, from a depth of 450 fathoms at Saya de Malha. It seems highly probable that they all formed part of a single specimen, which, owing to its brittle character, was broken into fragments in the dredge. The largest piece, drawn of the natural size in fig. 19, does not represent more than about one-sixth of the total material. Unfortunately the base is missing, but the sponge was doubtless attached in an erect position to a hard substratum by a somewhat expanded basal plate, as in the type. The branching is dichotomous (figs. 19 *a*, 19 *b*), and seems to have taken place mostly in one plane, though with occasional deviations into a plane even at right angles to the principal one. The branches are approximately circular in transverse section, there being no conspicuous flattening. The thickest branches measure about 10 mm. in diameter, while the most slender, terminal, branches may measure as little as 2 mm. Anastomosis of the branches appears to take place only occasionally.

The branches are partly tubular and partly solid. The tips may sometimes bear a small terminal opening, but at other times they appear to be solid, while considerable cavities may occur in the older portions. These cavities open to the exterior by very irregularly distributed oval apertures (figs. 19 *c*, 19 *d*, *ap.*) in the wall of the tube. They are sometimes occupied by polychæte worms, and I suspect it is the presence of these that keeps them open by preventing the ingrowth of tissues which takes place elsewhere. Certainly the solidification may take place while the branch is still very young. Topsent appears to regard the apertures in question as oscula, but I am very doubtful whether they can be correctly interpreted as such.

The surface of the sponge has a finely granulated character. The texture is hard but brittle, and the colour in alcohol and formalin is very pale brown*.

The whole of the surface of the sponge is more or less thickly studded with commensal or parasitic polyps (*pol.*), presumably zoanthids related to Palythoa. These are attached to the surface by expanded bases and can be picked off like scabs, leaving shallow depressions behind. It is extremely interesting to observe that the sponge responds to the presence of these polyps by enclosing each one in a delicate upgrowth of the dermal membrane, forming a thin translucent collar (figs. 19, 19 *f*, 19 *g*, *col.*), supported by the characteristic dermal spicules of the sponge, with a marginal fringe

* Topsent describes the sponge in life as being "semi-transparente, de teinte délicate, jaunâtre-rosée, émaillé d'Actinies commensales d'un orangé assez vif."

of sarulæ. These collars, however, are only preserved where the surface of the sponge has been protected from rubbing, as shown in fig. 19. In one case (fig. 19 *f*) two polyps, apparently formed by fission of a single one, were observed within the same collar. The polyps appear to be connected with one another by a network of stolons ramifying in the thickness of the sponge wall.

Similar polyps were described by Topsent in his specimen, and Schulze [1904] speaks of the macerated fragments obtained by the "Valdivia" as showing "dellenartige Oberflächenvertiefungen von ovaler oder doch rundlicher Form mit schwach erhabenem Rande." It seems probable that these are the shallow depressions left after the removal of the polyps. The association between sponge and polyp thus appears to be a constant one.

The main skeleton is a close framework of usually stout trabeculæ (up to about 0·07 mm. in thickness), with triangular meshes. As many as six bars of this framework may radiate from a common centre in approximately the same plane*, like the spokes of a wheel, connected at their outer ends by the spokes of similar adjacent systems, giving the whole framework a very characteristic appearance, as shown in fig. 33.

Apparently the whole framework grows not so much by incorporation of new hexacts as by the outgrowth of secondary trabeculæ, whose ends meet and fuse to form systems similar to those just described. This process is certainly responsible for the inward extension of the framework by which the original central cavity becomes more or less obliterated.

The structure of the dictyonal framework thus agrees very closely with Schulze's description and figure of *Ramella tubulosa*, except that what I may perhaps term the "rotulate" character, due to the formation of triangular meshes, appears to be more strongly pronounced (fig. 33). I have no doubt, however, that this character is a very variable one. In the older parts of the skeleton the trabeculæ are smooth, but in the younger parts, adjacent to the dermal and gastral surfaces, where the trabeculæ are more slender, they are often roughened with minute projections (fig. 34).

