

On the Genus *Plocamia*, Schmidt, and on some other Sponges of the Order ECHINONEMATA. By STUART O. RIDLEY, M.A., F.L.S. With Descriptions of two additional new Species of *Dirrhopalum* by Prof. P. MARTIN DUNCAN, M.B. Lond., F.R.S., F.L.S., &c.

[Read June 2, 1881.]

(PLATES XXVIII. & XXIX.)

PART I.

Introductory Remarks, and Descriptions of Species of *Dirrhopalum*.

By S. O. RIDLEY.

ALTHOUGH the genus *Plocamia* was only recognized as a distinct type in the year 1870*, it now proves to be one of the most widely distributed, as well as one of the most beautiful, of the now numerous genera of the interesting order to which it belongs. Hitherto only three species have been assigned to it, viz.:—

Plocamia gymnazusa, Schmidt, Spong. atl. Geb. p. 62, pl. iv. fig. 18.

Cuba, 270 fathoms.

P. clopetaria, Schmidt, l. c. p. 63, pl. iv. fig. 17. Florida, 195 fathoms.

P. plena, Sollas, Ann. & Mag. N. H. (5) iv. p. 44, pl. vi. W. Africa.

Lat. 15° S. Depth?

In the present paper I have described† a new species from New Zealand, and given annotations on others previously described under other generic names; the latter are known, one from Ireland, another from Ceylon, and another from Cape St. Vincent.

No species has been described from the Arctic regions; but Ehrenberg (Zweite deutsche Nordpolarfahrt, pl. iv. fig. 8) figures from the sea in the neighbourhood of either Spitzbergen or East Greenland a cylindrical spicule, entirely spined, arcuately curved, slightly enlarged at the ends, which probably belongs to an unknown species allied to *Dirrhopalum* (*Hymeraphia*) *microcionides*, Carter. Ehrenberg names the spicule *Amphidiscus anceps*.

The distribution of the genus is thus now seen to extend from the Equatorial Atlantic to the South Pacific Ocean, and into the Indian Ocean and North Atlantic.

* O. Schmidt, Spong. atl. Geb. p. 62.

† Note.—The terminology here adopted is, in general, that of Mr. Carter (Ann. & Mag. N. H. (4) xvi. p. 1 &c.). Measurements of spicules are the average maximum measurements; the diameters given are the greatest diameters of the spicules.

The name, under the form *Plocamium*, was long ago applied to a genus of seaweeds by J. P. Lamouroux ('Résumé de Phytographie,' vol. i. 1828, p. 38), and adopted by Kützing and subsequent writers. This genus has therefore precedence of *Plocamia*; and as a change is obviously necessary, I shall adopt throughout the rest of this paper the name *Dirrhopalum**, which Prof. P. M. Duncan has suggested for the genus distinguished by Schmidt.

Two definitions have been given of the genus, the one by Schmidt (l. c. *suprà*), the other (ostensibly a definition of the new group to which he assigns it, but practically, as being the only genus included, a generic diagnosis) by Sollas (Ann. & Mag. Nat. Hist. (5) iv. p. 47). Both need modification in the present state of our knowledge. Thus Schmidt, assuming, on insufficient grounds, that the second of his two species would prove to be upright and branched in the adult state, attributed this character to the genus, "Schwämme mit incrustirender Basis und darauf sich erhebendem ästigem Gellecht," which must give way, considering that no branching specimens of the species in question have yet been described. Sollas's definition includes the same hitherto unjustified character. An examination or study of the descriptions of the different species now assigned to the genus shows that the diagnosis should stand at present:—

"Echinonematous Sponges. Growth incrusting or upright: in the former case formed by a basal lamina of a dumbbell-shaped spicule characteristic of the genus, from which spring tufts of acute or slightly spinulate spicules radiating from axes formed by larger smooth acuates or subspinulates, which are enclosed by ceratinous or pseudo-ceratinous fibre; when the growth is upright, the spicular tufts are set in whorls on fibres which are at right angles to the axis of the stem, branch, or frond, and which are similarly connected by horizontal fibres containing the dumbbell spicule. Flesh-spicules, if present, a tricurvate (German 'Bogen') or equianchorate ('Haken'), or both."

With regard to the distinctness of the dumbbell form of spicule, which has justly been made a prominent character of the genus, it must be remembered that it differs but little in the principles of its construction from another type (the "*tibiella*" of Carter, "cylindrical" or "subfusiformi-cylindrical" of Bowerbank) occurring in several well-known sponges, as in the genus

* *ἰς* twice, and *ῥόπαλον* a club, alluding to the doubly clavate or dumbbell-shaped spicule.

Alebion, Gray (= *Halichondria Pattersoni*, *nigricans*, *pulchella*, Bowerbank, &c.), and *Tedania*, Gray (*T. nigrescens*, *Muggiana*, *digitata*, Schmidt, &c.), *Cribrella hospitalis*, Schmidt, and foreshadowed in the long cylindricals of *Suberotelites mercator*, Sdt., and *Desmacidon columella*, Bowerbank, in which a magnifying-power of about 400 diameters reveals a slight inflation. The "tibiella" also occurs in *Hymeniacion armatura*, Bowerbank, *Suberites fuliginosus* and in *Halichondria infrequens*, Carter, and *Desmacidon dianæ*, *emphysema*, *physa*, *anceps*, Schmidt. As to its relations to other linear spicules, see p. 485, where the systematic position of the genus is discussed.

The dumbbell spicule may, however, be distinguished from the "tibiella" by its having the maximum length not exceeding 20 of its own maximum diameters, and by its being always arcuately curved.

I propose to give notes on the species to be assigned to the genus, adding, in the case of those which are now assigned to it for the first time, the reasons which have led me to adopt this course in their respective cases. Beginning with Schmidt's own species, those on which the genus was based, I find it necessary to supplement his short descriptions by fuller details, taken from the microscopic preparations supplied by himself to the British Museum. It will be seen that the result of an examination of these preparations justifies, in part, Sollas's supposition (*Ann. & Mag. N. H.* (5) iv. p. 46) that Schmidt had perhaps overlooked the flesh-spicules of his species.

1. DIRRHOPALUM GYMAAZON. (Plate XXIX. figs. 1, 2.)

Plocamia gymaazon, Schmidt, *Spong. atl. Geh.* p. 62, pl. iv. fig. 17.

To the details given by Schmidt (*l. c.*) should be added the following:—

Bases of echinating- and main-fibre spicules connected by yellow ceratinous (?) * material. No spinulate spicules as stated by Schmidt.

Skeleton-spicules of three kinds:—(1) Long, slender, smooth, slightly curved acute, tapering from the base to the sharp point; size 2.13 to 2.48 by .04434 millim. (2) Stout smooth acute, tapering to a sharp point from within quarter of its length from the base, and slightly tapering to the base from the same

* As the slide appears to have a talc cover, the test of polarization (see p. 481 ad init. and note) is inapplicable here.

point; bent, but not so sharply as in Schmidt's figure 17b; size 0.99 by .06334 millim. (3) Dumbbell or double-headed, curved, cylindrical spicule; size .479 by .06334 millim.

Flesh-spicules of two kinds:—(1) Tricurved acute, bow-shaped, tapering gradually from centre to sharp points; size .082 by .003167 millim. (2) Equianchorate, bipalmate, the palms with squarely truncate proximal margins, shaft almost straight; length about .019 millim.

