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ECHINODERMATA.

By HUBERT LYMAN CLARK.

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(Plates xlvii.-lviii.)

The collection of Echinoderms made by the "Thetis" is not very extensive, containing, as it does, only eight hundred and seventy-five specimens, representing fifty-four species, with five hundred and forty-eight of the specimens belonging to four species. In spite of the small size of the collection it is of great scientific interest, not merely because eighteen of the species have not hitherto been described, but also because of the new light which it throws on the breeding habits of some species and the distribution of certain genera. The specimens sent me represent only twenty-five stations of the fifty-nine occupied by the "Thetis"; there are, however, in addition, forty-two specimens from Lord Howe Island, representing thirteen species, and a few labelled "near Sydney," "Barrenjoey," or "off Broken Bay." The stations which revealed the richest Echinoderm fauna (aside from Lord Howe Island) were 57, off Wata Mooli, 54-59 fathoms, where nine species were taken; 13, off Cape Three Points, 41-50 fathoms, where nine species occurred; and 48, off Wollongong, 55-56 fathoms, where eight species were found. At stations 10, 36, 44 and 54, five or more species were collected.

The specimens from Lord Howe Island are of particular interest, because when considered in the light of previous knowledge they furnish us with a fair idea of the Echinoderm fauna of that isolated islet. In 1887 the Trustees of the Australian Museum sent a party to Lord Howe Island for the purpose of extending our knowledge of its geology and zoology. In Mr. R. Etheridge's (junior) report on "The General Zoology of Lord Howe Island,"<sup>1</sup> which was based chiefly upon the work of this party, of which he was a member, the following Echinoderms are recorded from the island.<sup>2</sup>

*Asterias calamaria*, Gray.

*Asterina exigua*, Lamk.

*Ophidiaster germani*, Per.

*Patiria crassa*, Gray.

*Ophiocoma breviceps*, Peters.

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<sup>1</sup> Etheridge—Austr. Mus. Mem. ii., 1, No. 1, 1889, pp. 36-39.

<sup>2</sup>The names are reprinted here exactly as they are given, regardless of typographical errors.

*Ophiocoma crenacea*, M. and T.  
*Phyllacanthus*, perhaps *baculosa*, Lamk.  
*Centrostephanus Rodgersii*, A. Agass.  
*Echinometra lucunter*, Leske.  
*Strongylocentrotus tuberculatus*, Lamk.  
*Echinostrephus molare*, A. Agas.  
*Tripneustes angulosus*, Leske.  
*Echinoneus cyclostomus*, Leske.  
*Breynia australasiae*, Leach.  
*Holothuria*, "probably allied to the 'milk-fish.'"  
 "perhaps" *Holothuria vagabunda*, Selenka.  
*Stichopus chloronotus*, Brandt.  
*Cucumaria*, "of a pale straw-yellow."

While the "Thetis" collection does not actually add to this list, it does throw light on some of the doubtful species. Thus, the *Holothurian* referred to as "allied to the milk-fish," is probably *H. difficilis*, Semper; while the "*Stichopus chloronotus*, Brandt," is probably *H. macleari*, Bell; and the "perhaps *Holothuria vagabunda*, Selenka," is probably *H. fusco-cinerea*, Jäger. The reasons for each of these identifications will be given under the various "Thetis" species. Of the *Ophiurans* given above, each is so unfortunate as to have its name misprinted, *Ophiocoma brevipes* and *erinaceus* being intended. The former was taken by the "Thetis," but the common species of *Ophiuran* appears to be *Ophiocoma scolopendrina*, Lamk. Whether *erinacea* is really distinct from the latter is still a debatable question, but granting that it is, none of the specimens from Lord Howe Island before me are to be referred to that form. As for the *Echini*, there seems to be no revision of the list necessary, save for the change of two names. Loven in his "Echinoidea described by Linnæus"<sup>3</sup> has shown that the Indo-Pacific *Echinometra* should be called *mathæi*, and the *Tripneustes* from the same region, *gratilla*. Of the star-fishes, "*Patiria crassa*" appears to be, without doubt, the new species of *Henricia* brought back by the "Thetis." There is some reason for doubting whether the *Ophidiaster* from Lord Howe Island is really identical with *germani*, Perrier, but until more material is available it may well be left under that name. There can be little doubt that further collecting will reveal other species of *Ophiurans* and *Holothurians*, but the species of *Echinoderms* now known to occur at Lord Howe Island number eighteen, as follows:—

*Asterina exigua* (Lamk.). Common under rocks.

\**Ophidiaster germani*, Perrier. Rather uncommon.

<sup>3</sup> Loven—Bih. K. Svenska Vet.-Akad. Handl., xiii., Afd. 4, No. 5, 1887.

\* Collected by the "Thetis."

- \**Henricia heteractis*, sp. nov. Apparently not rare.
- \**Coscinasterias calamaria* (Gray). Very common.
- \**Ophiocoma brevipes*, Peters. Not uncommon.
- \**Ophiocoma scolopendrina* (Lamk.). Common; *O. erinacea*, M. & T., may occur with it.
- Phyllacanthus*, sp.? Apparently rare.
- \**Centrostephanus rogersii* (A. Ag.). Not uncommon.
- \**Echinometra mathaei* (Bl.). Very common.
- \**Strongylocentrotus tuberculatus* (Lamk.). Common.
- Echinostrephus molaris* (Bl.). Of very doubtful occurrence.
- \**Tripneustes gratilla* (L.). Not uncommon.
- Echinoneus cyclostomus* (Leske). Apparently not common.
- \**Breynia australasica* (Leach). Abundant in the lagoon.
- \**Holothuria difficilis*, Semper. Common.
- \**Holothuria fusco-cinerea*, Jäger. Common.
- \**Holothuria macleari*, Bell. Rather common.
- Cucumaria*, sp.? Apparently rare.

It would be interesting to give here a similar revised list of the Echinoderms of New South Wales, but as the "Thetis" collection contains only twenty-five of the considerably more than one hundred species previously known from that region, it would be presumptuous to attempt it with the material which is available to me at the present time.

The following are the new species described in this report. The one marked with an asterisk is not from the "Thetis" collection, but its relationship to one of the "Thetis" species is so close it was necessary to name it in order to refer to it for comparison. The type-specimen is in the collection of the Museum of Comparative Zoölogy at Cambridge, Mass. The types of all the other species are in the Australian Museum, but, except in the case of those species marked with a dagger, co-types are deposited in the M. C. Z. collection :—

- Oligometra thetidis*.
- Himerometra paedophora*.
- Henricia heteractis*.
- Coscinasterias dubia*.
- Pectinura dyscrita*.
- Ophiozona gymnopora*.
- Ophiura ctenophora*.
- Amphipholis australiana*.
- \**Amphipholis laevidiscus*, Chili, "Hassler" Expedition.
- Ophiacantha heterotyla*.
- †*Ophiopristis axiologus*.
- Ophiothrix acestra*.

† *Astroporpa australiensis*.

† *ASTROTHROMBUS* (gen. nov.) *rugosus*.

*Conocladus amblyconus*.

*Chaetodiadema tuberculatum*.

*Fibularia nutriens*.

*Molpadia dissimilis*.

*Molpadia productamensis*.

The study of this collection has been most interesting, and I desire to express here my thanks to the Trustees of the Australian Museum for the honour they have done me in entrusting it to my care. I wish, further, to express my great obligation to Mr. Etheridge for his constant courtesy, which has made possible the publication of the report in so short a time and so satisfactory a manner, in spite of the great distance that has separated us. I take pleasure also in acknowledging the patience and skill with which Miss Dandridge has succeeded in making accurate drawings of the Ophiurans, many of which were either so small or so badly broken, that good figures seemed almost impossible.

#### CRINOIDEA.

Although there are only three species of Crinoid represented in the collection, two of these appear to have been hitherto undescribed, and both are of rather more than usual interest. Mr. Austin Hobart Clark kindly examined much of the material and assisted in its identification, and I wish to express here my thanks to him for this aid and for many helpful suggestions. I have also followed the guidance of his published papers in writing my descriptions, in order that mine should be uniform with his. I have adopted his recently proposed genera without hesitation, not merely because his unusually extensive knowledge of the class justifies such a course, but because his classification appeals to me, on the whole, as being very natural. I regret to add that we do not agree on the status of *Himerometra pædophora*.

#### OLIGOMETRA THETIDIS,<sup>4</sup> sp. nov.

(Plate xlvii., figs. 1, 2, 3.)

Centro-dorsal small, low hemispherical, nearly concealed by two marginal rows of cirri; these (Pl. xlvii., fig. 3) are about sixteen in number, 7-8 mm. long, with fifteen-eighteen joints besides the claw; basal joints wider than long, but distally they are squarish; each

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<sup>4</sup> *Thetidis* = of the "Thetis."

one, beginning with the fourth, has, at middle of dorsal side, a transverse ridge, which in side-view looks like a spine, that of the terminal joint being distinctly the largest, but even here not nearly equalling thickness of joint; on basal joints dorsal ridge somewhat serrulate, while distal margin of joint projects as a more or less evident second ridge; in consequence of this arrangement, the dorsal side of some joints, notably fifth-eighth, appears as though provided with two low spines, one nearly at middle and one distal; terminal claw, usually sharp, curved and scarcely as long as penultimate joint. Radials plainly visible, but short; first costals oblong, fully twice as wide as long, in apposition and slightly flattened on proximal half of lateral edges; costal axillaries pentagonal, much wider than long. Ten arms, rather more than 25 mm. long; first brachials nearly oblong, much wider than long, more or less in contact proximally, outer side somewhat longer than inner; second brachial similar, but relatively longer; third and fourth brachials taken together as long as wide, squarish; fifth and sixth decidedly wider than long; the following nine or ten more or less wedge-shaped, but succeeding ones rather irregular; on distal part of arm the most distal portion of the distal edge of each brachial tends to project, though not sufficiently to be called a spine or even a tubercle. Syzygia occur between the third and fourth, and between the sixth and seventh, or rarely seventh and eighth brachials, and then at intervals of three oblique muscular articulations. First pinnule (Pl. xlvii., fig. 1) nearly 6 mm. long, with ten-twelve joints, the first about as long as wide, second a little longer, third twice as long as wide, fourth and fifth about the same, the succeeding gradually decreasing in length, so that the minute terminal joint is scarcely longer than thick; all the joints are semi-cylindrical, smooth, furrowed on the inner face; second and third pinnules shorter, with only seven or eight joints, but otherwise similar; succeeding pinnules somewhat longer, those at middle of arm (Pl. xlvii., fig. 2) with as many as fifteen joints, of which the third, fourth and fifth are flattened and have conspicuously flaring margins; distal pinnules all somewhat broken. Sacculi more or less abundant, especially in distal pinnules. Colour, in alcohol, cream-colour, sometimes uniform, but usually with more or less distinct markings of purple; very rarely the entire animal is dull purplish, lightest towards the tips of the arms.

Fifteen specimens from Station 48. Off Wollongong, 55-56 fathoms; sand and mud to rock.

This species is closely allied to *adeonæ*, Lamk., and *bidens*, Bell, but seems to be distinguished from either by the characteristic expansion of the genital pinnules. It differs from *adeonæ*, further, in its smaller size, shorter first pinnules, and fewer cirri with

fewer joints; the latter also appear to be rougher on the dorsal side. It differs from *bidens*, moreover, in the complete absence of the tubercles on the costals and lower brachials, in having a syzygy in the sixth or seventh brachial (though this is of little importance), and in somewhat different lower pinnules. Unfortunately, there is some uncertainty about the pinnules of *bidens*, as described by Bell<sup>5</sup>; he says the first one has "some twelve joints," with "the most proximal joint the longest," while the figure given shows fourteen joints, the third and fourth decidedly the longest. In view of our imperfect view of *adeonæ*, and the obvious resemblance between that species and both *bidens* and *thetidis*, it seems to me quite possible that more abundant material will show that the three names belong to a single species.

#### HIMEROMETRA PÆDOPHORA,<sup>6</sup> sp. nov.

(Plate xlvii., figs. 4-10.)