The manner in which the dictyonal framework spreads into the central cavity is well shown in figs. 35 and 36. Slender, more or less radially arranged outgrowths are given off from the superficial trabeculæ of the gastral surface (fig. 35, *pr.*), and their ends, coming in contact with one another, fuse to form a new node of the skeleton (fig. 36, *pr.*). Doubtless these slender processes, which are at first minutely roughened, are thickened and become smooth later on by the addition of concentric layers of silica. Growth seems to take place at the dermal surface of the dictyonal framework in precisely the same manner, and probably some, at any rate, of the freely projecting, minutely spiny knobs, which occur on this surface, are the immediate agents concerned therein. I have seen just the same fusion of such outgrowths to form a new node on the dermal as on the gastral surface. Some of the minutely spiny knobs on the dermal surface, however, appear to be the reduced centrifugal rays of the outermost fused hexacts of the original framework, as described by Topsent.

* Of course similar bars radiate from the same centre in other planes.

The dermal skeleton consists, in the first place, of stout hexacts (figs. 20, 21, 22), with the outwardly projecting ray much shortened and the inwardly projecting ray lengthened. The rays are bluntly rounded at their extremities and usually quite smooth, although a little roughening may sometimes be detected, especially towards the end of the longest ray, which may also be more sharply pointed (fig. 21).

Between the dermal hexacts occur numerous radially arranged sarulæ of the form shown in figs. 23, 24, 25. These remarkable spicules consist of a straight shaft, sometimes slightly roughened, and terminating at the inner end in a blunt point, while the outer end is oval club-shaped and covered with stout, sharp, forwardly-directed spines more or less fused together.

The dermal skeleton is evidently very easily rubbed off and is only well preserved in places, especially in the membranous collars surrounding the polyps, where, as already stated, the sarulæ form a marginal fringe.

The gastral skeleton consists of hexacts (figs. 26, 35, *hex.*) of the same general type as the dermal hexacts, but the rays are more slender, generally less unequal in length (though usually one still seems to be very short), and frequently knobbed at the extremities. In the invasion of the original central cavity by the skeleton these spicules become very irregularly arranged (fig. 35, *hex.*), but they may still be seen, crowded together in the middle of the sponge, even after the central cavity has been completely obliterated. They seem to retain their independence for a long time, but it is quite possible that they ultimately become incorporated in the dictyonal framework.

The parenchymal spicules are as follows:—

(1) Very long and slender uncinates, sharply pointed at the two extremities and with feebly developed teeth (fig. 32).

(2) Small spiny hexacts (fig. 27) lying between the trabeculæ of the dictyonal framework, with which their rays may become fused. (It is sometimes difficult to distinguish these from new nodes formed by outgrowth and fusion of spiny processes from the trabeculæ (cf. fig. 36, *pr.*).)

(3) Oxyhexasters (figs. 28, 29, 30). Very variable, with smooth, slender, sharp-pointed rays.

(4) Discohexasters (fig. 31). Rather compact, with not very long terminal rays, about five to each principal.

Although a good deal of the soft tissues of the sponge still remains, I have not been able to make out the flagellate chambers.

I do not think there can be any reasonable doubt that the "Sealark" specimen is specifically identical with Topsent's type from the Cape Verde Islands, in spite of the difference in locality. There do, it is true, appear to be some minor differences in spiculation, as indicated by Topsent's account of the dermal hexacts and pentacts, which, unfortunately, he does not figure, and by the absence of all mention by him of the spiny hexacts (No. 2 above). It is probable, however, that these apparent differences would disappear if it were possible to make a direct comparison of the specimens, and the agreement in other respects is so close that I feel justified in making an identification.

Previously known Distribution. Near Cape Verde Is. (Topsent and Schulze); Sumatra (Schulze); ? Eastern Pacific (Wilson).

Register Nos., Locality, &c. I., II., III., IV., IV*a*., Saya de Malha, 8.9.1905, C. 21, 450 fathoms.

LIST OF LITERATURE REFERRED TO.

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1880. SCHULZE, F. E. "On the Structure and Arrangement of the Soft Parts in *Euplectella aspergillum*." (Trans. Royal Soc. Edin., vol. 29.)

1887. Id. Report on the Hexactinellida of the "Challenger" Expedition.

1899. Id. "Amerikanische Hexactinelliden nach dem Materiale der 'Albatross'-Expedition."

1904. Id. Hexactinellida of the "Valdivia" Expedition.

1904. TOPSENT, E. "*Sarostegia oculata.* Hexactinellide nouvelle des îles du Cap-Vert." (Bull. Mus. Océanographique de Monaco, No. 10, 20 Mai 1904.)