2. DIRRHOPALUM? CLOPETARIUM.

Plocamia clopetaria, Schmidt, *l. c.* p. 63, pl. iv. fig. 18.

Consisting of a basal lamina, in which the dumbbell spicules and a peculiar pegtop-like form (4) are united by ceratinous material (polarizing light) and sarcode, and of spicular tufts rising from this lamina, and consisting each of a very large basally-spined acute (1) surrounded by a considerable number of small spicules (2) of a similar kind; the bases of the spicules in the tuft are united by ceratinous material.

It is possible that the points of the peculiar form (4) feebly echinate the basal lamina. In any case they cannot be varieties of the dumbbell spicule, as stated by Schmidt (*l. c.*), for no transition forms occur in the same preparation, and their independent existence in the fossil state is undoubted (see p. 486).

Skeleton-spicules of four forms:—(1) Large, curved acute, the base finely tuberculate; length (none were found entire) probably about 1.8 millim., thickness .057 millim. (2) Small, straight acute, basally spined, slightly constricted just above base; size .29 by .01108 millim. (3) Dumbbell spicule, curved so as to form about a third part of a circle, coarsely tuberculate in approximately verticillate whorls on shaft, evenly so over the ends; both ends and centre of shaft inflated to the same diameter; size .152 millim. long, inflated ends and centre .05067 millim. thick. (4) Short, rapidly tapering acute ("pegtop"-shaped spicule), coarsely tuberculate; one sixth of the apical end is almost smooth, becomes more rapidly narrow than the rest, and is traversed to its extremity by the central canal; size .1647 by .076 millim.

Flesh-spicules.—None were found after careful search in the mounting (which, however, is small) in the Museum collection, unless tricurveds are represented by a single specimen of a fine barely tricurved acute; size .108 by .003167 millim.

Obs. If the flesh-spicules should really be wanting, this species

should perhaps, looking to the peculiarity and antiquity of its characteristic spicule (4), be made the type of a distinct genus. I shall, for the present, allude to forms which resemble it as belonging to the "clopetarium section" of the genus *Dirrhopalum*.

3. DIRRHOPALUM PLENUM.

Plocamia plena, Sollas, *Ann. & Mag. N. H.* (5) iv. p. 44, pls. vi. & vii.

A member of the typical section of the genus, *i. e.* of that part which is represented by *D. gymnazon*, for it has a smooth-shafted dumbbell spicule coexisting with equianchorate and tricurvate flesh-spicules. The short-spined acute (plate vi. fig. 5, &c.), with the coarse and backwardly-directed spines of its shaft and the somewhat tubercular spines of its base, may perhaps represent the pegtop-like form of *D. clopetarium*, and thus the species may form one link in the chain, if it ever existed, between that species and *D. gymnazon*. This may well be, for if *D. clopetarium* is ultimately found, like *D. gymnazon*, to have the flesh-spicules, the only important points then separating it from *D. plenum* would be the tuberculation of the shaft of the dumbbell spicule, the tuberculate character of the short-spined acute, and possibly (and, if so, most important of all) the non-echinating position of this spicule, which is distinctly an echinating form in *D. plenum*.

The arrangement of the skeleton of *D. plenum* is also typically Dirrhopaline, showing a vertical or primary fibre echinated by an acute and subspinulate spicule, and a horizontal or secondary fibre or tract containing the dumbbell form. The yellow colour ascribed to the sarcode, and the firm consistency of the skeleton, appear to me to indicate that there is a decided admixture of a ceratinous element, or of some analogous substance, in it, in spite of Mr. Sollas's conclusions derived from facts of some importance. Whatever, however, may be the case with this species, it certainly seems to occur in an undoubted *Dirrhopalum*, viz. *D. manaarensis*, Carter, which I have examined, where its prominence is the most striking point about the fibre of the stem, when freshly mounted in balsam or when treated with strong alcohol. I am inclined to think that some forms of ceratinous material have a refractive index so near that of Canada balsam as to be hardly distinguishable when mounted in that medium. In opposition to this view, however, Sollas's experiments with glycerine jelly still remain. The firmness of union of the various spicules in this Echinonematous genus seems to demand some

more powerful uniting agent than mere sarcode: such a material is sometimes to be distinctly seen, and when it is found to polarize light may perhaps be still held to be keratose; where it does not, it may be termed *pseudokeratose**. The tough, dark, keratose-like substance of the stem of *D. manaarensis* exhibits decided polarizing effects, but the similar matter in *D. novizelanicum* does not.

The following must be added to the genus:—

4. DIRRHOPALUM CORIACEUM. (Plate XXIX. figs. 3-7.)

Isodictya coriacea, Bowerbank, *Mon. Brit. Spong.* iii. p. 228, pl. lxxvi. figs. 7-13.

It was obtained in Strangford Lough, Ireland. The original description is misleading, so I give the following supplementary account of the structure, made from Dr. Bowerbank's own preparations.

Skeleton.—Primary lines composed of (1) long, smooth acute and (2) shorter spined acutes, the latter chiefly echinating the fibre by the lateral outward projection of their points at a very acute angle to it. Secondary lines, one spicule in length, composed of from one to three dumbbell-shaped spicules (3) at right angles to the primaries. Dermal sarcode granular, very dark; subjacent sarcode dark; a yellowish material unites the primary and secondary lines, but it does not polarize light.

Skeleton-spicules of three kinds:—(1) Large smooth acutes, slightly inflated, constricted above base, thickest immediately above this constriction; size variable, viz. 317 to 4434 by 01268 to 014 millim. (2) Smaller acutes thickly spined at base, very sparsely over the whole of the shaft; size 158 by 0079 millim. (3) Cylindrical dumbbell-shaped spicule; ends slightly inflated and well spined; the shaft less strongly spined (a converse impression is conveyed by fig. 12 of *Mon. Brit. Spong.* iii. pl. lxxv.); size 117 by 0079 millim.

Flesh-spicules of two kinds:—(1) Tricurvate acute, much more slender in proportion to its length than as given in Dr. Bowerbank's figure (*l. c.* fig. 9), and the ends carry a few minute

* I have experimented with the polariscope in order to discover, if possible, some real difference in optical properties between ordinary sarcode and keratose in the living matter of Sponges. The results are remarkable: thus the living matter, mounted in balsam, of *Tuba* (a Chalinid), of *Rhizochalina oleacea*, *Hircinia lingua*, and *Euspongia virgulosa* polarizes light, while that of *Chitina finitima* does not; the sarcode was never found to polarize. Quekett ('Practical Treatise on the use of the Microscope,' edit. i. p. 448) ranks sponge-fibre with hoof, horn, and other ceratinous bodies as having this property of polarizing light.

spines; size .19 by .003167 millim. (2) Equiachorate; it has a web connecting the two lateral teeth all but the points; it thus approaches the form called "navicular" by Mr. Carter; it measures .0158 millim. in length. Considerable numbers, grouped and single, occur in the mounted specimen of the dermis.

5. DIRRHOPALUM MICROCIONIDES.

Hymenaphia microcionides, Carter, *Ann. & Mag. N. H.* (4) xviii. p. 390.