Centro-dorsal small, discoidal, carrying only a single series of cirri, of which there are only ten-fifteen; these (Pl. xlvii., fig. 10) are about 10 mm. long, with twenty-five-thirty-five (usually twenty-eight-thirty) joints; first four basal joints wider than long, but all succeeding joints about as long as wide; joints all smooth or nearly so, until near tip of cirrus, where a slight longitudinal keel is barely developed on dorsal side of each joint; in some cases this keel gives rise to a slight spine, but even on penultimate joint no conspicuous spine is found; terminal claw short and blunt. Radials barely visible; costals not at all swollen or peculiar in any way; first costals much wider than long, narrower proximally than distally, perfectly smooth, and distinctly separated from each other; costal axillaries smooth, much wider than long, with lateral edges very short, and distal edges slightly concave. Ten arms, 17-19 mm. long; first brachials wider than long, outer edge somewhat longer than inner, which touch each other at least proximally; second brachials similar, but distal margin not so straight; third and fourth brachials equal, discoidal, united by syzygy, the two together about as long as wide; succeeding joints more or less oblong, the outer and inner sides usually slightly differing in length. Syzygia occur between the third and fourth, seventh and eighth, eleventh and twelfth

<sup>5</sup> Bell—Zool. Rep. "Alert" 1884, p. 158, pl. xi., fig. A b. See also Döderlein, 1898, in Semon's Zool. Forsch. Austr. v., 4, p. 476, pl. xxxvi., figs. 3-3d.

<sup>6</sup>  $\pi\acute{\alpha}\iota\varsigma$ =child +  $\phi\omicron\rho\acute{\epsilon}\omega$ =to carry, in reference to the carrying of the pentacrinoid larvæ, on the pinnules.

(rarely tenth and eleventh), and subsequently at intervals of two, or more commonly one, oblique muscular articulations. All the brachials are smooth and rounded dorsally, and not only do the plates not overlap, but they are scarcely in contact (except at syzygies, of course). Pinnules rather few, twelve-fifteen on each side of an arm, widely spaced, owing to length of arm-joints and frequent syzygies. First pinnule (Pl. xlvii., fig. 4) stout, borne on second brachial, 2-3 mm. long, of seven joints, which are smooth and semi-cylindrical; first two about as wide as long, third, fourth and fifth longer than wide; terminal joint minute, blunt. Second pinnule (Pl. xlvii., fig. 5) borne on fourth (epizygal) brachial, very short, about a millimeter long, of only four joints; succeeding pinnules (Pl. xlvii., fig. 6) less stout, with eight-fourteen joints, the basal ones large but only a little expanded laterally. Sacculi abundant and large, especially in distal pinnules; very few on disc. When dry, the disc shows many small calcareous plates, largest and most conspicuous beside the ambulacral furrows and around the base of the anal tube, which is about as long as half the diameter of the disc, or longer. The oral surface of arms and pinnules seem to be free from plates. Colour of skeleton, very light brown; of soft parts and sacculi, very dark brown; terminal half of cirri with more or fewer of the joints marked dorsally, or strongly tinged with purple.

Twenty-three specimens from Station 28. Off Manning River, 22 fathoms; fine grey sand.

All of the individuals of this species were found tightly clinging by their cirri to the pinnules and cirri of the larger specimens of *Pt. macronema*, of which species they were, at first, supposed to be the young. One specimen of *macronema* carried no less than seven individuals. While it is quite possible that the entanglement took place in the dredge, the appearance of the specimens indicates that the smaller species lives symbiotically with the larger. Mr. A. H. Clark<sup>7</sup> has reported a somewhat similar association of a *Heliopecten* (*H. brachymera*, A.H.C.) with a much larger species (*H. eschrichtii maxima*, A.H.C.) of the same genus in the Sea of Japan. More remarkable than this association with *macronema* is the fact that all the larger specimens of *pædophora* carry pentacrinoid larvæ attached to their pinnules; the type-specimen bore no less than twenty-four such young. The youngest stage observed (Pl. xlvii., fig. 7) has a short, rather fleshy stalk, with a large attaching disc at one end, and the somewhat ellipsoidal body at the other; at this stage the joints of the stalk appear as more or less discoidal plates, while the body-wall

<sup>7</sup> Clark—Proc. U. S. Nat. Mus., xxxiii., 1907, p. 76.

contains ten large plates, five orals and five basals; no radial plates are visible. In a specimen a trifle older the radials have arisen in the space bounded by two oral and two basal plates, and the stem-joints are not so discoidal. At a still later stage (Pl. xlvii., fig. 8) the radials are conspicuous, though the orals and basals are equally prominent, the first costal and the costal axillary appear as rather elongated plates, and the arms consist of two or three joints; the stem, which is relatively far more slender than at the earlier stage, consists of ten-twelve joints, of which the middle ones are longer than wide, and are encircled at the mid-zone by a conspicuous ridge, a possible indication of a circle of cirri in some ancestral form. A similar ridge occurs on the stem-joints of *Metacrinus cingulatus* (and other species of the genus), where it appears to be purely ornamental. The older stages (Pl. xlvii., fig. 9) have the stem and attaching disc of approximately the same actual size, as earlier, and therefore relatively much smaller; the stem-joints have lost the encircling ridge and are practically smooth; the basals are relatively small, but the orals are still conspicuous; the cirri have begun to appear on the margin of the centro-dorsal; they have a variable number of joints, of course; and are very erect, parallel with the arms; the latter have elongated and the brachials are well defined; no syzygies are to be found, but the third and fourth plates appear to be somewhat closer together than the others. In the earliest free-swimming stage which I have found, the arms are about 7 mm. long, and have about nine pinnules on each side; distinct syzygies are present between brachials three and four, seven and eight, and eleven and twelve, but in the remaining sixteen-eighteen joints syzygies have not yet developed; the first pinnule has only four or five joints, but is somewhat stouter than the succeeding; there are six cirri, each with about thirty joints. Basal plates can no longer be distinguished, and the oral plates are reduced to a few large irregular fragments in each interradius of the disc. The transition from this stage to the adult condition is obvious.

I have placed this interesting species in the genus *Himero-metra*, only after considerable hesitation on account of its small size, the absence of any swelling or convexity on the costals, and the very small number of cirri. It resembles *Oligometra* in many respects, but the large number of cirrus-joints distinguishes it from the species of that genus. It has seemed to me better to include it in the large and somewhat heterogeneous group, *Himero-metra*, rather than to modify the definition of a smaller, natural genus like *Oligometra*.

It might be thought that we have here simply a young form of *Ptilometra*, especially as these specimens occur only with the adults of that genus. Fortunately, however, there are young

specimens of *Ptilometra* in the collection as small as the larger specimens of *pædophora*, and it is possible, therefore, to show that the two are not even nearly allied forms; the conical centrodorsal, the long cirri and the crowded prismatic pinnules distinguish the *Ptilometras* at a glance. Moreover it should be noted that pentacrinoid larvæ were not present on the pinnules of any undoubted *Pt. macronema*, even among those from Station 28. It is difficult for me to believe that the smallest *Ptilometras*, too young to have assumed any of their characteristic generic or specific features, should be the only ones which are breeding. In conclusion, I can only say that while I am perfectly sure these Comatulids are not *Ptilometras*, I am very much in doubt as to their real systematic position. I think it most unlikely that they are really *Himerometras*, but I do feel reasonably sure that they belong in the family *Himerometridæ*.

#### PTILOMETRA MACRONEMA.

*Comatula macronema*, J. Müller, K. Akad. Berlin Monatsb., 1846, p. 179.

*Ptilometra macronema*, A. H. Clark, Smithson. Misc. Coll., 1907, (Quarterly Issue), L, 3, p. 358.

4 specimens from Station 10. Off Broken Head, 28 fathoms; fine sand.

14 specimens from Station 12. Off Cape Three Points, 23-34 fathoms; sand.

26 specimens from Station 28. Off Manning River, 22 fathoms; fine grey sand.

11 specimens from Station ?

The smallest of these specimens has the ten arms only 16 mm. long, but nevertheless shows the adult specific characters fairly well; the centrodorsal is markedly conical, the ten cirri have each about forty joints and the pinnules are decidedly prismatic. In the largest specimen, there are eighteen arms which are 60 mm. long, and the cirri have over seventy joints. The colour of all the specimens is brown, but the shade varies considerably, some individuals being decidedly purplish, while others are yellowish, or more rarely somewhat reddish.

#### ASTEROIDEA.

The fifty starfishes in the collection represent but nine species, of which only two have previously escaped description, the others being for the most part well-known forms. Aside from the new *Henricia*, the collection throws no light on the question of distribution, and it contributes nothing to our knowledge of the natural history of any of the species, except the changes due to growth in one of the common *Astropectens* of New South Wales.

## ASTROPECTEN PECTINATUS.

(Plate xlviii.)

*Astropecten pectinatus*, Sladen, Journ. Linn. Soc., Zool., 1883, xvii., p. 251.

1 specimen from Station 21. Newcastle Bight, 28-40 fathoms; fine grey sand.

7 specimens from Station 25. Off Newcastle, 42-48 fathoms; soft mud.

1 specimen from Station 36. Off Botany Bay, 20-23 fathoms; sand to rock.

1 specimen from Station 41. Off Wata Mooli, 52-71 fathoms; soft mud.

1 specimen from Station 52. In Shoalhaven Bight, 19-20 fathoms; sand to mud.

5 specimens from "off Broken Bay" (? Station 13).

This series of specimens, ranging in diameter from 55 to 175 mm., is of particular interest, because it shows that the specimens upon which Sladen based his species were only half grown and that the fully grown individuals (Pl. xlviii., figs. 1-2) are so different, they have long passed under another name. In the small specimens,  $R=3.5r$ ; in specimens with  $R=60-80$  mm.,  $R=4.4.5r$ ; and in large specimens,  $R$  equalling about 100 mm.,  $R=5r$ . Moreover, in young specimens the rays taper to quite a slender point, while in the adult they are proportionately much wider at the tip. In the adults also the outer spine of the series on each inframarginal plate is greatly enlarged and much more conspicuous than in the young. In consequence of these changes, the general facies of the adult is entirely different from that of the young, and if one compares an adult specimen with Sladen's<sup>8</sup> figures, it seems incredible that the two are really the same species.

This seems to be a common species in water of moderate depth off the coast of New South Wales, and the adult specimens were identified, twenty years ago, by Mr. Thomas Whitelegge<sup>9</sup> as *Astropecten triseriatus* M. & T. As they do not have three series of spines (or tubercles) on the superomarginal plates, they cannot be that species, and it is fortunate that the "Thetis" collection enables us to determine what they really are. Specimens labelled "*Astropecten triseriatus*, M. & T." have been sent out in exchange by the Australian Museum, and it is therefore important to call

<sup>8</sup> Sladen—Chall. Report, Zool., xxx., 1889, Pl. xxxiii., figs. 3-4.

<sup>9</sup> Whitelegge—Journ. Roy. Soc. N.S. Wales, xxiii., 1889, p. 200.

attention here to the fact that they are really *A. pectinatus* Sladen. Aside from the differences between young and old, Sladen's description answers very well even for very large specimens. It may be mentioned, however, that the adambulacral armature even in small specimens, often has four and rarely five spines in one or more of the three rows of which it is composed. All of the specimens before me are light brown, but there is no clue as to what the colour may have been in life.

#### LUIDIA FORFICIFER.

*Luidia forficifer*, Sladen, Chall. Report, Zool., xxx., 1889, p. 258.

One specimen from Station 21. Newcastle Bight, 28-40 fathoms; fine grey sand.

This specimen, 125 mm. in diameter, ashy-grey in colour, shows no important differences from Sladen's description.

#### LUIDIA MACULATA.

*Luidia maculata*, Müller and Troschel, Syst. der Ast., 1842, p. 77.

Three magnificent specimens of this species, without any indication of locality, are in the collection. They are handsomely variegated with dull black and yellow, and each has seven arms. In the largest,  $R=250$  mm.

#### NECTRIA OCELLIFERA.

*Asterias ocellifera*, Lamarck, Anim. sans Vert., ii., 1816, p. 553.

*Nectria oculifera* (sic) Gray, Ann. Mag. Nat. Hist. vi., 1840, p. 287.

*Nectria ocellifera*, Dujardin et Hupé, Echinodermes, 1862, p. 406.

One specimen from Station 56. Off Botany Bay, 79-80 fathoms; sand and stones.

One specimen from Station ?

Both of these specimens are very fine adults, with  $R=130$  mm. Their colour is dark brown.

#### OPHIDIASTER GERMANI.

*Ophidiaster germani*, Perrier, Arch. Zool. Exp., iv., 1875, p. 394.

One specimen. Lord Howe Island.

This specimen is very pale fawn-colour, and has  $R=67$  mm. I refer it with some hesitation to Perrier's species, for while it answers well to his description, it has one character, not men-

tioned by him, which is so conspicuous he could hardly have overlooked it had it been present in his specimens; the first fourteen-sixteen large adambulacral spines of the outer series, beginning at the mouth, are so closely arranged that the distance between two is far less than the diameter of one, while the remainder are widely spaced, the distance between two greatly exceeding the diameter of one; the transition from the crowded to the open arrangement is abrupt and marked. Should this prove to be a constant character in the Ophidiasters from Lord Howe Island, it would probably entitle them to full specific rank. But it is possible it is only an individual peculiarity of the specimen before me.