1904. WILSON, H. V. Sponges of the "Albatross" Expedition of 1891.

DESCRIPTION OF PLATES.

Plate 40.

Figs. 1—10 *a*. *Aulocalyx serialis* n. sp.

Fig. 1. Restoration of entire sponge (based mainly on R.N. v. 1). × 2.
Fig. 2. Part of skeletal framework (R.N. v. 1). × 110.
Fig. 3. Part of skeletal framework ending in hooks which project into the gastral cavity (R.N. v. 1). × 110.
Fig. 4. Large parenchymal hexact (R.N. v. 1). × 100.
Fig. 5. Small parenchymal hexact (R.N. v. 1). × 320.
Fig. 6. Large pentact (R.N. v. 1). × 100.
Fig. 7. Small pentact with vestige of sixth ray (R.N. v. 1). × 320.
Figs. 8, 9. Discohexasters (R.N. v. 1). × 320.
Fig. 10. Characteristic large hexaster with spiny rays (R.N. v. 1). × 320.
Fig. 10 *a*. End of ray of large hexaster more highly magnified.

Plate 41.

Figs. 11—18. *Heterorete pulchra* n. gen. et sp.

Fig. 11. Part of a colony. × 2.
pol. parasitic or commensal Anthozoa.
Fig. 12. Part of dictyonal framework, as seen in transverse section, showing the transition to the layer of scattered and partially fused hexacts (*hex.*) in the inner portion of the sponge wall. × 100.
Fig. 13. Portion of skeletal framework from inner part of sponge wall, showing incorporation of discohexasters. × 360.
Fig. 14. Spiny-rayed hexact. × 540.
Fig. 15. Oxyhexaster. × 540.
Fig. 16. Discohexaster. × 540.
Fig. 17. Transverse section of sponge wall, showing soft tissues and canal system. (Combined drawing.) × 50.
d.m. dermal membrane; *e.c.* exhalant canal; *f.c.* flagellate chambers; *g.m.* gastral membrane; *hyd.* hydroid polyp; *i.c.* inhalant canal; *i.t.l.* inner (subgastral) trabecular layer; *o.t.l.* outer (subdermal) trabecular layer.
Fig. 18. Part of inner portion of a transverse section showing soft tissues, more highly magnified (Zeiss D. oc. 2).
disc. discohexaster; *hex.* hexacts. Other lettering as before.

Plate 42.

Figs. 19—31. *Sarostegia oculata* Topsent.

Fig. 19. The largest piece of the sponge. Nat. size.
col. collars of sponge tissue surrounding parasitic or commensal polyps (*pol.*).
Figs. 19 *a*, 19 *b*. Two other pieces, showing ends of branches. Nat. size.
Figs. 19 *c*, 19 *d*. Portions of two hollow branches showing apertures (*ap.*). Nat. size.

Fig. 19 *e.* A single polyp as it appears when removed from the sponge. × 3.
Fig. 19 *f.* Two polyps enclosed in the same collar (*col.*). × 3.
Fig. 19 *g.* Side view of collar (*col.*) enclosing polyp. × 3.
Figs. 20, 21, 22. Stout dermal hexacts, from collar around polyp. × 175.
Figs. 23, 24, 25. Sarulæ, from collar around polyp. × 175.
Fig. 26. Gastral hexact, from central cavity of skeletal framework. × 175.
Fig. 27. Spiny parenchymal hexact. × 175.
Figs. 28, 29, 30. Oxyhexasters. × 540.
Fig. 31. Discohexaster. × 540.