I am indebted to Mr. Carter himself for pointing out the resemblance which this species bears to the genus *Dirrhopalum*. Its description, together with sketches which Mr. Carter has kindly furnished me, show that its structure is essentially the same as that of the other incrusting species which I have referred to the genus. A basal lamina contains the (1) doubly-headed cylindrical-spined spicules lying horizontally, also the equiachorate flesh-spicule; from the lamina project upwards (2) the long, smooth, and (3) the small, spined, and basally contracted acute side by side. It does not appear that the smaller spined acuates are grouped in whorls round the larger ones, as in *D. clopetarium*. The colour is given as yellow, possibly owing to the presence of a ceratinous uniting substance, as in other *Dirrhopala*. The ends of the cylindrical spicule are slightly inflated, as I learn from Mr. Carter, and, as stated in his description, are more abundantly spined than the shaft. The locality is near Cape St. Vincent, the depth 374 fathoms. It belongs to the *gymnazon* section of the genus, but differs from the typical species, as at present known, in the absence of a tricurvate flesh-spicule.

6. DIRRHOPALUM MANAARENSE.

Dictyocylindrus manaarensis, Carter, *Ann. & Mag. N. H.* (5) vi. p. 37, pl. iv. fig. 1.

Mr. Carter has given me all the help which he possibly could with regard to its characters. An examination of mounted sections and fragments of a portion of the stem of the type specimen (for which I am indebted to Mr. Higgin, of the Liverpool Museum) shows that, as I had been led to suspect, the structure is essentially *Dirrhopaline*.

Skeleton.—In the stem a very horny primary fibre (probably less horny in the branches), running towards the surface, contains from one to three series of stout acuates (1), the points of the outermost of which project through the dermis, and it is sparingly

echinated by small acuates. A horny secondary fibre, at approximately right angles to them, connects the primary fibres and contains the dumbbells, which also occur sparingly in the primaries.

The *dermal skeleton* is formed of a reticulation of the dumbbell spicules lying generally in twos side by side, making angular meshes, their ends united by dark material polarizing light.

Of the *skeleton-spicules*:—(1) the smooth main acute tapers slightly to its base, but otherwise agrees with Mr. Carter's description; size .475 by .0206 millim. (2) Short echinating acute, smooth; is bent abruptly, like a scimitar, at about one third of its length from the sharp point; size .114 by .095 millim. (3) Fine acute, smooth, slightly inflated basally, scattered over fibres and in dermis, probably young form of (1); size about .3167 by .006334 millim. (4) Dumbbell, with smooth curved shaft and distinct heads, very minutely microtuberculate rather than microspined (spines made too evident in Mr. Carter's figure for the scale on which it is drawn); heads of same diameter as middle of shaft; size .234 by .019 millim.

Flesh-spicules.—(1) Tricurvate, as given by Mr. Carter; size .07 by .0025 millim. (2) Equiachorate, navicular; shaft nearly straight; proximal edges of palms slightly bidentate; length .019 millim.

Obs. I had occasion to examine the specimen to settle a doubt as to the identity of the species with *D. novizelanicum*, sp. n. (*infra*), and so think it worth while giving these measurements and notes, which supplement and slightly correct Mr. Carter's careful description. It differs essentially from *D. novizelanicum* in the smoother and more finished condition of the dumbbell spicule, in the proportions and shape of the smaller acute, and in differences in the measurements of most of the spicules. On the whole, in spite of its locality (Gulf of Mauaar, Ceylon), it is not far removed in structure from the Floridan species *D. gymnazon*.

7. DIRRHOPALUM NOVIZELANICUM, sp. n. (Pl. XXIX. figs. 8-16.)

Branching cylindrical stems of constant diameter, viz. about 3 millim., having a delicate linear focus for their axis; the branches sometimes anastomose. Apparently no rooting base: all extremities, both upper and lower, consisting of rounded points. Surface velvety, set with very slightly projecting ends of spicules. Texture elastic, slightly compressible. Colour in spirit dull umber-brown.

Vents. None apparent.

Main skeleton.—Spiculo-fibres containing a large proportion of pseudo-keratose; the primary fibres at right angles to surface, containing a single row of large, smooth acute spicules (1), surrounded irregularly by two or three rows of shorter acuates (2), slightly spined basally, whose points project to the sides; a distinct margin of ceratinous material lies outside most of the spicules. The secondary fibres are numerous, irregular, formed of pseudo-ceratinous material, surrounding and showing distinct margins outside the dumbbell spicules (3), which occur, one or two together, in each fibre; secondary fibres about one spicule in length. Fine spinulate or supra-basally spinulate spicules (4) (probably young forms) scattered over primary fibres.

Dermal skeleton indefinite; consists of a reticulation of the dumbbell spicule, with the spinulates (4) scattered through it, perforated at intervals by the terminal long acuates (1) of the primary fibres.

Pseudo-ceratinous material dense, pale amber-yellow.

Sarcoid very slightly granular, of almost the same colour.

Skeleton-spicules.—(1) Strong, smooth, slightly curved acute, tapering to rounded base from a point at about 3 diameters from it and to sharp point from same place; size $\cdot 5$ by $\cdot 025$. (2) Smaller acute, slightly curved, slightly constricted immediately above and very slightly microspined upon the base, and tapering to sharp point from just above the constriction; size $\cdot 2724$ by $\cdot 0174$. (3) Dumbbell spicules; shaft decidedly curved, and generally very sparsely microspined; ends well spined, separated from shaft by slight constriction; of about same diameter as middle of shaft; size $\cdot 177$ by $\cdot 0158$ millim.

Flesh-spicules.—(4) Long, straight, spinulate spicules, or with head just above base: various in size, viz. $\cdot 19$ by $\cdot 0021$ to $\cdot 36$ by $\cdot 00475$ millim. Probably young forms of skeleton-spicules. (5) Fine, decidedly tricurvate acute, bow-shaped, tapering to fine points from middle, smooth; size $\cdot 06334$ by $\cdot 0021$. (6) Equi-anchorates, bipalmate, navicular; shaft almost straight; length $\cdot 019$ millim.

Hab. Bay of Islands, north-eastern extremity of New Zealand (Antarctic Expedition). Depth?

Examined in spirit and mounted in balsam from spirit.

Obs. One chief mass, 48 millim. long, with about eight branches given off at sharp angles from the single stem, and three or four fragments of similar character, all more or less growing over the

fucus above mentioned, occur in the Museum collection. It is doubtful whether they were naturally upright in growth, and whether they ever were rooted. The nearest described ally is apparently *D. gymnazon*, but the generally smaller size of the spicules distinguishes it; it is also near *D. manaarensis* from Ceylon (*v. supra*).

Systematic position of Dirrhopalum.

Prof. Sollas has already made the genus the type and sole occupant of a new "group" named PLOCAMLANINA. I am inclined to think that in so doing he has exaggerated the distinctness of the genus, and that *Clathria*, Schmidt (as based on *C. coralloides*, Schmidt, &c.), might with advantage be included in the group. The spiculation of the type species of that genus, as shown by the mounting in the British Museum, much resembles that of *Dirrhopalum*, consisting of a short cylindrical, two sizes of acuates (one of which is contracted at the base), a fine spinulate, and a navicular equi-anchorate; it has a well-marked horny fibre of distinctly echinonematous structure. More I cannot add from Schmidt's description; but in support of my view I would bring forward *Clathria rectangulosa*, Schmidt, and the species which, in my view, should be termed *Clathria Beani*, viz. *Isodictya Beani*, Bowerbank, Mon. Brit. Spong. ii. p. 334, iii. pl. lviii. figs. 1-6.