### HENRICIA HETERACTIS,<sup>10</sup> sp. nov.

(Plate xlix., figs. 1 and 2.)

Rays 7 (in two smaller specimens 6).  $R=25$  mm.,  $r=8$  mm.,  $R=3r$ . Interbranchial arcs acute. Rays more or less cylindrical, stout and very blunt. Breadth at base, 7.5 mm. Disc rather large; vertical diameter, 7 mm. Plates of abactinal skeleton stout and crowded, more or less crescentic, with the concave side towards the centre of the disc. Along the sides of the rays, especially near tip, a more or less distinct, longitudinal arrangement can be seen. Papular areas reduced to a minimum, each with a single rather large papula. Spinelets very numerous on all the abactinal plates, minute and very slender; in the interbranchial arcs the spinelets are longer and less crowded. Actinal surface of rays flattened, closely covered by three or four longitudinal series of squarish plates on either side, each bearing a dense covering of minute spinelets, only a little larger than those of the abactinal surface. Adambulacral armature (Pl. xlix., fig. 1) consists of a marginal series of five or six spines, more or less connected by a membrane, the middle one or two about 1 mm. long and decidedly longer and stouter than the others; the aboral and adoral ones the smallest. Just outside, and close to this marginal series is another very similar set of four or five spines; these are a trifle shorter but fully as stout, and are hardly as much united to each other by a membrane. The adambulacral plates are well spaced, and their adoral and aboral margins bear a few small spinelets which may form a continuous series with the outer marginal series. The surface of the plate carries from one to four short, sharp spines. *There is no furrow spine.* Oral

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<sup>10</sup> ἑτερος=other than usual + ἀκτίς=a ray, in reference to the number of rays.

plates each with four large marginal spines, the innermost the largest. Madreporic plates, in type specimen, present in each interradius, of very irregular form and size. In the other specimens, however, only a single, very small, somewhat triangular madreporic plate was found. Colour in alcohol, and dry, light brown. Under a magnification of seventy diameters, all the spines and spinelets are found to be very thorny at the tip.

Five specimens. Lord Howe Island.

In the type specimen, which is the largest, the seven rays are only slightly unequal, and in a second, much smaller, specimen there are six nearly equal rays. In the other specimens, however, there is great diversity in the relative size of the rays; one has two large and four smaller rays, a second has four large and three very much smaller rays, and the third has four large and three very minute rays, which are only visible actinally. These last two specimens would seem to show that this *Henricia*, like some species of *Stichaster*, reproduces by fission, for in both cases the large and small rays form separate groups on opposite sides of the animal.

There can be no doubt, I think, that this is the starfish referred to by Etheridge<sup>1</sup> as "*Patiria crassa*, Gray," which he describes as "somewhat solariform, with six or seven rays, and grey in colour." The known species of *Patiria* have only five rays, and they are structurally quite different from this species from Lord Howe Island. In all essentials this form is a typical *Henricia* except in the complete absence of a furrow spine. In this particular it agrees with the nearly related *Perknaster*, Sladen, but its general facies is utterly unlike the species of that genus. It does not seem to me advisable, however, to base a new genus upon this character (or perhaps more properly, lack of character), even though it is combined with an unusual number of rays. It is interesting to note that while four species of *Henricia* (each having five rays and furrow spines) are known from the New Zealand region, the genus has not hitherto been reported from Australian waters.

#### COSCINASTERIAS CALAMARIA.

*Asterias calamaria*, Gray, Ann. Mag. Nat. Hist., vi., 1840, p. 179.  
*Coscinasterias muricata*, Verrill, Trans. Conn. Acad. i., 2, 1867.  
 p. 248.

*Coscinasterias calamaria*, Perrier, Exp. "Trav." et "Tal." Echinod., 1894, p. 106.

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<sup>1</sup> Etheridge—Austr. Mus. Mem., ii., 1, No. 1, 1889, p. 39.

3 specimens from near Sydney.

2 specimens from Lord Howe Island.

It is interesting to note that while the specimens from near Sydney have eleven rays each, those from Lord Howe Island have only seven. It would be much more interesting to know what the average number is for each locality and what degree of variation is shown. This would afford an admirable subject for a biometrical investigation.

COSCINASTERIAS DUBIA,<sup>12</sup> sp. nov.

(Plate xlix, figs. 3 and 4; pl. 1.)

Rays 5.  $R=83$  mm.,  $r=16$  mm.,  $R=5r$ . Interbranchial arcs acute. Rays somewhat flattened (markedly so in dried specimens), with sides vertical and actinal surface sharply marked off. Breadth of ray near base, 20 mm. Disc moderate or small vertical diameter, 9 mm. Rays slightly constricted where they join disc. Whole abactinal surface provided with conspicuous slender spines, 3-5 mm. high, each surrounded at its base with a dense wreath of minute pedicellariæ. There are about twenty of these spines on the disc, where they are smaller than those on the rays. The latter are arranged in five fairly regular longitudinal series, the median one containing about thirty spines, the marginal about twenty each, and the intermediate about ten each. Abactinal skeleton rather stout, with relatively small spaces, each showing about half-a-dozen papulæ or fewer. At base of arms and on disc, scattered irregularly among the spines, are large solitary pedicellariæ (Pl. xlix., fig. 2) about 2 mm. long. Similar pedicellariæ, but scarcely half so large, occur on many of the wreaths of minute pedicellariæ surrounding the spines (Pl. xlix., fig. 3). Adambulacral armature consists of two more or less cylindrical spines about 3 mm. long, standing one directly outside the other, so that two very distinct rows of adambulacral spines are conspicuous. Near the mouth, these spines are larger and are decidedly flattened at tip. Actinal surface of ray, outside of adambulacral armature, more or less covered by three series of spines, so arranged as to form oblique rows of two or three each, of which the marginal is decidedly the largest and most adoral. These marginal spines are about 5 mm. long, and for fully half their length are united to each other by a membrane, which thus forms a conspicuous marginal fringe to the actinal surface of the ray. Each spine is very much flattened and widened at the tip

<sup>12</sup> *dubia*=doubtful, in reference to the close resemblance to *Asterias eustyla*.

and deeply furrowed on the actinal side. A large cluster of pedicellariæ covers about one half of the upper side of each spine; these clusters spread somewhat on to the membrane between the spines, but scarcely extend on to the actinal side. The series of spines just below the marginal fringe is placed close to the latter, but the spines are somewhat shorter and more slender, are not connected with each other by any membrane, and carry no pedicellariæ. The third series of spines does not begin quite so near the base of the ray as the other two, and extends only to within 15 or 20 mm. of the tip. These spines are decidedly smaller than those of the second and marginal series, but are much stouter than the adambulacral spines. They are much less numerous than the latter, however, for at the middle of the ray there are three adambulacral spines to each one of the third actinal series. Oral plates, each with two marginal spines at the inner end, of which the inner one is much the larger. A still larger superoral spine is present on each plate, and there are also two or three very large but slender pedicellariæ at the inner end. Madreporic plate 3 mm. in diameter, free from spines, situated nearer the margin than the centre of the disc. Colour of alcoholic, and dry, specimens deep yellowish-brown.

3 specimens from Station 36. Off Botany Bay, 20-23 fathoms; sand to rock.

1 specimen from Station 44. Off Coogee, 49-50 fathoms; fine sand.

10 specimens from Station ?

This species is surprisingly near *Asterias eustyla*, Sladen, known only from the vicinity of Tristan da Cunha. In a specimen of *dubia* of the same size as the only known specimen of *eustyla* ( $R=60$  mm.), the following differences are obvious: the rays of *dubia* are much broader and the disc larger than in *eustyla*,  $r=11$  instead of 7 mm. and  $br.=13$  mm. instead of 8 or 9; there are in *dubia* only two series of inferomarginal spines, which are much flattened and with a deep longitudinal furrow on the actinal side, and there is a considerable space between these spines and the adambulacral series, while in *eustyla* there are three series of spines, only slightly flattened and not furrowed, and closely crowded against the adambulacral series; finally, the adambulacral spines are longer and the large forciform pedicellariæ are more numerous in *dubia* than in *eustyla*. From *Asterias mollis*, Hutton, of New Zealand, *dubia* may be at once distinguished by the blunt and only slightly tapering rays, the much heavier skeleton, the much larger wreaths of pedicellariæ, the much larger but more slender forciform pedicellariæ and the more numerous inframarginal spines; the general facies of the two forms is thus

quite different, at least so far as one can judge from Museum specimens. It seems somewhat strange that such a large and apparently common starfish should have escaped notice hitherto, but it is quite possible that specimens have been regarded as 5-rayed examples of *calamaria*, the superficial resemblance to that species being quite obvious. But *dubia* is markedly "dipacanthid" in its adambulacral armature, not "monacanthid" as is *calamaria*; if one considers the feature of generic value, *dubia* belongs to Perrier's genus "Distolasterias." For my part, I do not consider the character either important enough in itself, or sufficiently reliable in all cases, to warrant the recognition of that genus.

#### UNIOPHORA GLOBIFERA.

*Uniophora globifera*, Gray, Ann. Mag. Nat. Hist., vi., 1840, p.288.

Three specimens, without locality.

Aside from the fact that one of the specimens has six rays, they are of no particular interest, as they are not full grown, are rather poorly preserved (dry) and give no indication as to where they were taken.

#### O P H I U R O I D E A .

The large series of Ophiurans, representing nineteen species, is of great interest, not merely because ten species appear to be new, but because some very peculiar facts in distribution are brought to light. Thus the two species of *Ophiocoma* which appear to be common at Lord Howe Island are not represented in the material from the coast of New South Wales, while none of the seventeen species from New South Wales were found at Lord Howe Island. A very remarkable fact is the occurrence in Australian waters, of an *Astroporpa*, a genus known hitherto only from the West Indian region. The collection thus adds very materially to our knowledge of Australian Ophiurans.

#### PECTINURA DYSCRITA,<sup>13</sup> sp. nov.

(Plate xlix., figs. 5, 6, 7.)

Diameter of disc, 10 mm.; length of arm, 45 mm. Disc flat, distinctly pentagonal, completely covered by a coarse granulation, about 125 granules to a square millimeter, at centre, and about 70 at interradial margin; radial shields entirely covered. Upper

<sup>13</sup>δύσκριτος=hard to determine, in reference to the perplexity afforded by this, among other species of *Pectinura*.

arm-plates oblong, with rounded corners, about two-thirds as long as wide. Interbrachial spaces below closely granulated. Oral shields somewhat wider than long, with a nearly straight distal margin, but strongly convex proximally. Adoral plates small and bare. Oral plates concealed by a coarse granulation, about 30-35 granules on each jaw. Oral papillæ about seven on each side, penultimate decidedly largest. Under arm-plates nearly octagonal but with distal angles rounded, a trifle longer than wide; first under arm-plate triangular, much wider than long, without pores between it and second plate. Side arm-plates rather larger, with a strongly convex distal margin, but well separated from each other throughout the whole length of arm; each plate carries six (very rarely seven) spines, of which the lowest is more or less cylindrical and blunt, and about two-thirds as long as joint; the others are a trifle shorter, and are flatter and pointed; the uppermost is clearly the smallest. Tentacle-scales two, the outer decidedly wider than the inner, but, except on basal joints, hardly more than half as long. Colour (dry) very light brown, with a greyish cast on the upper side; under arm-plates and oral shields nearly white; dorsal side of disc and upper arm-plates, indistinctly clouded with purple, and faintly marked with a few very small, round, whitish spots.

1 specimen from Station 42. Off Wata Mooli, 70-78 fathoms; coarse sand.

1 specimen from Station 48. Off Wollongong, 55-56 fathoms; sand and mud to rock.

It is not a little exasperating, after having just completed a careful revision of the genus *Pectinura* and its allies,<sup>14</sup> to find these two specimens, which agree in being unlike any of the previously known species! They are nearly related to *P. assimilis*, Bell, but the smaller number of arm-spines distinguish them from that species at a glance, for in specimens of *assimilis* of the same size as the larger specimen of *dyscrita*, there are at least eight or nine arm-spines on the basal joints. I see no other course open, therefore, than to regard them as representing a previously unknown species.

#### OPHIOZONA GYMNOPORA,<sup>15</sup> sp. nov.

(Plate li., figs. 1-3.)

Diameter of disc, 3 mm.; length of arm, 4 mm. Disc flat, covered by about sixty plates, among which the central dorsal,

<sup>14</sup> Clark—Bull. Mus. Comp. Zool., lii., 1909, pp. 111-132.