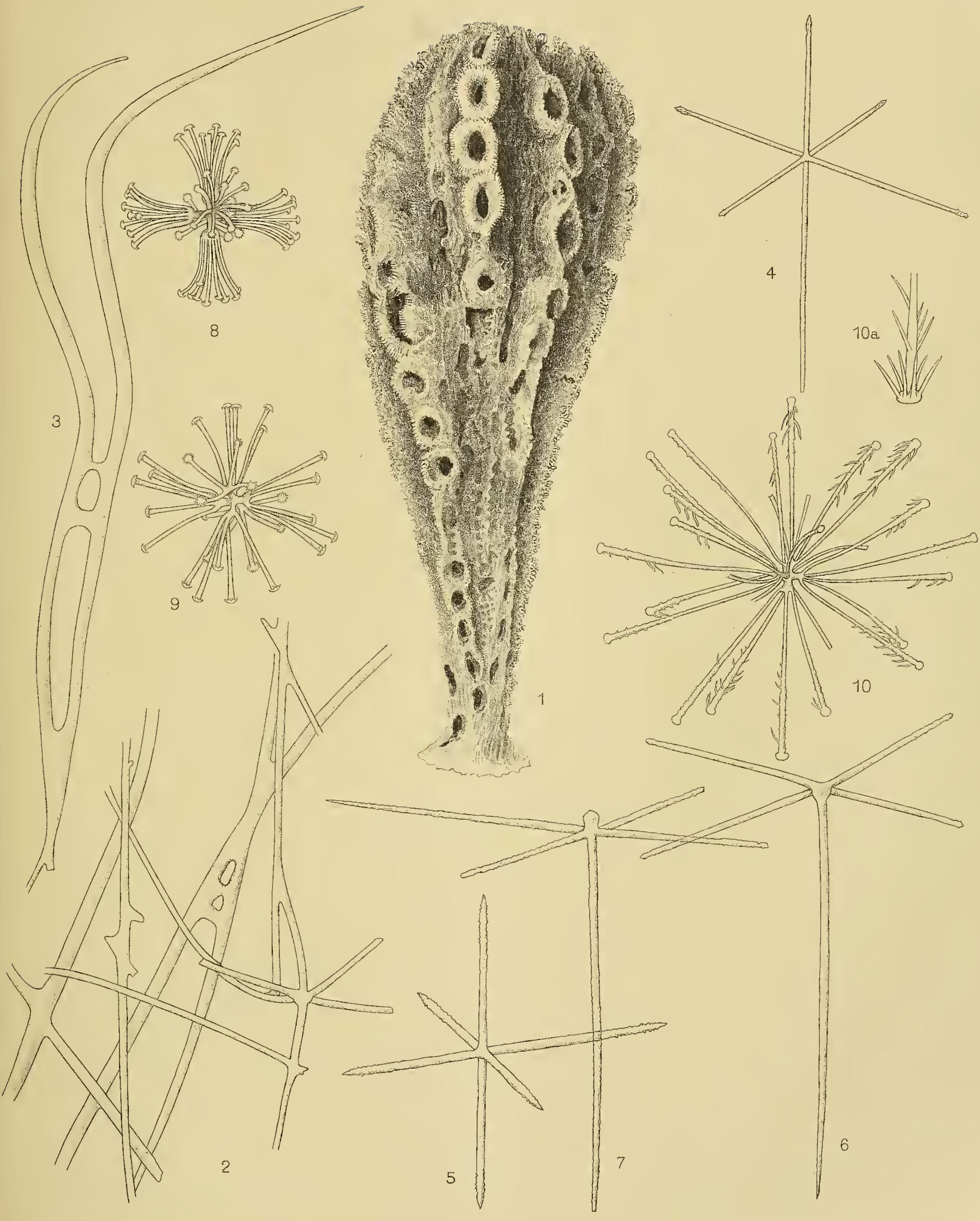
Plate 43.

Figs. 32—36. *Sarostegia oculata* Topsent.

Fig. 32. Uncinate. × 102.
Fig. 33. Part of dictyonal framework as seen in longitudinal section through end of branch. × 60.
Fig. 34. Part of dictyonal framework as seen in tangential section just below surface. × 175.
Fig. 35. Skeleton surrounding central cavity, as seen in transverse section near tip of young branch. × 60.

c.c. central cavity; *hex.* hexacts; *pr.* spiny processes of trabeculæ.

Fig. 36. Skeleton surrounding central cavity, as seen in transverse section, to show the union of spiny processes (*pr.*) to form a new node of the network. × 60.