Clathria rectangulosa has small acute spicules tapering to their base, smooth cylindricals, subspinulate acuates, delicate equi-anchorates and tricurvates.

The British *C. Beani*, Bowerbank, agrees in the most extraordinary manner with *Dirrhopalum coriaceum* in the structure of its skeleton, and also in almost every particular of the forms and distribution of its spicules. It has a primary fibre composed of (1) large smooth acute, surrounded by a group of (2) smaller ones, which are basally constricted; and a secondary fibre composed of (3) short, thick, entirely spined acuates, basally inflated, of almost the same diameter from the base to within a diameter of the point which abruptly terminates it. There are also a fine tricurvate and an equi-anchorate flesh-spicule. The spined acute or spinulate (3) differs from the correspondingly placed dumbbell form of *D. coriaceum* by the addition of a *point* to one end, and by the absence, as a rule, of a well-marked *head* or swelling at the distal end; this end, however, is frequently marked off from the rest of the shaft by a slight neck, as if to form an incipient head,

and the point is sometimes so reduced in dimensions as to suggest that it might be readily lost altogether; in one instance it was found replaced by a blunted, but almost smooth extremity; thus the only serious difference between these species lies in the character of the pointed end of this spicule. It seems to me that we have here the very point of transition from *Clathria* to *Dirrhopalum*, and for these reasons I believe in a close affinity between the two genera. And this fact is the more interesting, as Prof. Schmidt has called attention to the British Sponge-fauna as consisting of an aggregation of indistinctly differentiated forms.

Sollas (Ann. & Mag. N. H. (5) iv. p. 49) found gradations between the dumbbell spicule of *D. plenum* and the spined and basally inflated acute of the skeleton. May his transitional forms not show rather that the dumbbell spicule of the secondary fibre was originally like that of *D. Beani*, a spined spinulate or acute, which is now only represented by these occasional reversions to the primitive type?

Existence of Dirrhopalum in the Fossil State.

This fact appears to be indicated with some probability by the figure given by Mr. Carter (Ann. & Mag. N. H. (4) vii. p. 133, pl. ix. fig. 50) of a spicule from the Upper Greensand of Haldon Hill, near Exeter, which corresponds in size to the average dimensions of the dumbbell spicules of *Dirrhopalum*. It has a smooth shaft, and smooth large extremities sharply distinguished from the shaft.

Prof. Sollas (*op. cit.* (5) vi. p. 392, pl. xx. fig. 46) figures and describes, as the basis of a provisional new genus and species called *Rhopaloconus tuberculatus*, a large subconical spicule rounded at each end, and covered with stout tubercles, just such as those of the two distinctive spicules of *D. clopetarium*, Schmidt. Its size, however, is .95 by .24 millim. It may perhaps represent an ancient divergence from the spined acute form in the direction of a simple cylinder.

A. K. Zittel, in his memoir on the genus *Czloptychium* (Abh. math.-phys. Kl. bayec. Akad. Wiss. xii. pt. iii. p. 1), figures, among a large number of spicules obtained from fossil Sponges of that genus, some (viz. pl. iv. figs. 20, 51, 65) which seem likely to have belonged to species of *Dirrhopalum* of the *clopetarium* section; they belong to the Upper Chalk. His fig. 17, a very remarkable form, with slight smooth shaft and large strongly

spined ends, might have been taken for an extreme form of dumbbell spicule but for Carter's observations, described and supported by Sollas (Ann. & Mag. N. H. (5) vi. p. 394), which tend to show it to be merely a foraminifer-cast.

Further, Mr. G. J. Hinde, in his inaugural dissertation entitled 'Fossil Sponge-Spicules from the Upper Chalk' (Munich, 1880), figures at pl. i. figs. 19, 20, two spicules of about the same contour as the "pegtop" form of *D. clopetarium*, but without tubercles, and of about three times the size of that spicule. The tubercles may have been lost by absorption, for the central canals are greatly enlarged. Fig. 22 of his paper represents a similar but slightly smaller spicule, provided, however, with tubercles tending, as in *D. clopetarium*, to disappear towards the point, which is broken off. Mr. Hinde refers to *D. (Plocamia) gymnazon* and *clopetarium* among other Sponges in connexion with some accompanying large acuates (p. 21, pl. i. figs. 10-15); but they can have, taken alone, no necessary connexion with those species, although occurring in conjunction with the conical types above mentioned, they seem to show very conclusively the existence of a *Dirrhopalum* of the *clopetarium* section in the seas of the Chalk period.

A. Rutot (Annales Soc. Malac. Belg. ix. pl. iii.), at fig. 7 figures a dumbbell spicule, at fig. 6 an elongated smooth pegtop form, and at fig. 39 a cylindrical, from the "Grès" of the lower and middle Brussels strata (Eocene).

We have, then, for the distribution of the genus in time as at present known:—

	Recent.	Tertiary.	Upper Chalk.	Lower Chalk.	Greensand.
<i>D. gymnazon</i> group	*	*	*
<i>D. clopetarium</i> group	*	*?	*

PART II.

Descriptions of two additional new Species of Dirrhopalum.

By Prof. P. MARTIN DUNCAN.

During an examination of some débris which had been brought up by the dredge and tangles from the North Atlantic by H.M.S. 'Porcupine,' and from off the south-west coast of Spain in association with corals, I found an *Echinus*-spine, and also a darkly stained calice of a coral. Both were more or less covered with bristly sponges of an incrusting habit, and with very remarkably shaped, bent, cylindrical, terminally-inflated spicula forming the basis. A careful examination proved that they must be associated with Oscar Schmidt's genus *Plocamia*.

The first species to be described came up with a mass of the coral *Amphihelia ramea*, Sars, from the *Globigerina*-ooze in deep water from the North Atlantic; it covered an *Echinus*-spine.

The spine (Pl. XXIX. fig. 18), about two thirds of an inch in length, has been fractured; but what remains is covered with a very delicate incrustation of a very spiculiferous siliceous sponge. This is silvery white in colour, and shows neither oscules nor pores; but a considerable number of regular minute elevations are visible, out of the centre of each of which projects a large glassy spiculum. A low magnifying-power shows that the elevations are produced by whorls of spicula which radiate nearly at right angles from one spot around each large glassy spicule. The blunt ends of the radiating spicula are towards and in contact with the axial spicule; and their sharp terminations describe a circle, the periphery of which touches those of the neighbouring whorls around other large spicula.

The whorls have the spicula close together near the great or axial spicula, but they permit the sharp distal ends to be slightly separated. A sarcode fills up and covers all (Pl. XXIX. figs. 18 & 30).

Underneath this layer of whorled spicula there is a close layer of curved, cylindrical, globose-headed, entirely-spined spicula, which rests on the *Echinus*-spine. The large glassy axial spicula start from this layer and project at right angles to it (Pl. XXIX. fig. 30).

There are several kinds of spicula, which may be considered under the heads of those of the outer skeleton, the body, and the derm.

Outer Skeleton.—Large and smaller attenuato-acuates basally spined.

Subfusiform acuates with ovoid basal inflations, minutely spinulate.

Body.—Curved, cylindrico-globose-headed, entirely-spined spicula.

Derm.—Cylindrical, cylindrical laterally spined, linear cylindrical minute, and minute fusiform spicula.