<sup>15</sup> γυμνός=naked+πόρος=a way through, a pore, in reference to the absence of the tentacle-scales.

five radial primary plates and ten radial shields are conspicuous. Radial shields much larger than central dorsal plate, decidedly longer than wide, broadly in contact, only the proximal ends being slightly separated by one or two small scales; there is a single interradial marginal plate, wider than long, between each two pairs of radial shields. Upper arm-plates broadly triangular, much wider than long, with convex distal margin and rounded outer corners; somewhat swollen; all, or all but first two or three, separated by side arm-plates. Interbrachial spaces below covered with a rough pavement of very large, coarse granules, in marked contrast to the plates of the upper side. Genital slits wholly wanting. Oral shields wider than long, with straight distal and lateral margins, the latter parallel to each other; proximal margin with an angle inwards. Adoral plates rather large, somewhat swollen, about as wide as long. Oral plates indistinct. Oral papillæ closely fused, apparently two or three on each side and a very large one at apex of jaw. Under arm-plates swollen, about as wide as long, pentagonal with a sharp proximal angle and rounded distal angles, all except first two separated by side arm-plates; first under arm-plate decidedly longer than wide, its outer end wider than inner. Side arm-plates large, swollen, meeting above and below, except at very base of arm; each plate carries two minute, stout, pointed spines, about half as long as joint, or more, the lower the longer. Tentacle-scales, none, except a very minute one on inner distal side of first pore; pores very large. Colour (in alcohol) pale yellowish or whitish.

117 specimens from Station 13. Off Cape Three Points, 41-50 fathoms; sticky mud and shell.

88 specimens from Station 22. Newcastle Bight, 26-40 fathoms; grey sand to mud and shell.

9 specimens from Station 35. Off Port Hacking, 22-38 fathoms; sandy.

10 specimens from Station 38. Off Jibbon, 46-55 fathoms; sand to mud.

95 specimens from Station 57. Off Wata Mooli, 54-59 fathoms; all mud.

This little species, which makes up three-quarters of the collection of Ophiurans, appears to be very common on suitable bottom off the coast of New South Wales. Owing to its small size, it is easily overlooked, and it is not strange that it has escaped observation and description hitherto. There is no other species with which it can be confused, the peculiar covering of the ventral interbrachial spaces, combining with the absence of tentacle-scales to separate it sharply from all other members of the genus, or even of the family.

OPHIURA CTENOPHORA,<sup>16</sup> sp. nov.

(Plate li, figs. 4-6).

Diameter of disc, 13 mm.; length of arm, 33 mm. Disc high, slightly convex, covered by about 100-150 plates, among which the central dorsal, five radial, five interradial, five interradial marginal, and ten radial shields are easily distinguishable. Radial shields broad at outer end, but longer than wide, more or less separated proximally by two or three small plates; in young specimens they are in contact distally, but in some old ones they are separated for their entire length. Upper arm-plates in contact on basal part of arm, but on outer half or third of arm are well separated; first upper arm-plate very broadly triangular, but apparently oblong, slightly swollen, seemingly longer than broad, entirely contained between upper ends of genital plates, which conceal much of it; second plate very short, two or three times as wide as long; third plate also two or three times as wide as long, but with a more or less convex outer margin; fourth plate more or less hexagonal, much wider than long; fifth plate (in adults) also hexagonal, but nearly as long as wide; sixth and following (sometimes as far as thirteenth) plates similar, but inner end becoming narrower; succeeding plates triangular, with a sharp proximal angle and a convex outer margin, becoming very minute at tip of arm. Upper ends of genital plates conspicuous on each side of arm, at base, rounded, very slightly swollen, as wide as or wider than first upper arm-plate; a supplementary genital plate lies between the ventral end of the genital plate and the oral shield; arm-comb begins on supplementary genital, and following edge of genital, passes up on to outer end of radial shield; it consists of about 30-35 papillæ, which are ventrally small and bead-like, but becoming broad and flat, they are gradually more and more elongated, and appear, dorsally, as slender spinelets, which are longest on upper end of genital plates; a conspicuous supplementary arm-comb of very small spinelets is developed on each side of basal upper arm-plate. Interbrachial spaces below, covered by the huge oral shields and supplementary genital plates; a few marginal plates are barely visible. Oral shields much longer than wide, with a blunt angle inward. Adoral plates longer than wide, narrower at outer end than at inner. Oral plates conspicuous, nearly or quite as large as adorals, often with a third transverse plate at tip of jaw. Oral papillæ three or four on each side, outermost widest; an infradental papilla at apex of jaw. First under-arm plate much

<sup>16</sup> κτείς, κτερός=comb + φέρω=to bear or carry, in reference to the highly developed arm-comb.

wider than long, much narrower proximally than distally; second similar but more nearly square; third, fourth and fifth somewhat hexagonal, but with three distal sides much longer than three proximal; sixth, seventh and eighth plates rather pentagonal, with sharp proximal angle, or somewhat heptagonal; succeeding plates triangular, or slightly pentagonal or hexagonal, about as long as wide; first five or six plates clearly in contact, and they may touch as far as the fifteenth. Side arm-plates very large, thick and projecting distally, separating upper and under arm-plates except on basal half or two-thirds of arm; each plate carries three, or sometimes four, terete, pointed spines, the next to the lowest the longest, and about half as long as a joint; when there are three spines, the third one is two or three times as far above the second as the second is above the lowest; when four are present, the fourth is usually just above the third, and is the smallest of all. Tentacle-pores conspicuous, first eight or nine with scales on both sides, but further out there are seen, on distal margin of side arm-plate, only two scales, and finally only a single one; the scales never closely resemble the arm-spines; first pore entirely distinct from mouth-slit, with about five scales on each side; succeeding pores have five (proximally) and four (distally), four and three or two, three and two, or three and one. Colour (dry), pale purplish-brown above, nearly white beneath.

3 specimens from Station 25. Off Newcastle, 42-48 fathoms; soft mud.

4 specimens from Station 28. Off Manning River, 22 fathoms; fine grey sand.

1 specimen from Station 52. In Shoalhaven Bight, 19-20 fathoms; sand to mud.

This well-marked species of *Ophiura*<sup>17</sup> belongs very evidently to the *variabilis* group, but does not seem to be closely allied to any of the species hitherto described. While it resembles both *lacazei* and *lienosa*, it is easily distinguished from either by the under arm-plates, the basal upper arm-plates and arm-comb, the disc plates and the huge oral shields. It is not nearly related to any of the species of the genus hitherto known from Australia.

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<sup>17</sup> I have been unable to find any flaw in Bell's reasoning (Ann. Mag. Nat. Hist., (6), viii., 1891, p.339), by which he shows that the familiar name *Ophioglypha* must be abandoned in favour of *Ophiura*, while the brittle-stars included in *Ophiura* by Lyman, Verrill, et al., must bear Müller's and Troschel's name *Ophioderma*. Koehler (Bull. Sci. France et Belg, xli., 1907, p.281 and p.290) goes only half-way, using *Ophioderma*, but clinging to *Ophioglypha*. This would be most unsatisfactory even if it were justifiable, for it would leave us without a genus *Ophiura*.

## OPHIOMUSIUM FLABELLUM.

*Ophiomusium flabellum*, Lyman, Bull. Mus. Comp. Zool., v., 7, 1878, p.120.

3 specimens from Station 13. Off Cape Three Points, 41-50 fathoms; sticky mud and shell.

1 specimen from Station 55. Off Crookhaven River, 11-15 fathoms; sand to rock.

It is a piece of real good fortune that the "Thetis" should have taken this interesting little species, previously known from only the single specimen taken by the "Challenger." On account of its small size it might be easily overlooked, but once noted, its peculiar specific characters would prevent any mistake in identification. The "Thetis" specimens have the disc about 3 mm. in diameter, and the arms  $2\frac{1}{2}$  mm. long. Their colour is nearly white.

## OPHIACTIS RESILIENS.

*Ophiactis resiliens*, Lyman, Bull. Mus. Comp. Zool., vi., 2, 1879, p. 36.

9 specimens from Station 10. Off Broken Head, 28 fathoms; fine sand.

16 specimens from Station 44. Off Coogee, 49-50 fathoms; fine sand.

1 specimen from Station 54. Within Jervis Bay, 10-11 fathoms; seaweed and sand.

1 specimen from Station 57. Off Wata Mooli, 54-59 fathoms; all mud.

This is another of the "Challenger" species which has been brought to light again by the "Thetis." The series of specimens ranges in diameter of disc from three to ten millimetres, and the arms are six to eight times as long. Lyman<sup>18</sup> places this species in the group in which, he says, "the number of mouth papillæ increases with age." In his original description he says there was only one specimen in the "Challenger" collection, and it is therefore hard to understand upon what evidence he bases the statement. The series of specimens collected by the "Thetis" reveals no such increase. The number of spinelets in the interbranchial spaces varies greatly in different individuals; they are often very numerous, extending well on to the disc, but sometimes they are very few and scarcely to be seen from above. The arms are very flat, noticeably wider at about the twelfth joint than at the base, and then tapering to a long and very attenuate point.

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<sup>18</sup> Lyman—"Chall." Report, Zool., v., 14, 1881, p.113.

The upper arm-plates in large individuals are often broken into two or more plates. There are usually five arm-spines, but occasionally six are found on the basal joints.

*AMPHIPHOLIS AUSTRALIANA*,<sup>19</sup> sp. nov.

(Plate lii, figs. 1-3).

Diameter of disc, 3.4 mm.; length of arm, 8 (?) mm. Disc flat, circular, covered by 100-150 coarse scales, in addition to the conspicuous radial shields, which are half as wide as long, in close contact along their inner margins, and strongly convex on the outer side. Upper arm-plates about as long as wide, squarish or pentagonal, with a wide angle proximally, and corners usually more or less rounded; even at base of arm they are widely separated from each other. Each interbrachial space below, completely covered by about forty-fifty scales. Oral shields rather triangular, with a sharp angle inward and a strongly convex distal margin about as wide as long. Adoral plates large, three times as long as wide, somewhat wider at outer than at inner end. Oral plates very small and indistinct. Oral papillæ three on each side, distal one wider than other two together. Under arm-plates more or less pentagonal; first one about as wide as long, hardly one-fourth as large as second, in contact with it; second and succeeding plates longer than wide, well separated from each other. Side arm-plates large, meeting broadly both above and below, the distal margin somewhat flaring; each plate carries three (at base of arm sometimes four) spines, subequal or middle one shortest; uppermost slender, terete and pointed; middle one thickened at base; lowest like uppermost, but less slender; at base of arm uppermost spine equals or may exceed a joint, but is usually much shorter. Tentacle-scales two, relatively large, the one on side arm-plate noticeably larger than the one on under arm-plate. Colour, pale yellowish or whitish, apparently without light spots on outer ends of radial shields.

Seven specimens from Station 57. Off Wata Mooli, 54-59 fathoms; all mud.

It is with no little hesitation that I establish a new species of *Amphipholis* closely allied to the common European and American species, and I have only done so after a careful comparison of a large series of specimens from Norway, Denmark, England and Naples, Algeria, Maine, Newport (R.I.), Cape Frio (Brazil), and Talcahuano (Chili), with these seven from Australia. I fail to find any constant character by which the specimens from Europe

<sup>19</sup> *Australia + ana*, implying association.

and Algeria, and those from North America, are to be distinguished from each other, and I believe they should all be united under the specific name *squamata*, Delle Chiaje.<sup>20</sup> The specimens from Cape Frio, Brazil, are labelled *tenera*, Ltk., but I cannot see that they are essentially different from *squamata*, and I am inclined to agree with Koehler,<sup>21</sup> that *tenera* is not entitled to recognition even as a variety. The specimen from Talcahuano, on the other hand, is easily distinguishable, and I think is entitled to specific rank. It is labelled *squamata*, but I propose to call it *LÆVIDISCA*, sp.nov., because of the smooth, rather indistinct scaling of the disc. The other characters are given in the following key, by which the three species here recognised may be distinguished:—

Disc covered by numerous (150-300) scales; upper arm-spine more or less flattened; arm-joints short, about equal to or shorter than spines.

Disc-scales distinct (when dry); outer margins of radial shields decidedly convex; upper arm-spine narrow, moderately flattened; white spot at outer ends of radial shields. .... *squamata*.

Disc-scales indistinct (even when dry), appearing as though a smooth, delicate skin covered the whole disc; outer margins of narrow radial shields nearly straight; upper arm-spine wide and very flat, others similar; no white spot on radial shields. .... *laevidisca*.

Disc covered by 100-150 scales; upper arm-spine slender, terete; arm-joints long, commonly exceeding the spines. .... *australiana*.