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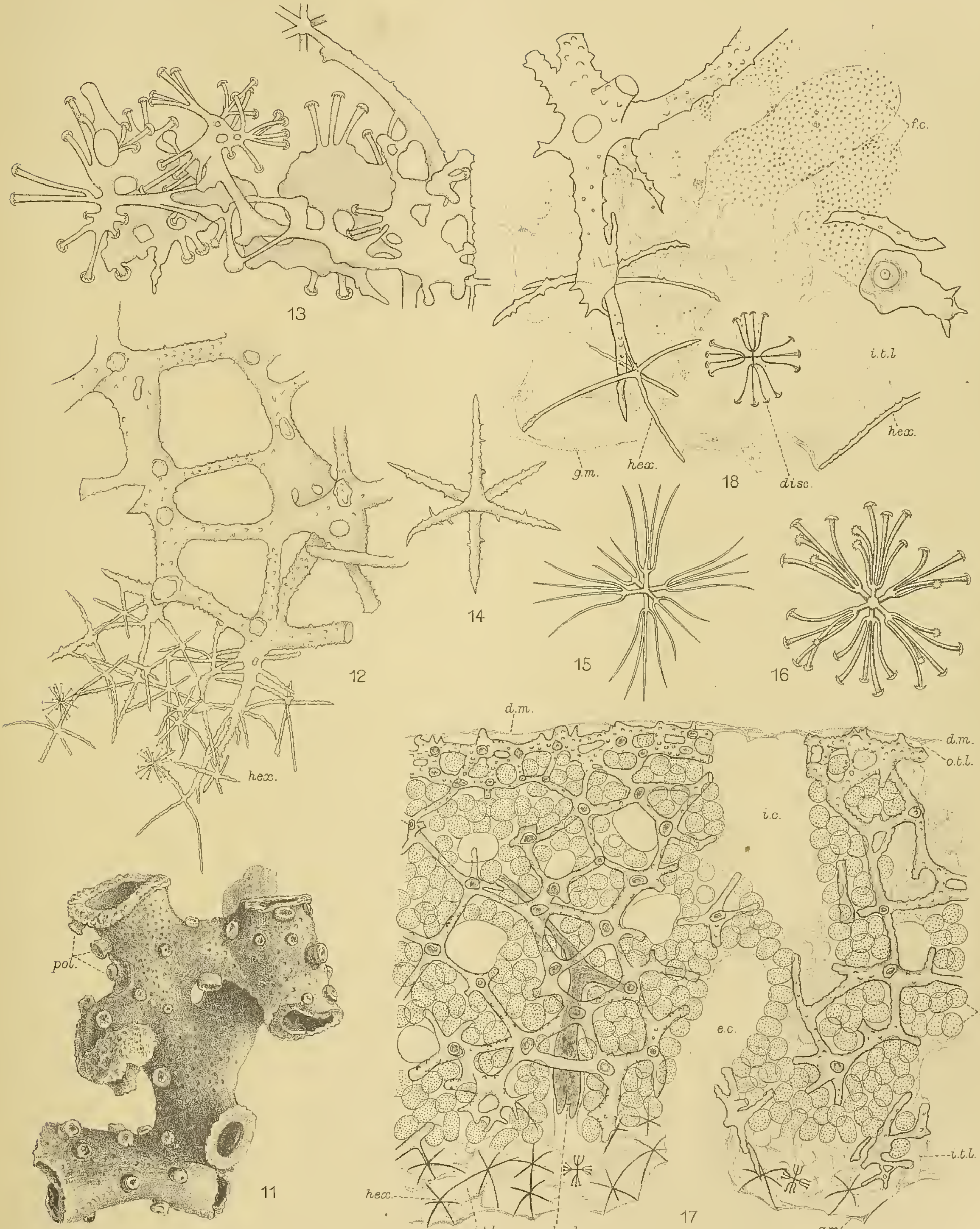
AULOCALYX SERIALIS n. sp.