One large bihamate spiculum is amongst a whorl of spicula; but as it is in company with a coccolith, it is probably a foreign body.

Description of the Spicula.—The large skeleton-spicula, axial to the whorls, few in number, protrude at right angles to the mass of the sponge and extend beyond any of the others, forming a regular series of nearly equidistant sharp projections, glassy in appearance. They are slightly bent, and gradually taper from their rounded base (which is placed amongst the cylindrical curved and bossed spicula of the body) to their apex (which becomes sharp rather suddenly). The rounded head is minutely and scantily spinulate and is about $\frac{1}{30}$ inch in diameter, and the whole spicule is $\frac{1}{2}$ inch long (Pl. XXIX. figs. 28 & 30). Sometimes very minute spinules exist for some distance up the spicule, which, moreover, has a minute axial canal. Some others (attenuato-acuates), smaller than these, but having the same shape and direction, exist, and they are evidently correspondingly immature spicula.

The whorled spicula (Pl. XXIX. figs. 24–27) are very slender, straight, and have a basal inflation of the ovispinulate type. This oviform enlargement is excessively minutely spinulate, and joins the shaft at a constricted neck. The shaft is fusiform, but the swelling is in the basal third of the spicule; thence the spicule becomes slenderer, and ends rather suddenly by becoming sharp-pointed. In some instances there are a few very minute point-like spines on the shaft near the neck. Some basal inflations are very ovoid, others are more globular; but in every instance the external or terminal portion is narrower than that just within and nearer the neck. The usual length of these spicula is $\frac{1}{15}$ inch, and the breadth $\frac{1}{30}$ inch. The swelling of the shaft and the constricted neck and small-spined ovoid base are very distinctive. They are very numerous, and are placed in one or two whorled layers; the bases are towards the

great attenuato-acuates, and the shafts radiate at nearly right angles. The oviform bases are in contact at their sides with their fellows, and at their ends with the great spine, which they surround (Pl. XXIX. fig. 30). The axial canal is not to be seen.

The body-spicula in contact with the spine of the *Echinus* are short, curved, cylindrical, having globose or subhemispherical ends, slightly constricted where they join the body of the spicule. They are entirely bluntly spined. The spinulation is small and close on the rounded ends; but there is less of it on the constricted necks, and it is wider apart, stouter, and longer on the body. The boss-shaped ends are wider than the body (Pl. XXIX. fig. 19). Usually a large axial canal is visible in these spicula, and it extends far into the heads of the elongated curved dumb-bells. These spicula form one or two layers, one above the other; they are placed close together, without order as regards their direction; but there is some diversity in their size and shape, owing mainly to age.

A typical spiculum of this kind has a perfectly cylindrical body, not more swollen out in any part than elsewhere; the cylinder, slightly bent, is narrower than the terminal bosses, and is more than double the length of one of them.

The blunt spinulation surrounding the whole surface is irregular, distant, and the tops of the projections, which differ in length, are blunt.

Varieties.—Spicula of the same length as the type, but having the boss more spherical and the constriction of the neck more decided, the spinules being scanty on the neck and larger than usual on the body. Spicula with one boss perfect and the other less so or smaller.

In all, the spinulation of the boss-like ends is minute and in a series of concentric circles; but there is no order in that of the curved stems, where it is larger.

The diameter of these body-spicula is $\frac{1}{300}$ inch, and the length $\frac{1}{100}$ inch.

The sarcoderm covered the radiating whorled spicula and the spaces between them; it closed in the spaces or interstices between the numerous whorls, and it extended further out, to the tops of the long skeletal spicula. The spicula of the derm are few in number; and some are apparently quite superficial. Three kinds are to be noticed; but one appears to be a young form. One is a minute cylindrical rod; another is of the same

diameter, but is four or five lines longer (Pl. XXIX. fig. 29). The third kind is a very minute fusiform spicule, sharper at one end than at the other.

Amongst the whorls of spicula are some differing in shape and dimensions from the majority. They are placed between the radiating skeletal elements, and are free in the sarcoderm which unites the whole. They are much shorter and slenderer than the others, and are cylindrical and very slightly curved at one end. Some of them are about one third the diameter of the whorled spicula, and others are less than one sixth, appearing to be almost linear under a quarter-of-an-inch object-glass (Pl. XXIX. figs. 22, 23). Larger than these, but still not equalling in breadth the common whorled spicula, are some cylindrical spicules with slightly bent ends, the shaft being very sparingly and minutely spinulate, but not the end (Pl. XXIX. fig. 21). Larger cylindrical spicula are rare; they are straight, and minutely and sparsely spined, and only on the stem; their diameter is greater than that of the whorled series, and is about equal to that of the curved cylindrical body-spicula (Pl. XXIX. fig. 20).

The second species was found on the septum of a dead manganese-covered coral, dredged up from 1095 fathoms, the locality being off the coast of Spain, No. 17 dredging, N. lat. 39° 30', W. long. 9° 39'.

The sponge covers a large septum, is of a dirty-white colour, and is hirsute, with separate long acuates, which arise as it were out of a stubble of smaller spicula, grouped so as to radiate upwards and outwards, from near the base of the long spicula. Each long spicula has thus a group of shorter ones around it, assuming the direction just mentioned. On separating these structural elements from the coral, a layer of large, curved, or bent, or nearly straight, cylindrical spicula, with one well-developed globose head at least, becomes visible; they rest on a membranous-looking derm, which is closely applied to the dark-coloured coral-surface. No oscules or pores can be distinguished, and there is no keratose fibre.

The curved body-spicula (Pl. XXIX. fig. 34) are large, and often $\frac{1}{100}$ inch in length; they are, in some instances, symmetrically curved, and have a rounded globose termination at either end, which is joined to the body by a very slight constriction. There is a small and close spinulation on the ends, and a larger and

scantier on the body. A second form of body-spicule has a less decided curvature and but one globose end, the other being a mere rounding of the cylindrical body. The spinulation resembles that of the first type (Pl. XXIX. fig. 35). A third is longer than the others, is bent more or less like a boomerang, has a globose process at one end, and a narrow, cylindrical, and rounded termination at the other (Pl. XXIX. fig. 36). The spinulation is scanty on the body. There are intermediate shapes, and on some there is a large spinule, in particular, on the cylindrical body (Pl. XXIX. fig. 37). These spicula are placed without order on the surface of the coral in one layer, and are not very close. Length $\frac{1}{50}$ to $\frac{1}{100}$ inch, thickness $\frac{1}{100}$ inch.

The long acuates, straight or sometimes slightly bent, project well beyond the other spicula, and were covered with sarcodae. Their bases, rounded off and very minutely spinulate, are as thick as one of the curved spicula just noticed; they slope gradually to a sharp point, and their axial canal is very manifest near the base (Pl. XXIX. figs. 32, 33). The radiating spicula are very numerous and are arranged in bundles, the faintly enormispinulate heads of the spicula being close together and surrounding the stout long and large acuates. The shafts of the spicula are slightly swollen in the first third, so that they are more or less fusiform, and the point suddenly becomes sharp, like a straight sword. The shafts project upwards and slightly outwards, and their points form a circle around the acute spicule and tolerably close to it (Pl. XXIX. fig. 31). The heads of the spicula (length $\frac{1}{30}$ to $\frac{1}{60}$ inch) are remarkable in shape; there is a cylindrical swelling with a short neck, and then there is a projecting end, which is longer than broad, cylindrical, and rounded. An excessively delicate and scanty spinulation is seen on the cylindrical part and also on the rounded end (Pl. XXIX. fig. 39). There are no other spicula. The sarcodic structures enveloped the whole, and were stretched out to the tops of the long acuates; there was a definite basal membrane.