Both Lyman<sup>22</sup> and Koehler<sup>23</sup> report *squamata* from Australia. I find it hard to believe that such eminent authorities on Ophiurans as are these savants should be mistaken, but it is certainly very remarkable if *Amphipholis squamata* occurs, as well as *australiana*, in Australian waters.

#### OPHIOCNIDA PILOSA.

*Ophiocnida pilosa*, Lyman, Bull. Mus. Comp. Zool., vi., 2, 1879, p. 32.

1 specimen from Station 13. Off Cape Three Points, 41-50 fathoms; sticky mud and shell.

1 specimen from Station 55. Off Crookhaven River, 11-15 fathoms; sand to rock.

2 specimens from Station 57. Off Wata Mooli, 54-59 fathoms; all mud.

<sup>20</sup> Leach's *Ophiura elegans* is absolutely unrecognizable.

<sup>21</sup> Koehler—Bull. Sci. France et Belg., xli., 1907, p.305.

<sup>22</sup> Lyman—"Chall." Report, Zool., v., 14, 1881, p. 136.

<sup>23</sup> Koehler—Ophiuroidea: Fauna Sudwest Australiens, i., 3-5, 1907, p.244.

These specimens are all in poor condition, but I think there can be no doubt of their identity with the "Challenger" species from the same region.

#### OPHIOCOMA BREVIPES.

*Ophiocoma brevipes*, Peters, Arch. Naturg., xviii., 1, 1852, p.85.

Five specimens from Lord Howe Island.

The single young specimen (disc diameter, 7 mm.) is much lighter coloured than the adults (disc diameter, 25 mm.), and its general appearance is correspondingly different.

#### OPHIOCOMA SCOLOPENDRINA.

*Ophiura scolopendrina*, Lamarck, Anim. s. Vert., ii., 1816, p.544.

*Ophiocoma scolopendrina*, Agassiz, Mém. Soc. Sci. Neuchâtel, i., 1835, p. 192.

Nine specimens from Lord Howe Island.

Only one of these specimens is so uniformly dark as to resemble *erinaceus*, and even in that one the banding of the arm-spines, characteristic of *scolopendrina*, is indicated.

#### OPHIACANTHA HETEROTYLA,<sup>24</sup> sp. nov.

(Plate lii, figs. 4-6).

Diameter of disc, 3 mm.; length of arm, 6 (?) mm. Disc rather flat, circular, covered by a layer of rather coarse scales, which are, however, completely concealed by a uniform coat of coarse, nearly spherical granules. Radial shields nearly concealed, the distal ends visible, rounded, widely separated; position of proximal part of each shield is indicated by a longitudinal series of spinelets, usually three, rarely two or four; these spinelets are very conspicuous, and seem to be the only spinelets on the disc. Upper arm-plates fan-shaped, with strongly convex distal margin, and sharp, proximal angle about as long as wide, separated from each other from the very first. Interbrachial spaces below like disc above. Oral shields much wider than long, roughly pentagonal, with wide proximal angle. Adoral plates large, quadrilateral, about equally wide at both ends. Oral plates much smaller than adoral. Oral papillæ three on each side, subequal, and a much larger tooth-like one at apex of the jaw. Under arm-plates pentagonal, with a proximal angle, a little wider than

<sup>24</sup> ἑτερος = other, different + ὅλῳ = anything rising like a lump, in reference to the two kinds of grains or spinules on disc.

long, widely separated (even first and second) from each other; first is widest proximally, but others are all widest distally. Side arm-plates large, somewhat flaring, meeting broadly above and below; each plate carries four (on basal joint five) smooth spines, the uppermost much the longest and stoutest; these spines are slender and terete, blunt or somewhat acute, and the uppermost on basal joint (where the two series of opposite sides meet) is as long as two and a half arm-joints. Tentacle-scale single, rather large, flattened, but narrowed and often spiniform. Colour uniform light brown, lightest beneath.

2 specimens from Station 35. Off Port Hacking, 22-38 fathoms; sandy.

10 specimens from Station 55. Off Crookhaven River, 11-15 fathoms; sand to rock.

29 specimens from Station 57. Off Wata Mooli, 54-59 fathoms; all mud.

This little species, though such a small member of a large and perplexing genus, is easily recognised by the peculiar arrangement of spinules on the disc. I know of no species with which it can be confused.

#### OPHIOPRISTIS AXIOLOGUS,<sup>25</sup> sp. nov.

(Plate liii, figs. 1-3).

Diameter of disc, 3 mm.; length of arm, 6 (?) mm. Disc covered by coarse scales, each of which carries one or two short, thorny stumps, which are a little expanded at the top, and bear a crown of three or four very short teeth there. Radial shields are scarcely to be distinguished, though a pair of plates, widely separated, somewhat larger than the disc scales and without stumps, can be seen at the bases of some of the arms. Upper arm-plates triangular, with a sharp proximal angle, widely separated from each other. Interbrachial spaces below covered by stump-bearing scales, similar to those of disc. Oral shield very small, wider than long. Madreporic shield large, and swollen with four conspicuous pores. Adoral plates small, about as wide as long. Oral plates large, but outlines very indistinct. Oral papillæ about eight, of which the distal three or four are remarkably long and sharp, and serve as tentacle-scales on the outer side of the first pore; the jaw ends in one or two infra-dental papillæ; inner side of first pore guarded by four or five shorter, but sharp, papillæ; these may be so reduced as to be

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<sup>25</sup> ἀξιόλογος = worthy of mention, remarkable.

hardly visible. Under arm-plates more or less pentagonal; first one much longer than wide, narrowest proximally; succeeding wider than long, distinctly separated from each other. Side arm-plates large, meeting both above and below; each one carries a conspicuous vertical ridge, bearing five or six sharp, rather stout, smooth arm-spines; lowest spine longest, exceeding a joint; uppermost spine shortest, about half as long as lowest. Tentacle-scales long and sharp, very conspicuous; the second pore has three, the third two or three, the fourth two or one, the fifth and all succeeding pores one. Colour, very light brown.

1 specimen from Station 57. Off Wata Mooli, 54-59 fathoms; all mud.

This specimen is so small and in such poor condition, I have hesitated to base a new species upon it. But there seems to be no question that it belongs in Verrill's genus *Ophiopristsis*, and I do not find any species of that group to which the specimen could possibly be assigned.

#### OPHIOTHRIX ACESTRA,<sup>26</sup> sp. nov.

(Plate liii, figs. 4-5).

Diameter of disc, 7.5 mm.; length of arm, 24 (?) mm. Disc somewhat puffed in interbrachial areas, but not conspicuously so, covered with erect, slender stumps, which are crowned with three or four (rarely five) long, slender, acute, diverging spinelets; these spinelets are more than half as long as the stump. Many of the stumps, particularly at centre of disc, are prolonged into very slender, needle-like spines, three times as long as the ordinary stumps; these acicular spines are not smooth, but carry at least, near middle and below, three or four irregularly scattered, coarse, sharp teeth. Radial shields broadly triangular, more or less separated by a narrow series of stump-bearing plates, and more or less concealed by the thorny stumps, which are borne to some extent by the radial shields themselves; outer ends of radial shields usually bare and well-defined. Upper arm-plates somewhat keeled, trapezoidal, but overlapping so as to appear pentagonal, with a very short proximal side; two distal sides longer than two proximal; distal angle rounded. Interbrachial spaces below bare, except at centre and margin, where the stump-bearing plates on the disc are continued; when dry, the supplemental genital plates, next to oral shield, and the genital plates themselves, become very conspicuous. Oral shields wider than long,

<sup>26</sup> Ἀκέστρα—a darning needle, in reference to the long needle-like spines on disc.

rounded or pointed proximally, and more or less abruptly contracted distally into a sort of handle, which may be half as long as the plate, and is truncate distally, where it joins the supplemental genital plates. Adoral plates large, usually in contact. Tooth-papillæ remarkably long, the length three or four times the thickness. Under arm-plates much wider than long, somewhat octagonal or hexagonal, with proximal side concave. Side arm-plates not very large, not meeting either above or below; each plate carries seven glassy, very thorny arm-spines; basal joints have eight or even nine spines; uppermost or next to uppermost spine longest, equal to about four joints. Tentacle-scale single, small. Colour of disc, very light grey or yellowish; of arms, pale pinkish, with indications of a broad, longitudinal, white-stripe, dorsally.

1 specimen from Station 48. Off Wollongong, 55-56 fathoms; sand and mud to rock.

2 specimens from Station 52. In Shoalhaven Bight, 19-20 fathoms; sand to mud.

It seems best for the present to consider this an undescribed species, but in view of the great variety of *cæspitosa* I shall not be surprised if it proves to be an extreme variant of that species. The specimen from Station 48 is much more like *cæspitosa* than the other two, and should, perhaps, be referred to that species, but it is in such poor condition that its real relationship is uncertain.

#### OPHIOTHRIX CÆSPITOSA.

*Ophiothrix cæspitosa*, Lyman, Bull. Mus. Comp. Zool., vi, 2, 1879; p. 53.

4 specimens from Station 10. Off Broken Head, 28 fathoms; fine sand.

1 specimen from Station 13. Off Cape Three Points, 41-50 fathoms; sticky mud and shell.

1 specimen from Station 36. Off Botany Bay, 20-23 fathoms; sand to rock.

2 specimens from Station 44. Off Coogee, 49-56 fathoms; fine sand.

4 specimens from Station 48. Off Wollongong, 55-56 fathoms; sand and mud to rock.

1 specimen from Station 55. Off Crookhaven River, 11-15 fathoms; sand to rock.

These specimens are all small, except three of those from Station 10, and most of them are in very poor condition. I have compared them with a cotype of *cæspitosa* from Port Jack-

son, and I am satisfied that the specimens from Stations 13, 48 and 55 are conspecific, although none of them have the disc so closely covered with stumps, or the radial shields so completely concealed, as in the "Challenger" specimen. The individual from Station 36 is remarkable for having very few stumps and the radial shields conspicuously bare; but it is a very young specimen. The specimens from Station 44 are so small and in such poor condition, their identification is pure guess-work. The specimens from Station 10 are the largest and best preserved of all; the disc bears many slender, acicular spines among the stumps, as in *acestra*, and were it not for two things I should have referred them to that species; the upper arm-plates are like those of *cæspitosa*, not like those of *acestra*, and the arms are prettily banded with pink (or reddish) and blue (or purplish), exactly as in nearly all the specimens of *cæspitosa*, and entirely unlike *acestra*. For the present, it seems to me best to consider these specimens from Station 10, a variety of *cæspitosa*, but we shall never understand their true position until a careful study can be made of an abundance of living and fresh material of *Ophiothrix* at Port Jackson or some neighbouring point.

#### OPHIOTHRIX SPONGICOLA.

*Ophiothrix spongicola*, Stimpson, Proc. Acad. Nat. Sci. Phil., vii., 1855, p. 385.

1 specimen from Station 10. Off Broken Head, 28 fathoms; fine sand.

1 specimen from Station 36. Off Botany Bay, 20-23 fathoms; sand to rock.

1 specimen from Station 54. Within Jervis Bay, 10-11 fathoms; seaweed and sand.

These specimens are identical with three fine specimens from Port Jackson in the collection of the Museum of Comparative Zoölogy, which were received in exchange from the Australian Museum, labelled *O. fumaria*, M. & T. I have compared these specimens with the specimens of *O. fumaria* in the collection of the Museum of Comparative Zoölogy, which Mr. Lyman has marked as having been compared with the original specimens of *fumaria* in Paris, and they are certainly not conspecific. Bell<sup>27</sup> is responsible for the identification of these Port Jackson specimens, as they are undoubtedly the same as those referred by him to *fumaria*. Finding that they were not *fumaria*, I made a more thorough examination of the literature on *Ophiothrix*, and I am

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<sup>27</sup> Bell—Zool. Rep. "Alert," 1884, p. 140.

now satisfied that they belong to Stimpson's species, the type of which was from Port Jackson. Unfortunately, Stimpson's originals are no longer extant; they were probably destroyed with so much else of his material in the great Chicago fire. But his description fits these specimens in every particular, except that he gives the colour as "black," and the arms "black and red." This difficulty is, however, a very slight one, for while the real colours appear to be blue and reddish, the blue is usually so deep that it is almost bluish-black, and in life large specimens probably give the impression of black and red. Stimpson's description of the disc, the arms, and the arm-spines fit these Port Jackson specimens so well, it does not seem to me there can be any doubt that we have to do with his species, *spongicola*.

#### OPHIOMYXA AUSTRALIS.

*Ophiomyxa australis*, Lütken, Add. ad. Hist. Oph., Pt. 3, 1869, p. 45.

One specimen from Station 48. Off Wollongong, 55-56 fathoms; sand and mud to rock.