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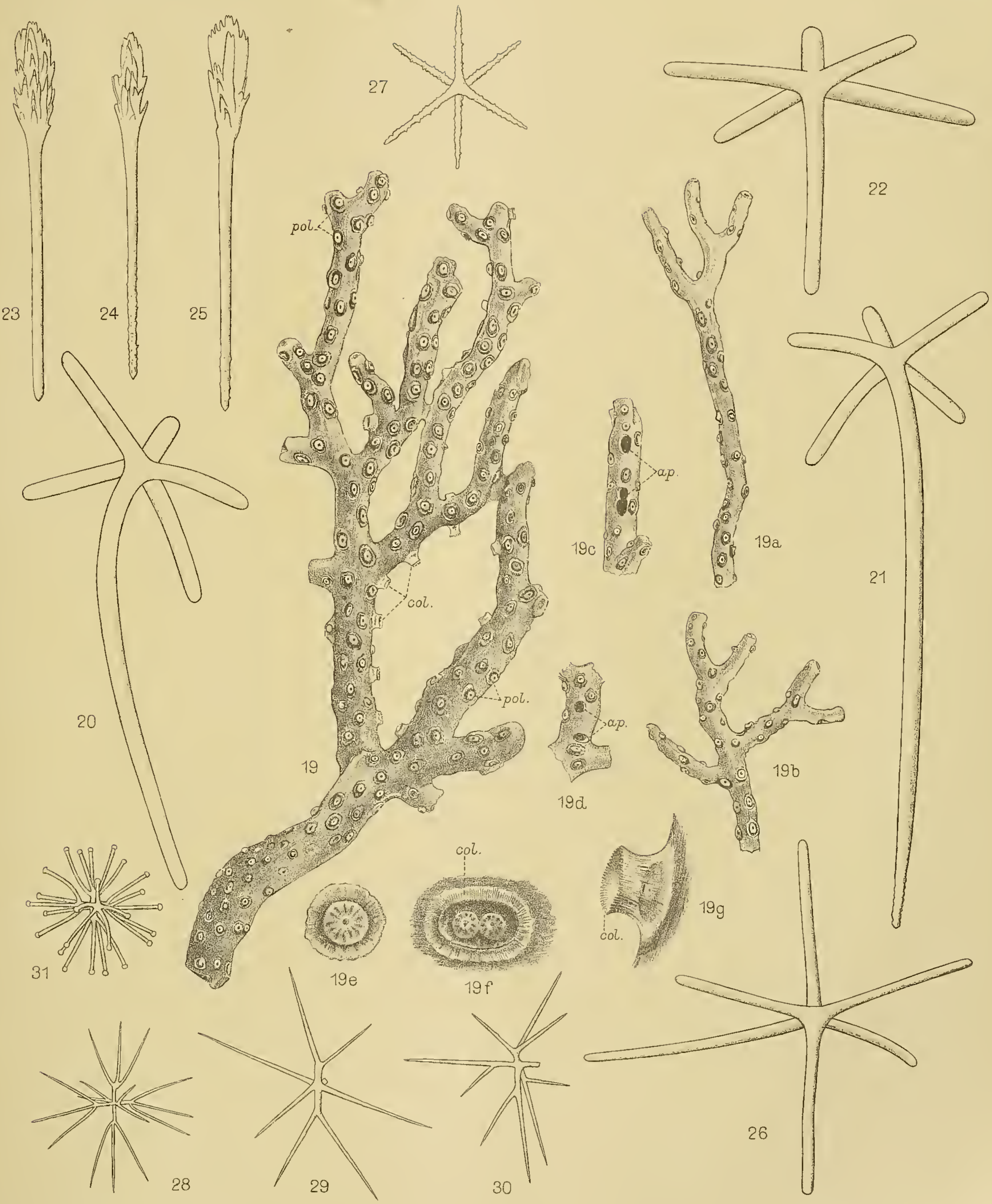
HETERORETE PULCHRA n.sp.



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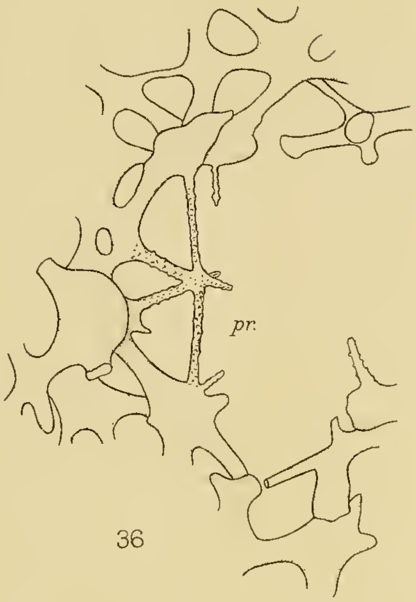
SAROSTEGIA OCULATA Topsent.