It is evident that this form is closely allied to the first species I have described, from which it is distinguished by the shape of the deeply-seated spicula and the direction of the enormispinulates. It is possible that these distinctions may be racial; but, under existing circumstances, it is best to separate the forms specifically.

The first species I have named *Dirrhopalum Carteri*, and the second *Dirrhopalum hystrix*.

PART III.

On some Sponges of the Order Echinonemata.

By S. O. RIDLEY.

The concluding part of this paper deals with an hitherto unrecognized generic type, which may be assigned to the

Order ECHINONEMATA, Carter.

Family AXINELLIDA, Carter.

Group MULTIFORMIA, Carter.

ECHINODICTYUM*, n. gen.—Sponge erect; cup-shaped or ramose. Skeleton formed of spicules united into distinct coherent fibres. From the fibre project at right angles short strongly-spined cylindrical spicules tapering from their attached ends. Spicules of fibre smooth, acerate (doubly pointed). No special flesh-spicules.

Type *Spongia bilamellata*, Lamarck, Ann. Mus. Hist. Nat. xx. p. 434.

Obs. The nearest affinities of this genus appear to be with *Dictyocylindrus*, Bowerbank, s. str., i. e. with those species which have a more or less distinct firmer axis and echinated fibre, combined with a spiculation of smooth acuates and acerates in the fibre, smooth acuates and spined cylindricals, or blunt acuates echinating it, and no minute flesh-spicules (e.g. *Dictyocylindrus hispidus*, Bowk., *Axinella damicornis*, Schmidt, *D. Pykei* and *laciniatus*, Carter). It differs from *Dictyocylindrus* mainly in the absence of the smooth acuates, usually so abundant in that genus, and in the much greater definiteness of the fibre. It perhaps connects *Dictyocylindrus* by these characters with the *Ectyonida* (Carter).

As the typical species has never been described from a microscopic examination or figured, and as such fine specimens are available, I append a full description with figures.

ECHINODICTYUM BILAMELLATUM. (Plate XXVIII. figs. 1-6.)

Spongia bilamellata, Lamarck, Ann. Mus. Hist. Nat. xx. p. 434;

Anim. s. Vert. (2) ii. p. 556.

Sponge erect, turbinate, expanded, or compressed; the margin of the cup is prolonged in adult specimens into one or more broad expansions; a short pedicel. Internal surface of cup smooth (occasionally undulating), bearing the numerous scattered vents. External surface exfoliating so as to form obscure longitudinal ridges, which, together with the intermediate spaces, grow out into larger or smaller rounded excrescences, composed of reticulate fibrous tissue. Texture of inner surface dense, that of outer loose; in dry state firm, subelastic. Colour in dry state pale brown.

* *ἐχίνοσ*, a sea-urchin or hedgehog, and *δίκτυον*, a net.

Vents numerous, apparently only on inner surface of cup; round; diameter 1 to 3 mm.

Main Skeleton.—Arrangement rather irregular. The stout, somewhat flexuous primary fibres run approximately at right angles to the surface; they are connected, usually at short (.2 to .43 mm.) intervals, by secondary fibres, which run at angles varying from 45° to 90°, with the primaries, and are often curved. Pseudo-ceratinous (*antea*, p. 481) material pale yellowish brown in upper part of sponge, extending beyond the margins of the skeleton-spicules; does not polarize light. Primary fibres ending on surface by anastomosis with a dermal set of secondaries, or projecting beyond it to a distance not exceeding .4 mm. on the inner, 1.5 mm. on the outer surface of sponge. Both primary and secondary fibres filled with parallel smooth acuates, apparently of two sizes; both generally 8 to 15 spicules broad, and both echinated at short intervals by single-spined cylindrical spicules, which project at right angles to the surface of the fibre, and are attached by their extreme base.

Dermis.—Fibres very tortuous, stout, forming meshes of very various size and generally rounded outline: echinated by large numbers of the cylindrical spicule.

Sarcodae.—In dried state transparent yellowish brown; that of the surface, however, almost covered by minute patches of a granular reddish pigment.

Skeleton-spicules of two kinds:—(1) Smooth acerate (pointed at both ends), more or less bent, rather sharply, tapering to sharp points from within 3 diameters of the ends; size from .26 to .32 by .014 mm.; occurring in all the fibres, and occasionally free in sarcodae near fibre. (2) As no. 1, but size from .19 to .25 by .011 to .0127 mm.; form the greater part of the fibre.

Echinating spicule.—Cylindrical, blunt at both ends, tapering from attached end, which is about twice the diameter of free end; covered with spines, especially thickly at ends; spines prominent, sharp, the basal ones projecting at right angles to the axis of spicule, the remainder curved towards base; size .1 to .12 mm. by .0095 to .0126 mm.

Hab. "Southern Ocean" (*Péron & Lesueur ap. Lamarck*); pearl-oyster bed on N.W. coast of Australia, and W. Australia? (*Brit. Mus. coll.*).

Examined. Dry and in balsam.

Obs. Two specimens of this species are known—the type specimen in the Paris Museum (*cf. Lamarck, loc. cit.*), and a fine specimen recently purchased for the British-Museum collection.

The latter is a remarkably fine and attractive specimen; has

the shape of corals of the genus *Turbinaria*, viz. an open cup; its short pedicel measures about 2½ inches in maximum diameter.

Maximum diameter of cup about 12 inches, height 7 inches; thickness of wall near edge ¼ to ½ inch (6 to 12 mm.). It is attached to the upper valve of a pearl-oyster (*Avicula margaritifera*), which was evidently alive when taken from the sea, in spite of the presence of its bulky messmate.

The occurrence of a third specimen is certified by a slide of spicules in the Museum collection, which, as it was presented by Mr. G. Clifton, to whom the Bowerbankian collection of foreign Sponges owes an immense series of very fine specimens from Fremantle, S.W. Australia, probably was made from a sponge obtained in that region.

As the Museum has been fortunate enough to obtain (owing to the liberality of M. E. Perrier, of the Museum at the Jardin des Plantes, Paris) a fragment of Lamarck's original type specimen, I am enabled to give a comparative Table of some of the chief characters of these three specimens, which will afford some idea of the range of variation within the species.

<i>Echinodictyum bilamellatum.</i>	Type, "Southern Ocean."	B.M. spec., N.W. Australia.	Mr. Clifton's spec., W. Australia?
External form	Infundibular at base, edges prolonged into two lamella. Outer surface roughened ("sero-biculated").	Infundibular, one side prolonged as an everted lip. Outer surface roughened ("sero-biculated").	?
Vents	On inner surface 1 or more mm. in diam.	On inner surface 1 to 3 mm. in diam.	?
Colour in dry state:	Pale yellowish brown.	Pale yellowish brown.	?
Primary skeleton-fibre (inner surface of sponge):	6 to 10 spicules thick.	8 to 15 spicules thick.	?
Secondary skeleton-fibre:	6 to 10 spicules thick.	8 to 15 spicules thick.	?
Length of primary fibre between the secondaries (inner surface of sponge):	.21 to .28 mm.	.28 to .43 mm.	?
Large smooth acerate spicule:	.266 by .014 mm.	Shape as in type. .304 by .014 mm.	Shape as in type. .3167 by .014 mm.
Smaller smooth acerate:	.19 by .01268 mm.	Rather more abruptly pointed than in type. .2216 by .011 mm.	Rather more abruptly pointed than in type. .2534 by .01263 mm.
Spined cylindrical..	Spines least numerous just above base. .108 by .0095 mm.	Shape &c. as in type. .114 by .0095 mm.	Spines coarser and equally distributed all over. .108 by .01263 mm.