The specimen is a small one, with a disc diameter of 7 mm., and an arm-length of about 28 mm., but I do not think there is any doubt that it belongs to this species.

#### ASTROPORPA AUSTRALIENSIS,<sup>28</sup> sp. nov.

(Plate liv, fig. 2.)

Diameter of disc, 11.5 mm.; length of arm, about 68 mm.; thickness of arm at base, 3 mm. Disc made up of five wedge-shaped divisions, each of which corresponds to a pair of radial shields, though no indications of such shields are to be seen; the inner ends of the wedges are united to form a pentagonal area, 6 mm. in diameter, which is covered with rather coarse granules of variable size and very irregular arrangement. Upper surface and sides of arms completely covered with alternating half-circles of hook-bearing granules, and of smooth granules; the former are colourless or whitish, and there are four or five series in each half-circle, while the smooth granules are brown, in marked contrast, and there are only two or three series in each half-circle. These alternating half-circles continue on to the disc, forming curved ridges across each radiating wedge, the innermost ridge of hook-bearing granules forming the outer boundary of the disc-pentagon alluded to above. There is thus no evident line of division between disc and arms. Entire oral surface, even to tip of arms,

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<sup>28</sup> *Australia + ensis*, expressing locality.

covered with a fine, granular pavement. Each jaw carries about a dozen more or less spiniform oral papillæ and teeth. Genital slits minute. First pair of arm-pores without tentacle-scales, but all subsequent pores are guarded by a series of four to seven, very small, peg-like tentacle-scales (arm-spines), of nearly equal size. Colour, very light brown or dirty whitish, prettily annulated from tip of arm to centre of disc with bright brown; lower surface of arms brown.

One specimen from Station 48. Off Wollongong, 55-56 fathoms; sand and mud to rock.

The occurrence of a species of *Astroporpa* in Australian waters may be considered one of the noteworthy discoveries made by the "Thetis," for the two species previously known are exclusively West Indian. The Australian species resembles *A. annulata*, Orst. and Ltk., very closely, but is easily distinguished by the fact that the half-circles of hook-bearing granules are broader and more flattened and carry less conspicuous granules and hooks, particularly at base of arms; thus, in *annulata* there are only two or three series of granules in each half-circle and at base of arm there is usually only a single, conspicuous series, while in *australiensis* there are four or five such series. The colouration of the two species is remarkably similar.

#### ASTROTHROMBUS,<sup>29</sup> gen. nov.

Disc covered by a very irregular, rough pavement of granules and plates of very diverse sizes, among which one fails to find any definite indications of radial shields, though the largest plates are at the bases of the arms, and may even be arranged in a more or less noticeable pair. The arms are simple, capable of coiling vertically, with the side arm-plates continued upwards in double lines of close-set nodules, homologous with upper arm-plates, and bearing minute hooks. Tentacle-scales, several, short and rough at tip. Jaw with a very few sharp teeth or papillæ at apex. Two genital openings in each interbrachial space.

Type-species, the following.

#### ASTROTHROMBUS RUGOSUS,<sup>30</sup> sp. nov.

(Plate liv, fig. 3.)

Diameter of disc, 7 mm.; length of arm, 30(?) mm. Disc covered with a very irregular pavement of granules of diverse

<sup>29</sup> *ἀστροπὸν*=a star + *θρόμβος*=a lump, symphonious with its generic allies, and in reference to the rough disc.

<sup>30</sup> *rugosus*=rough, in reference to the irregular covering of the disc.

sizes and forms; the large ones are rounded, but some of the small ones are quite angular. The largest are at the bases of the arms, but no radial shields are visible, and it is probable that the large pair of plates shown at the base of one arm in the figure given, are really bare spots from which the granules have been rubbed off. Upper surface and sides of arms completely covered with half-circles of hook-bearing granules, alternating with much coarser, smooth granules; there are two or three series of granules in each half-circle; the smooth ones are much larger than those bearing hooks. Oral surface of disc and arms covered with a rough pavement of small granules. Each jaw carries at apex several sharp, flattened, tooth-like papillæ.

Genital slits minute. First pair of arm-pores without tentacle-scales, but all subsequent pores with two (three?) small, peg-like tentacle-scales, rough at the tip. Colour, uniformly light brown.

1 specimen from Station 48. Off Wollongong, 55-56 fathoms; sand and mud to rock.

Although this species is obviously nearly related to the preceding, it does not seem possible to place it in the same genus, the character of the disc is so different. It seems to be necessary, therefore, to institute a new genus for its reception.

#### CONOCLADUS AMBLYCONUS,<sup>31</sup> sp. nov.

(Plate lv.)

Diameter of disc, 15 mm.; length of arm, about 50 mm.; width of arm at base, 7 mm.; height of arm at base, 3.5 mm. Disc wholly made up of five wedge-shaped divisions, each composed of a pair of radial shields; no distinct line of division between disc and arm. Each wedge-shaped area carries eight—ten large, rounded tubercles, 1—2 mm. in diameter and rather less than that in height; the largest ones are crowded at centre of disc; among these tubercles are scattered twenty-five—thirty more or less circular, bare plates, the spaces between which are filled by minute rounded granules. Arms dichotomously branched four or five times, the basal, undivided portion about equalling diameter of disc; upper surface and sides of arms covered by tubercles, plates and granules like those of the disc; there are about four series of the large tubercles on basal portion, two above and one on each side; the latter series hardly extend beyond the first fork, but the upper ones may be traced at least to the third fork, and usually beyond. Lower surface of disc and arms covered

<sup>31</sup> ἀμβλύς = blunt + κώνος = a cone, in reference to the blunt, conical tubercles on the disc and arms.

with a close pavement of flattened granules, largest in the inter-radial areas. Apex of jaws with a group of flattened, slender, pointed, but hardly spiniform teeth; sides of jaw with four or five similar, but smaller oral papillæ. One large madreporic plate. Genital slits short but conspicuous. Oral tentacle-pores inconspicuous; next pair conspicuous and without tentacle-scales; succeeding pores are protected by four or five short, thick, tentacle-scales (arm-spines?), of which the inner are much the largest. Smallest branches of arms show the usual arrangement in the Astrophytidæ, of alternating rings of minute hooks, and of granules. Colour, uniform reddish-brown. Other specimens are much paler, and some are nearly white.

1 specimen from Station 12. Off Cape Three Points, 23-34 fathoms; sand.

6 specimens from Station 44. Off Coogee, 49-50 fathoms; fine sand.

1 specimen from Station 49. Off Port Kembla, 63-75 fathoms; mud and pebbles.

1 specimen from Station 53. Off Crookhaven River, 23 fathoms; rock.

6 specimens from Station 54. Within Jervis Bay, 10-11 fathoms; seaweed and sand.

1 specimen from Station 55. Off Crookhaven River, 11-15 fathoms; sand to rock.

3 specimens from Station (?)

The largest of these specimens has the disc nearly 50 mm. in diameter, the tubercles are more numerous than in the type and are very rough, the arms branch seven times, and there are six tentacle-scales at the base of the arm; in other respects it resembles the type very closely. The smallest specimen has the disc only 3 mm. in diameter, and the arms branch only once or twice; there is a single large tubercle on the disc, at the base of each arm. The differences between this species and the following in the form and arrangement of the tubercles seem to be very constant, and it is an easy matter to separate specimens of the two when they have been mixed. If one may judge from the "Thetis" collection, this species seems to be decidedly the more common.

#### CONOCLADUS OXYCONUS.

*Conocladus oxyconus*, H. L. Clark, Bull. Mus. Comp. Zool., lii., 1909, p. 132.

One specimen from Station 10. Off Broken Head, 28 fathoms; fine sand.

One specimen from Station 44. Off Coogee, 49-50 fathoms ; fine sand.

One specimen from Station (?)

The largest of these specimens has the disc about 25 mm. in diameter ; the colour is dirty whitish, prettily but irregularly spotted with purplish-brown. This specimen raised the question in my mind whether it were not really conspecific with Verrill's<sup>32</sup> *Astrophyton australe*. Although smaller than Verrill's type, and with different proportions and colouration, in some respects it answers well to his description ; the conspicuous wedges of which the disc is made up, and to which Verrill makes no reference, and the apparent absence of radial shields and interradiial areas, to both of which Verrill refers, made it seem impossible, however, that the two could be identical. Thanks to the kindness of Mr. Henry V. Pelton, who has sent me from Poughkeepsie, one of Verrill's originals, I have been able to settle the question in the negative ; though nearly related, the two are not even congeneric. Verrill's species seems to be a true *Gorgonocephalus*, with distinct radial shields, well separated from each other, and well-marked interradiial areas. The tubercles on the arms are very much smaller than those on the radial shields, and the line of separation between the disc and arms is obvious. In spite of these differences, however, no one who compares the specimens will question that *Conocladus* has been derived from an ancestral form, strikingly like *Gorgonocephalus australe*.

#### ECHINOIDEA.

Although the 243 Echini in the collection represent fifteen species, the great bulk of the collection, 174 specimens, belongs to only two. One of these two, however, proves to be a most interesting new species of *Fibularia*, remarkable for the brooding of the young by the female, and the consequent striking difference between the sexes. Of the other thirteen species, one appears to be a new species of *Chaetodiadema*, a genus first established in 1900, but of which this is the third species discovered since the type-species was described. There are a number of specimens of an *Echinocyamus*, first collected by the "Siboga," and a dozen of the recently-described *Asthenosoma thetidis*, H.L.C. A single beautiful specimen of *Stephanocidaris bispinosa*, Lamk., is one of the great prizes of the collection. The remaining ten species are all well known, and all have been previously recorded from Australia. It is remarkable that there is no Spatangoid in the collection, except a single specimen of *Breynia* from Lord Howe Island.

<sup>32</sup> Verrill—Bull. U.S. Nat. Mus., No. 3, 1876, p. 74.

## PHYLLACANTHUS IMPERIALIS.

*Cidarites imperialis*, Lamarck, Anim. s. Vert., iii., 1816, p. 54.

*Phyllacanthus imperialis*, Brandt, Prodrome, 1835, p. 268.

One specimen from Station 54. Within Jervis Bay, 10-11 fathoms; seaweed and sand.

This specimen has the test 62 mm. in diameter, and there are 7 coronal plates in each column. The largest primary spines are 54 mm. long and 6 mm. in diameter. The neck of the primaries is purplish and shining, while the collar is fawn-colour and minutely roughed. The secondary and miliary spines are bright brown, becoming reddish at the tips. The abactinal system is .31, and the actinal system is .40, of the horizontal diameter of the test.

## STEPHANOCIDARIS BISPINOSA.

(Plate liv, fig. 1.)

*Cidarites bispinosa*, Lamarck, Anim. s. Vert., iii., 1816, p. 57.

*Stephanocidaritis bispinosa*, A. Agassiz, Rev. Ech., Pt. 1, 1872, p. 160.

One specimen from Station 17. Off Broughton Island, 29-48 fathoms; sand and shell to rock.

It is impossible not to be enthusiastic over the superb specimen of this lovely species, one of the handsomest of the Cidaridæ, which the "Thetis" has been so fortunate as to collect. The horizontal diameter is 45 mm.; the vertical diameter is 25 mm. (.55 h.d.); the abactinal system measures 21.5 mm. across (.48 h.d.); and the actinal system, 18 mm. (.40 h.d.). There are seven coronal plates. The longest primary is 60 mm. (1.33 h.d.). There are no large globiferous pedicellariæ whatever, but tridentate (similar to those of *S. hawaiiensis*) are fairly common; the specimen is in such perfect condition that there is no possibility that the large globiferous pedicellariæ have fallen off since it was taken. The interambulacral secondary spines are greenish with a dark longitudinal stripe, and pinkish tips. The primary spines are more or less green and purplish; collar conspicuously spotted with pure white. The actinal primaries have the conspicuous cap characteristic of the genus, and the abactinal system is also like that of the original specimen, on which the genus was based. This specimen confirms my previously expressed opinion<sup>33</sup> that neither Mortensen nor Döderlein has seen a specimen of *bispinosa*, and it must therefore be very rare. It

<sup>33</sup> Clark—Bull. Mus. Comp. Zool., li., 7, 1907, p. 194.

is particularly interesting to find that this perfect specimen from Australia agrees with the specimen in poor condition in the collection of the Museum of Comparative Zoölogy, and with all the specimens of its near ally, *S. hawaiiensis*, in the absence of large globiferous pedicellariæ; whereas the East Indian *S. glandulosus* has such pedicellariæ present in abundance.

#### GONIOCIDARIS TUBARIA.

*Cidarites tubaria*, Lamarck, Anim. s. Vert., iii., 1816, p. 57.

*Gonoicidaris tubaria*, Lütken, Bid. Kund. Ech., 1864, p. 137.