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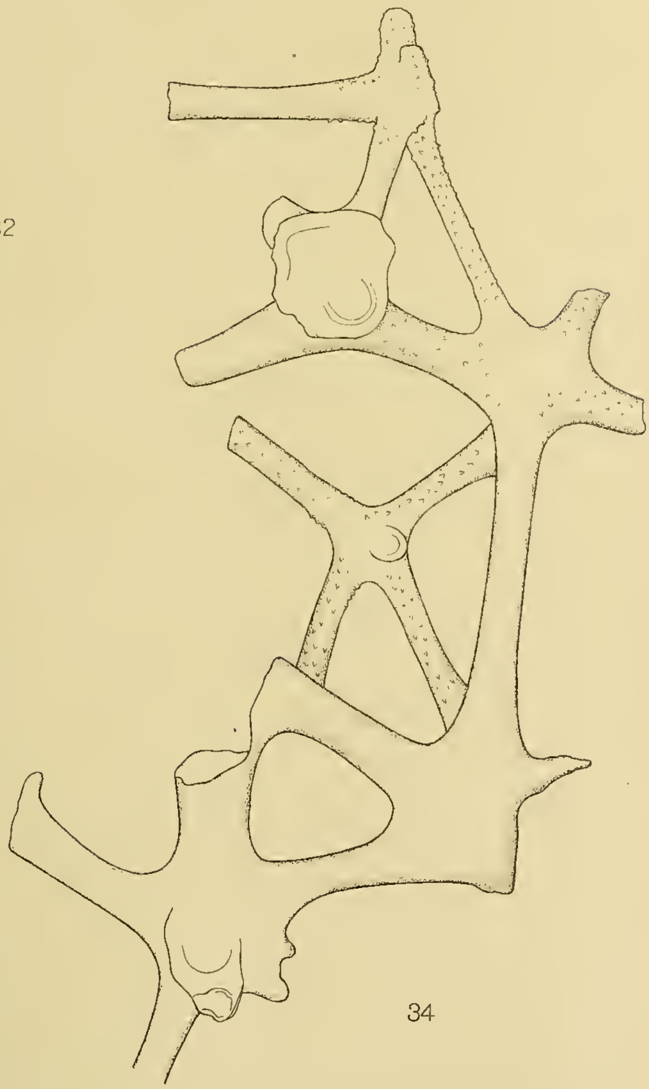

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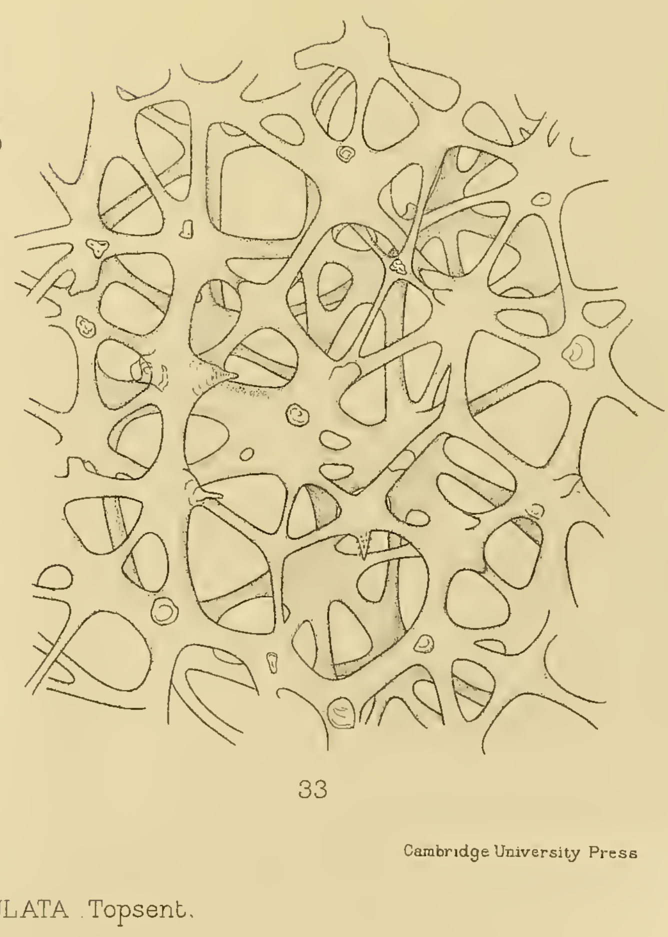

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