ECHINODICTYUM NERVOSUM. (Plate XXVIII. figs. 7-10.)

Spongia nervosa, Lamarck?, *Ann. Mus. Hist. Nat. Paris*, xx. p. 450; *Anim. s. Vert.* (2) ii. p. 567.

Spongia cancellata, Lamarck?, *Ann. Mus. Hist. Nat. Paris*, xx. p. 456; *Anim. s. Vert.* (2) ii. p. 571.

Sponge branched in one plane from almost obsolete stem; branches long, anastomosing at points, which are generally adjacent in the various branches; near base irregularly cylindrical, becoming flattened higher up; apices digitiform, adjacent edges narrow, knife-like. Surface normally covered by dense white incrustation; minutely reticulate on back, and minutely hispid in front of frond when this is removed. Texture hardish; it is slightly elastic, but easily broken. Colour in dried state pale yellowish white.

Vents numerous, in one side only of frond (the front), scattered, numerous, 1 to 2 mm. in diameter, indistinctly defined. Pores?

Main skeleton composed of spiculo-fibre, in which the smooth acerate spicules almost entirely conceal the ceratinous uniting substance; primary fibres straight, at right angles to surface, from 3 to 6 spicules in diameter; secondary fibres short, about 1 spicule long and 2 to 3 broad, connecting primaries at various angles; both sets of fibres sparsely echinated by single, short, entirely-spined cylindrical spicules.

Dermal skeleton consisting of broad, irregularly anastomosing tracts of smooth acute spicules slightly echinated by spined spicules.

Sarcode transparent. *Ceratinous material* amber-yellow in basal skeleton, almost colourless in branches; polarizes light.

Skeleton-spicules of one kind:—Smooth stout acerate, bent at a slight angle, and tapering to sharp points from about the centre (as occasional variations they may have one or both ends rounded off); size .39 (occasionally .46) by .03167 (occasionally .038) mm.

Echinating spicule short, straight, spined, cylindrical, tapering slightly from rounded base (which is slightly inflated in some cases) to distal rounded end; spines abundant, strong, and recurvate over distal half, slighter and curved towards apex on base, very slight or absent on part immediately above the base; size .114 by .0174 mm.

Hab. S.E. coast of Arabia (*Carter*) (Indian Ocean?, *Lamarck*).

Examined. Dry and mounted in balsam.

Obs. The dry specimen in the Bowerbank collection is 9 inches high, and about the same in breadth at the broadest part.

Another species of this genus is known to me, to which I hope to refer on some future occasion.

DESCRIPTION OF THE PLATES.

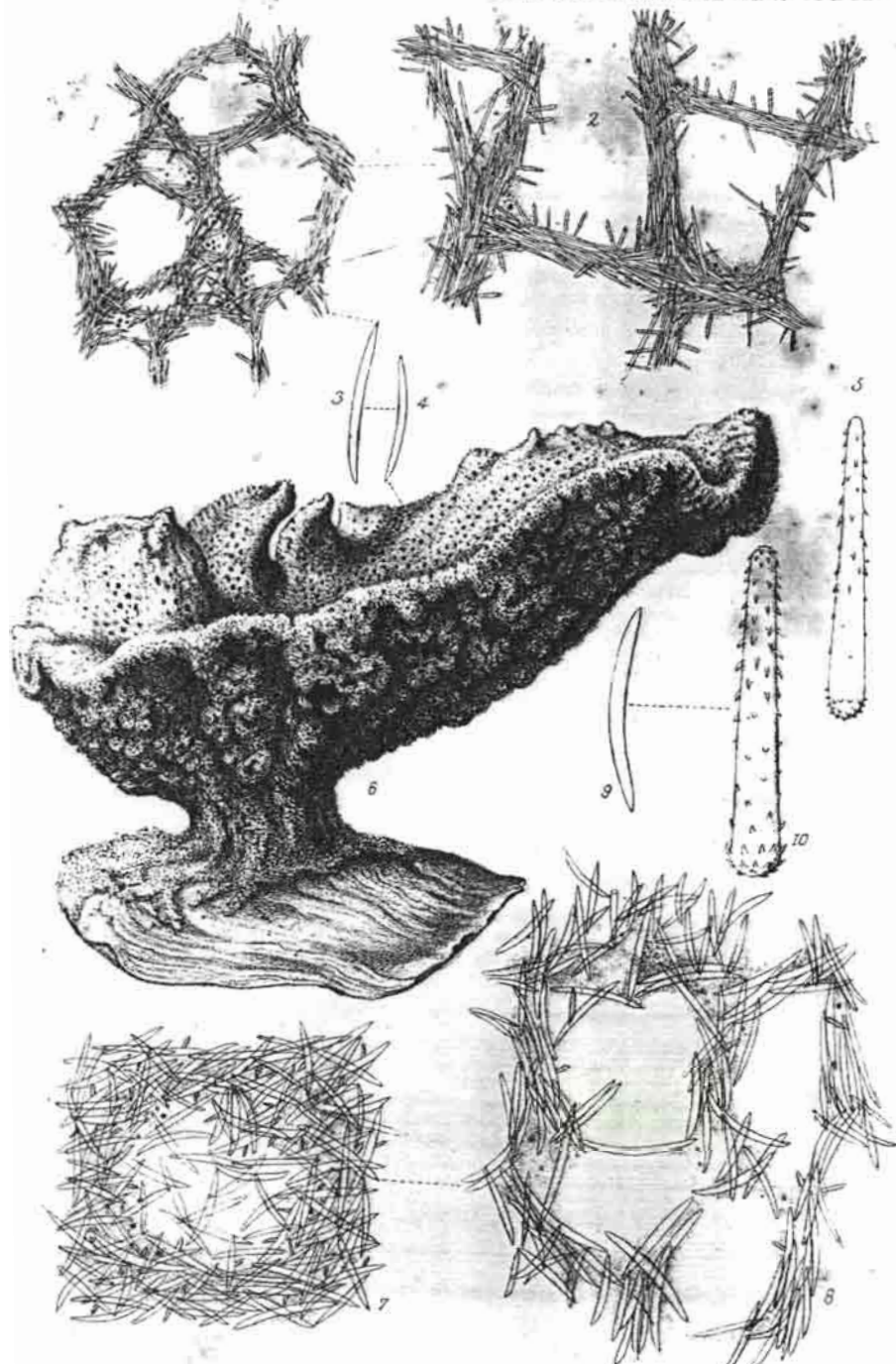
PLATE XXVIII.