1 specimen from Station 10. Off Broken Head, 28 fathoms; fine sand.

9 specimens from Station 36. Off Botany Bay, 20-23 fathoms; sand to rock.

1 specimen from Station 41. Off Wata Mooli, 52-71 fathoms; soft mud.

4 specimens from Station 48. Off Wollongong, 55-56 fathoms; sand and mud to rock.

1 specimen from Station 54. Within Jervis Bay, 10-11 fathoms; seaweed and sand.

1 specimen from Station 57. Off Wata Mooli, 54-59 fathoms; all mud.

3 specimens from Barrenjoey.

15 specimens collected 23 Feb., 1898, but no locality given.

52 specimens with no label or an illegible one.

It is rather remarkable that in all this material of *Gonoicidaris* from so many localities, there is not a single specimen of *geranioides*, but all are typical *tubaria*. In my revision of the Cidaridæ<sup>34</sup> I failed to refer to the excellent coloured figures of this species given by McCoy on Plate 100 of his "Prodromus of the Zoology of Victoria," published in 1885. The omission is the more regrettable, as I virtually state (p. 182) that *tubaria* had never been figured previous to the appearance of my paper.

#### CENTROSTEPHANUS RODGERSII.

*Trichodiadema Rodgersii*, A. Agassiz, Proc. Acad. Nat. Sci. Phil., 1863, p. 354.

*Centrostephanus Rodgersii*, A. Agassiz, Rev. Ech., Pt. 1, 1872, p. 98.

One specimen from Lord Howe Island.

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<sup>34</sup> Clark—Bull. Mus. Comp. Zool., li., 7, 1907.

Though completely crushed and otherwise in bad condition, there is no doubt as to the identity of this specimen. According to Etheridge,<sup>35</sup> who gives an interesting account of its habitat and habits, it is fairly common on Lord Howe Island, but is not abundant.

CHÆTODIADEMA TUBERCULATUM,<sup>36</sup> sp. nov.

(Plates lvi. and lvii.)

Test strongly flattened; vertical diameter (15 mm.) only about .27 of horizontal (55 mm.); coronal plates about 16, uppermost four without primary tubercles; next two, each with one near outer end; those just above ambitus with two or three; those at ambitus and just below with three or four; remaining actinal interambulacral plates with very small primary tubercles or none; above ambitus, secondary tubercles of interambulacra few, scattered and confined almost wholly to outer end of plates; becoming more numerous and more generally distributed at ambitus, they increase rapidly actinally and completely cover the surface of the lowermost coronal plates; miliary tubercles fairly abundant on actinal surface, but comparatively infrequent abactinally. Ambulacral areas rather narrow (9 mm.), about one-third as wide as interambulacra (28 mm.); uppermost two or three ambulacral plates without primary tubercles, but all others above and at midzone carry one each; below midzone only secondary and miliary tubercles are present, but these completely cover the surface of the plates. Pairs of pores in distinct arcs of three at and above midzone, but below midzone apparently only two pairs, or even a single pair, to each plate, and these are widely separated, and form a straight series; from actinostome to ambitus there are about twenty pairs of pores on each side of each ambulacrum. Primary tubercles of both ambulacra and interambulacra perforate and decidedly crenulate. Abactinal system 19.5 mm. in diameter (.35 h.d.), with all the oculars broadly insert. Genital and ocular plates each with three or four secondary tubercles. Centre of periproct occupied by anal tube and a surrounding zone of very minute plates, outside of which is a zone of plates 1—3 mm. in diameter, each carrying a secondary or miliary tubercle. Actinostome very small, 10 mm. in diameter (.18 h.d.), with very distinct but rather wide actinal cuts; buccal membrane sparsely covered by minute plates, some

<sup>35</sup> Etheridge—Austr. Mus. Mem., ii., 1, No. 1, 1889, p. 37.

<sup>36</sup> *tuberculum* = a tubercle + *atus* = possessing, in reference to the actinal surface having distinct tubercles, instead of being closely granulated as in *C. granulatum*, Mortensen.

of which carry pedicellariæ; five pairs of rather small buccal plates. Teeth strongly notched on each side of sharp tip. Primary spines all broken, slender, hollow, finely ridged longitudinally and covered with crowded whorls of minute teeth. Secondary spines very slender, acicular. Pedicellariæ of two kinds, triphyllous and tridentate; former rather scarce, very small, heads only about .23 mm. in length, ends of valves truncate, sides nearly parallel; tridentate common on all parts of test, except bare abactinal interambulacral spaces, very variable in size, heads ranging from 20 to 50 mm. in length (one much larger (Pl. lvii., fig. 8) but not fully developed was found); neck about as long as head; valves slightly curved, widened and distinctly hooked at tip; apophysis rounded, rather conspicuous; one example of what Mortensen calls a claviform pedicellaria was found (Pl. lvii., fig. 2), but it had no valves, and it seems to me doubtful whether it is a pedicellaria at all. Colour of specimen dried from alcohol, test abactinally, purplish-brown; tubercles, greenish-yellow; a similar tint on outer part of interambulacral plates; a deep blue line, over a millimetre wide, runs on abactinal surface from second interambulacral plate to ambitus, along midline of each column of interambulacral plate. Primary spines greenish or lavender. Actinally, both test and spines are very light brown.

1 specimen from Station 41. Off Wata Mooli, 52-71 fathoms; soft mud.

1 specimen from Station 58 (?). Off Wata Mooli, 28-42 fathoms; fine sand to mud.

The discovery of a *Chaetodiadema* off the Coast of New South Wales extends the range of the genus far to the southward. The type-species (*granulatum*) was originally described from the Gulf of Siam, and has been taken also at various stations in the East Indies as far south as New Guinea and at the Maldive Islands; the second species (*japonicum*) is known only from Japan; and the third (*pallidum*) only from the Hawaiian Islands. The Australian species is nearest *japonicum*, having the same conspicuous abactinal blue stripes as that species; it differs from it, however, in the general coloration, in the arrangement of the tubercles, and in the tridentate pedicellariæ; the latter are much like those of *granulatum*.

#### ASTHENOSOMA THETIDIS.

*Asthenosoma thetidis*, H. L. Clark, Bull. Mus. Comp. Zool., lii., 1909, p. 134.

Twelve specimens from Station 56. Off Botany Bay, 79-80 fathoms; sand and stones.

This is an excellent series of this interesting species, but I have nothing to add to the original description. Perhaps it ought to be repeated here that this is the species referred to by Mr. Edgar R. Waite<sup>37</sup> in his general account of the "Thetis" work, as "*Phormosoma hoplacantha*"; he states that between "two and three hundred examples" were taken "in eighty fathoms off Botany Bay." His further statements deserve quotation:—

"When first removed from the water, these Echinoderms presented a globular form and heaved with a panting or pulsating action. Water oozed from them till they became quite flat; if one of globular form was pricked with a knife the fluid ran out, the larger examples supplying quite a pint. We placed a number of these Echinoderms in a large tin, stacking them to the height of about two feet; in a short time they had shrunk down to a layer of not more than six inches in depth, and were covered by the water which exuded from them. We found wounds from their spines to be very painful."

#### ECHINOMETRA MATHÆI.

*Echinus mathæi*, de Blainville, Dict. Sci. Nat., xxxvii., 1825, p. 94.

*Echinometra mathæi*, de Blainville, Dict. Sci. Nat., lx., 1830, p. 206.

Seven specimens from Lord Howe Island, where this species is said to be the commonest sea-urchin.

#### STRONGYLOCENTROTUS TUBERCULATUS.

*Echinus tuberculatus*, Lamarck, Anim. s. Vert., iii., 1816, p. 50.

*Strongylocentrotus tuberculatus*, Brandt, Prodrôme, 1835, p. 64.

Three specimens from Lord Howe Island, where it is said to be common.

#### HOLOPNEUSTES INFLATUS?

*Amblypneustes inflatus*, A. Agassiz, Bull. Mus. Comp. Zool., iii., 1872, p. 56.

*Holopneustes inflatus*, A. Agassiz, Rev. Ech., Pt. 1, 1872, p. 136.

One specimen from Station 50. In Shoalhaven Bight, 15-18 fathoms; sand.

The specimen is so small (18 mm. in diameter) that its specific identification is open to some doubt.

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<sup>37</sup> Waite—Austr. Mus. Mem., iv., 1899, p. 18.

## TRIPNEUSTES GRATILLA.

*Echinus gratilla*, Linné, Sys. Nat., 10th ed., 1758, p. 664.

*Tripneustes gratilla*, Lovén, Echinodermata, 1887, p. 77.

Two specimens from Lord Howe Island. The larger is 130 mm. in diameter.

## ECHINOCYAMUS PROVECTUS.

*Echinocyamus provectus*, de Meijere, Tijdschr. Ned. Dierk. Vereen., (2) viii., 1903, p. 6.

17 specimens from Station 13. Off Cape Three Points, 41-50 fathoms; sticky mud and shell.

6 specimens from Station 57. Off Wata Mooli, 54-59 fathoms; all mud.

These specimens range from 1.5 to 8 mm. in long diameter. The larger ones agree in every detail of both internal and external anatomy with de Meijere's description, except that there are rarely more than six pairs of pores on a side in the petals, and usually there are fewer. The smallest specimens can scarcely be distinguished from the males of the next species.

FIBULARIA NUTRIENS,<sup>38</sup> sp. nov.

(Plate lviii, figs. 1-11.)

Test ellipsoidal (female) or ovoid (male) in outline, decidedly flattened, distinctly gibbous actinally and posteriorly, somewhat elevated abactinally and anteriorly in the female. Petals wanting; with a magnification of seventy diameters it is possible to detect ambulacral pores. Genital pores conspicuous (especially in the female), excepting in the posterior interambulacrum, where there is none. Ocular pores apparently wanting. A single large madreporic pore can be plainly seen. Actinostome circular, or nearly so, little sunken, *posterior* to centre of abactinal surface, bare; teeth rather prominent, the posterior one much the largest. Anal system much wider than long, situated half-way between actinostome and posterior margin. In the female, a large part of the abactinal surface is deeply depressed to form a brood-pouch, into which the four large genital pores open, while the posterior interambulacrum, with the madreporic pore at its tip, projects anteriorly in such a way as to make the brood-pouch horse-shoe shaped, with the opening posterior. In the male, the

<sup>38</sup> *nutriens*=nursing, in reference to the caring for the young by the mother.

only indication of the pouch is a very slight depression of the upper ends of the five ambulacra. The dimensions of the female are as follows:—length, 3·3 mm.; width, 2·4 mm.; height of test, 1·7 mm.; distance of anterior edge of actinostome from anterior end of test, 1·5 mm.; diameter of actinostome, ·8 mm. Males are a trifle smaller. Pedicellariæ of two kinds, tridentate and ophicephalous; former very infrequent, the valves (Plate lviii., fig. 3) with remarkably wide bases and expanded, coarsely dentate tips; ophicephalous pedicellariæ (Plate lviii., figs. 1 and 2) with enormously enlarged loops and powerful dentate jaws. Spines with somewhat flaring tips (Plate lviii., fig. 4), made up of eight pointed rods. Colour, very pale brown.

85 specimens from Station 13. Off Cape Three Points, 41-50 fathoms; sticky mud and shell.

2 specimens from Station 57. Off Wata Mooli, 54-59 fathoms; all mud.

Among the novelties taken by the "Thetis," none is more interesting than this remarkable little Echinoid, the only Clypeastroid known in which the test of the female is profoundly modified for the purpose of caring for the young. On account of the complete absence of petals I was at first inclined to establish a new genus for this peculiar species, but as the species of *Fibularia* and *Echinocyamus* have the petals more or less reduced, it has seemed that this character can hardly be used for a generic difference. In its internal anatomy (Plate lviii., figs. 10 and 11) this species is a typical *Fibularia*, but reveals certain peculiarities of its own. The posterior position of the mouth, the short intestine, and the powerful jaws, forming a lantern which is bilaterally symmetrical but radially most asymmetrical, are all noteworthy features. Only two of the females actually had young in the brood-pouch; in each case there were two young ones present. These young were nearly spherical, and measured about ·5 mm. in diameter. It is worthy of remark that this species was found on muddy, rather than sandy, bottom, in company with *Echinocyamus* and seven other Echinoderms.

#### ECHINANTHUS TESTUDINARIUS.

*Echinanthus testudinarius*, Gray, Proc. Zool. Soc. 1851, p. 35.

1 specimen from Station 36. Off Botany Bay, 20-23 fathoms; sand to rock.

5 specimens from Station 41. Off Wata Mooli, 52-71 fathoms; soft mud.

7 specimens from Station (?)