Figs. 1-6. *Echinodictyum bilamellatum*. 1. Portion of surface of inner aspect of sponge, from type in Paris Museum, $\times 38$ diam. 2. External part of section perpendicular to inner (upper) surface of cup, $\times 38$ diam. (from the British-Museum specimen from N.W. Australia). 3 & 4. Skeleton acerate spicules, $\times 68$ diam., from type specimen. 5. Spined cylindrical echinating spicule, $\times 370$ diam., from type specimen. 6. The British-Museum sponge (*E. bilamellatum*) from N.W. Australia, reduced to one third nat. size.

7-10. *Echinodictyum nervosum*. 7. Part of surface, $\times 50$ diam. 8. Part of section perpendicular to branch, $\times 50$ diam. 9. Skeleton acerate spicules, $\times 68$ diam. 10. Spined cylindrical spicule, $\times 370$ diam.

PLATE XXIX.

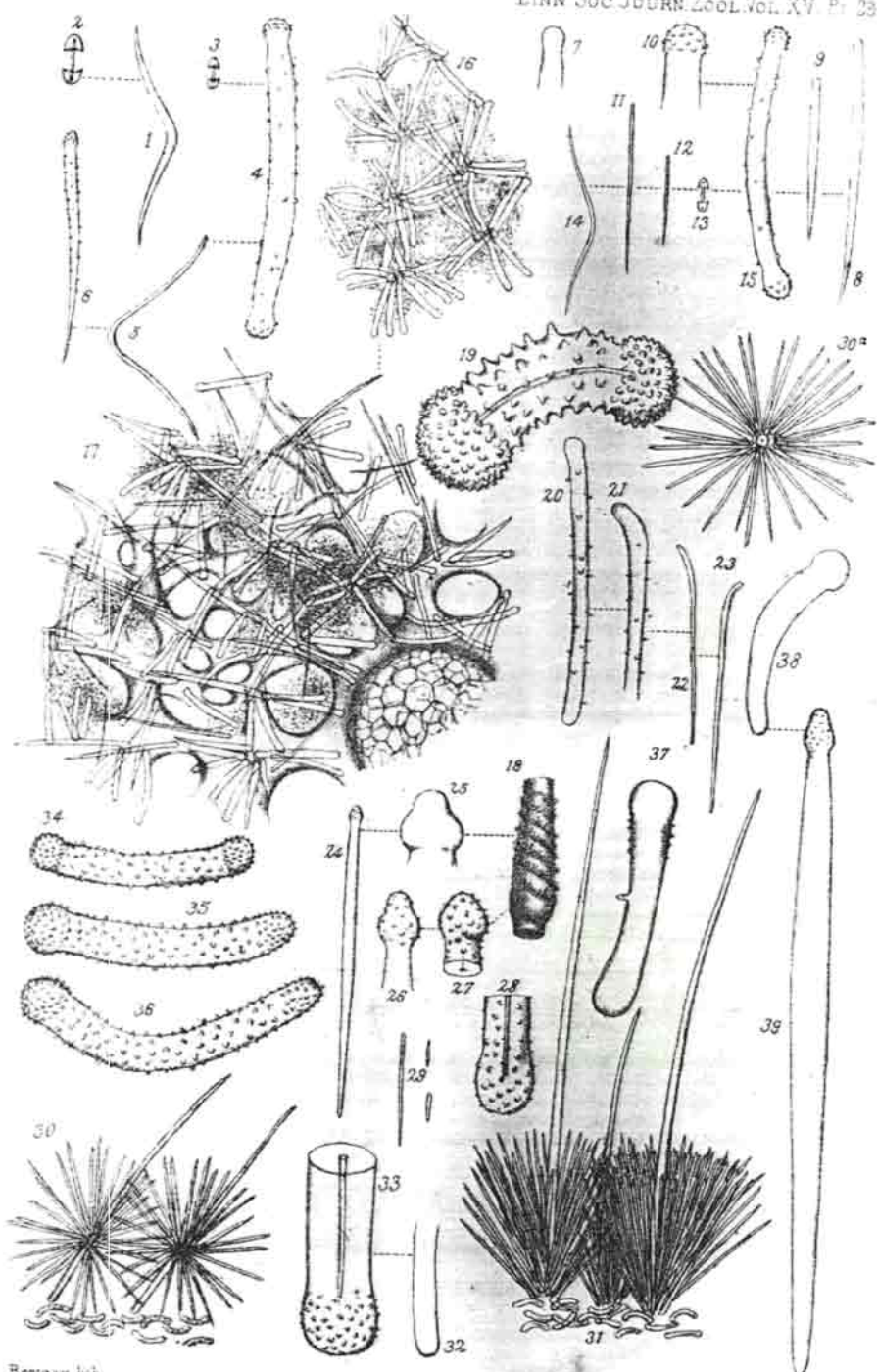
- Figs. 1 & 2. *Dirrhopalum gymnazon*. 1. Tricurvate flesh-spicule, $\times 370$ diam. 2. Equianchorate flesh-spicule, $\times 370$ diam.
- 3-7. *Dirrhopalum coriaceum*. 3. Equianchorate flesh-spicule, $\times 370$ diam. 4. Dumbbell spicule, $\times 370$ diam. 5. Tricurvate flesh-spicule, $\times 185$ diam. 6. Smaller (spined) acute spicule, $\times 185$ diam. 7. Head of larger (smooth) acute, $\times 370$ diam.
- 8-17. *Dirrhopalum novizelandicum*. 8. Large skeleton acute (no. 1), $\times 68$ diam.? 9. Smaller skeleton acute (no. 2), $\times 68$ diam. 10. The same, head, $\times 370$ diam. 11 & 12. Fine spinulates of flesh (no. 4), $\times 68$ diam. 13. Equianchorate flesh-spicule, $\times 370$ diam. 14. Tricurvate flesh-spicule, $\times 370$ diam. 15. Dumbbell spicule, $\times 370$ diam. 16. Portion of surface, $\times 30$ diam. 17. Section across long axis of sponge, $\times 30$ diam.
- 18-30a. *Dirrhopalum Carteri*. 18. The sponge, around portion of an *Echinus*-spine, nat. size. 19. Curved cylindrical, globose-headed, entirely-spined axial spicule, magnified. 20. Cylindrical straight spinulate, magnified. 21. Cylindrical curved spinulate, magnified. 22 & 23. Small cylindrical curved spicules, magnified. 24. Ovispinulate subfusiform whorl-spicule, magnified. 25-27. Different forms of head of 24, more highly magnified. 28. Base of the large acute, magnified. 29. Three minute cylindrical derm-spicules, magnified. 30. Diagram of the position of the spicules 19, 24, 28. 30a. A whorl of spicules round a large acute one, which is seen in section, magnified.
- 31-39. *Dirrhopalum hystrix*, magnified. 31. Diagram of the position of the spicules. 32 & 33. Base of long acute, magnified, showing a plain ending and terminal spinulation respectively. 34. Curved dirrhopalate spicule, magnified. 35. Curved cylindrical spicule, magnified. 36. Spicule with an irregular bend, and only one globose end, magnified. 37. Curved cylindrical bent spicule with large spinule on it, magnified. 38. Spicule with an irregular bend and only one globose end, magnified. 39. Enormispinulate, magnified.



Berjean lith

1-6 *ECHINODICTYUM BILAMELLATUM*.
7-10 *E. NERVOSUM*.

Hanhart imp



Berjeau lith

STRUCTURAL DETAILS SPECIES OF DIRRHOPALUM.
 (=PLOCAMIA, *vs. Schmitt*)

Hanhart imp