One of these specimens is of particular interest because it affords a remarkable illustration of the resorption of an animal's tissue by another animal. A barnacle (acorn shell) attached to the upper side of the test has resorbed an area 16 mm. across, and practically through the test, so that the base of the barnacle is completely sunken below the surrounding surface. There is every indication that both the *Echinanthus* and the barnacle were living when dredged.

#### LAGANUM PERONII.

*Laganum Peronii*, Agassiz, Mon. Scut., 1841, p. 123.

1 specimen from Station 44. Off Coogee, 49-50 fathoms; fine sand.

1 specimen from Station (?) A dead and bare test.

These specimens are about 20 mm. long. They show no peculiar features.

#### BREYNIA AUSTRALASIÆ.

*Spatangus australasice*, Leach, Zool. Misc., ii., 1815, p. 68.

*Breynia, australasice*, Gray, Ann. Mag. Nat. Hist., (2), vii., 1851, p. 131.

One specimen from Lord Howe Island, where it is said to occur "in great abundance in the sandy bottom of the lagoon."

#### HOLOTHURIOIDEA.

The collection of Holothurians is so small and the specimens are as a rule in such poor condition that it is of far less interest than any one of the other classes. The only notable fact is the occurrence of two species of *Molpadia* at the same station, three specimens of each, and both new to science. In view of my recent critical revision of the genus,<sup>39</sup> in which I have refused to recognize as valid a considerable number of species described by other workers, I feel that I lay myself open to criticism in so quickly describing two new species. I can only plead inability to find any known species to which they could possibly be referred; each appears to be remarkably well-characterised.

#### HOLOTHURIA DIFFICILIS.

*Holothuria difficilis*, Semper, Holothurien, iii., 1868, p. 92.

Two specimens from Lord Howe Island.

The larger of the two specimens has only eighteen tentacles, while the condition of the smaller prevented its number from

<sup>39</sup>Clark—Apodons Holothurians, 1908, pp. 156-172.

being ascertained. As the Cuvier's organs are well-developed, in spite of the small size (50-75 mm.), it is probable that this is the species of which Mr. Etheridge<sup>40</sup> writes, "The smallest and commonest of the four, a *Holothuria*, of a brownish colour, emits, when touched, a white, sticky, fibrous discharge, which congeals like india-rubber."

#### HOLOTHURIA FUSCO-CINEREA.

*Holothuria fusco-cinerea*, Jäger, De Holothuriis, 1833, p. 22.

Four specimens from Lord Howe Island.

These specimens are all small (40-50 mm. long) and are probably the young of this widely distributed Indo-Pacific species. I believe the species referred to by Etheridge<sup>41</sup> as "a large form, a foot in length, perhaps *Holothuria vagabunda*, Selenka, of a blackish-brown colour," is probably the adult form of which these specimens are the young.

#### HOLOTHURIA MACLEARI.

*Holothuria macleari*, Bell, Zool. Rep. "Alert," 1884, p. 152.

One specimen from Lord Howe Island.

Although this specimen is more than twice as large as Bell's type-specimen (115 mm. as against 49 mm.), I believe the peculiar coloration (brown, with pedicels and papillæ whitish, in striking contrast) and the similarity in the spicules, warrant calling this specimen *macleari*. It has only nineteen tentacles, one stone canal, and one long, polian vesicle. I infer from the colour that this is the species of which Etheridge<sup>41</sup> says, "A third and rather common Holothurid, brown, mottled with white, we believe to be *Sticophus chloronotus*, Brandt"; so far as I know, *Stichopus chloronotus*, Brandt, is always olive-brown or olive-green, without white marks of any sort. It is, however, quite possible that the species may occur at Lord Howe Island, and that it may there be mottled with white. Colour is, as a rule, an unreliable specific character among the Holothurians.

#### CUCUMARIA MIRABILIS.

*Cucumaria mirabilis*, Théel, Chall. Rep. Zool., xiv., Holoth., Pt. 2, 1886, p. 61.

Two specimens from Station 13. Off Cape Three Points, 41-50 fathoms; sticky mud and shell.

<sup>40</sup>Etheridge—Austr. Mus. Mem., ii., 1, No. 1, 1889, p. 32.

<sup>41</sup>Etheridge—Loc. cit., p. 39.

## COLOCHIRUS AUSTRALIS.

*Colochirus australis*, Luding, Arb. Zool. Inst. Würzburg, ii, 1874, p. 88.

Two specimens from Station 13. Off Cape Three Points, 41-50 fathoms; sticky mud and shell.

Although both specimens are very young, there seems no doubt that they belong to this species.

## COLOCHIRUS SPINOSUS.

*Holothuria spinosa*, Quoy and Gaimard, Voy. de l'Astrolabe, iv., 1833, p. 118.

*Colochirus spinosus*, Selenka, Zeit. f. Wiss. Zool., xviii., 1867, p. 117.

One specimen from Station 10. Off Broken Head, 28 fathoms; fine sand.

Although the specimen is obviously young, it agrees not only with the description and figures of Quoy and Gaimard, but with specimens of this species from Port Jackson. I have also compared it with a specimen of *Stereoderma validum*, Bell, received from Professor Bell himself, and I am entirely at a loss to see how that species is to be distinguished from *spinosus*. Bell<sup>42</sup> says, "Mr. Ramsay tells me that the naturalists of Sydney have been in the habit of regarding *S. validum* as the *Holothuria spinosa* of Quoy and Gaimard: this determination cannot, I think, be accepted." After a comparison of Bell's specimen, and other similar ones from Port Jackson, with the description and figures of Quoy and Gaimard, I find myself forced to side with "the naturalists of Sydney," especially as Bell does not point out a single character by which his species is to be distinguished from the earlier one.

MOLPADIA DISSIMILIS,<sup>43</sup> sp. nov.

(Plate lviii, figs. 12-21.)

Body moderately stout, 70 mm. long by about 30 in diameter; both oral disc and caudal appendage so contracted no measurements could be made, nor could the number of tentacles be determined. In another specimen the total length is 45 mm.; diameter, 15 mm.; caudal appendage, 4 mm. long; diameter of

<sup>42</sup>Bell—Zool. Rep. "Alert," 1884, p. 151.

<sup>43</sup>*dissimilis*=unlike, in reference to its distinctness from the following species taken at the same Station.

oral disc, 5 mm.; number of tentacles, 15; tentacle a little over a millimeter long, with a minute digit on each side, close to the blunt, rounded tip. No evident genital papilla. Calcareous ring moderately stout; radial projections rather wide, not deeply notched. Polian vessel, stone-canal and respiratory trees could not be discovered in the mud with which the body-cavity was largely filled. Calcareous deposits in body-wall abundant, making the surface very rough to the touch; these deposits are well-formed tables with a high, rough, more or less pointed spire; small ones (Pl. lviii, figs. 12, 13) have the disc more or less triangular, perforated by about six holes, the spire made up of three rods with three or four cross-bars; larger tables (Pl. lviii, figs. 14-16) have the disc more or less round, with ten or twelve holes, the spire with six-eight cross-bars; height of spire commonly greater than diameter of disc, which may be as much as 2 mm; in caudal appendage, tables (Pl. lviii, figs. 17-21) smaller, with numerous (20-40) minute holes in disc, and a low squarish spire, with one or no cross-bar, and coarse teeth at the top. Many tables in the body are in process of transformation into phosphatic deposits; the latter are comparatively few in the small specimen, but are exceedingly numerous in the type, forming patches often a millimeter across. Oral disc and caudal appendage very light grey; in the small specimen the tentacles are yellowish, the body light yellowish-grey, with scattered spots of yellowish-red; in the type the phosphatic bodies are so numerous, the general colour is brick-red, finely speckled with grey.

Three specimens from Station 46. Off Jibbon, 50-66 fathoms; mud and abattoir refuse.

The affinities of this interesting Holothurian will be discussed in connection with the following species.

#### MOLPADIA PRODUCTAMENSIS,<sup>44</sup> sp. nov.

(Plate lviii, figs. 22-30.)

Body quite stout, 68 mm. long by 35 in diameter; oral disc, 5 mm. in diameter; caudal appendage, 6 mm. long. Tentacles so contracted neither their number nor the position and number of the digits could be determined. No evident genital papilla.

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<sup>44</sup>*productus*=drawn out + *mensis* (ablative plural of *mensa*, table)=with tables, in reference to the drawn out ends of the table in the caudal appendage.

Calcareous ring remarkably wide, with conspicuous anterior projections and posterior radial prolongations; entire length of radial piece more than 5 mm.; posterior prolongation, 2 mm., notched for nearly its whole length. Polian vessel, stone-canal, and respiratory trees not observed. Calcareous deposits in body-wall very abundant, making the surface rough to the touch; these deposits are rather stout tables (Pl. lviii, figs. 22-26) with more or less irregular disc (often .25 mm. in diameter) and high, rough, pointed spire, made up of three rods; disc usually with two or three principal holes, and one or more irregular or incompletely closed ones on or near margin; spire with seven or eight cross-bars; in caudal appendage, tables (Pl. lviii, figs. 27-30) much smaller and more regular, with five—ten perforations in disc, each end of which is drawn out into a short, smooth, blunt rod, and a low triangular spire with only three or four cross-bars. Most of the tables in the body are more or less discoloured, apparently a step towards being transformed into phosphatic bodies, which are excessively numerous, and deeply coloured. Oral disc and caudal appendage very light grey; body almost uniform, deep purplish-red, showing under a lens a fine variegation with light grey lines and dots.

Three specimens from Station 46. Off Jibbon, 50-66 fathoms; mud and abattoir refuse.

It is certainly remarkable that *Molpadids* were taken only at this one Station, where perhaps the "abattoir refuse" may prove a source of food-supply to these mud-loving and mud-eating animals. But it is even more remarkable that the six specimens taken should be divided equally between two quite distinct species, neither of which has been described hitherto. There appears to be no doubt of their distinctness, for none of the specimens shows the least tendency towards intergrading characters. The difference between the two species in their calcareous rings is almost as striking as the difference in their calcareous deposits. While both species approach the common Pacific species *intermedia* in their general appearance, the calcareous tables are so different from those of that species that they cannot be considered very closely allied to it.

The discovery of these two new species necessitates the modification of the key to the species of *Molpadia*, published early last year<sup>45</sup> and subsequently altered<sup>46</sup> to admit a new species from Japan. The first part of this key will now read as follows:—

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<sup>45</sup>Clark—*Apodous Holothurians*, 1908, p. 158.

<sup>46</sup>Clark—*Bull. Mus. Comp. Zool.*, li., 1908, p. 311.

A. Anchors wanting, etc.

B. Phosphatic deposits present, etc.

C. No true supporting rods, etc.

D. Tables of body normal or often very irregular, distorted or incomplete, sometimes wholly wanting; disc seldom with more than ten holes (those in tail may have 20-40 holes).

E. Tables with more or less distinct disc, having 2-10 or more (usually 3-6) holes, often with irregular outline and marginal projections; sometimes with no spire, and thus reduced to small irregular plates with 2-10 perforations.

F. Tables or plates of moderate size, 80-350 $\mu$  in diameter, usually with a single spire.

G. Tables often wanting in skin of body, present in tail; disc quite asymmetrical; spire of moderate height and often with teeth or branches at top... { OOLITICA-  
CONCOLOR.

GG. Tables (or perforated, disc-like plates) present in skin of body; disc rather symmetrical with 3-6 or more holes; spire (when present) high.

H. Phosphatic deposits more than 60 $\mu$  in diameter; tables with spires; colour not old-rose red.

I. Discs of tables in tail not narrowed and drawn out into a rod at either end.

Discs of tables in tail with 6-12 large and small holes... INTERMEDIA.

Discs of tables in tail with 20-40 small holes... DISSIMILIS.

II. Discs of tables in tail narrowed and drawn out at each end into more or less of a rod.

Discs of tables in tail with numerous (10-30) holes, the ends flattened and rough or serrate... ANDAMANENSIS.

Disc of tables in tail with few (5-10) holes, the ends rounded and smooth... PRODUCTAMENSIS.

HH. Phosphatic deposits very minute, 40 $\mu$  or less in diameter; tables reduced to perforated disc-like plates; colour old-rose red... ROSEA.

FF. Tables very small, etc.

EXPLANATION OF PLATE XLVII.

CRINOIDEA.

*Oligometra thetidis.*

Fig. 1.—First pinnule.  $\times 5$ .

Fig. 2.—A pinnule from middle of arm.  $\times 5$ .

Fig. 3.—A cirrus.  $\times 5$ .

*Himerometra pædophora.*

Fig. 4.—First pinnule.  $\times 10$ .

Fig. 5.—Second pinnule.  $\times 10$ .

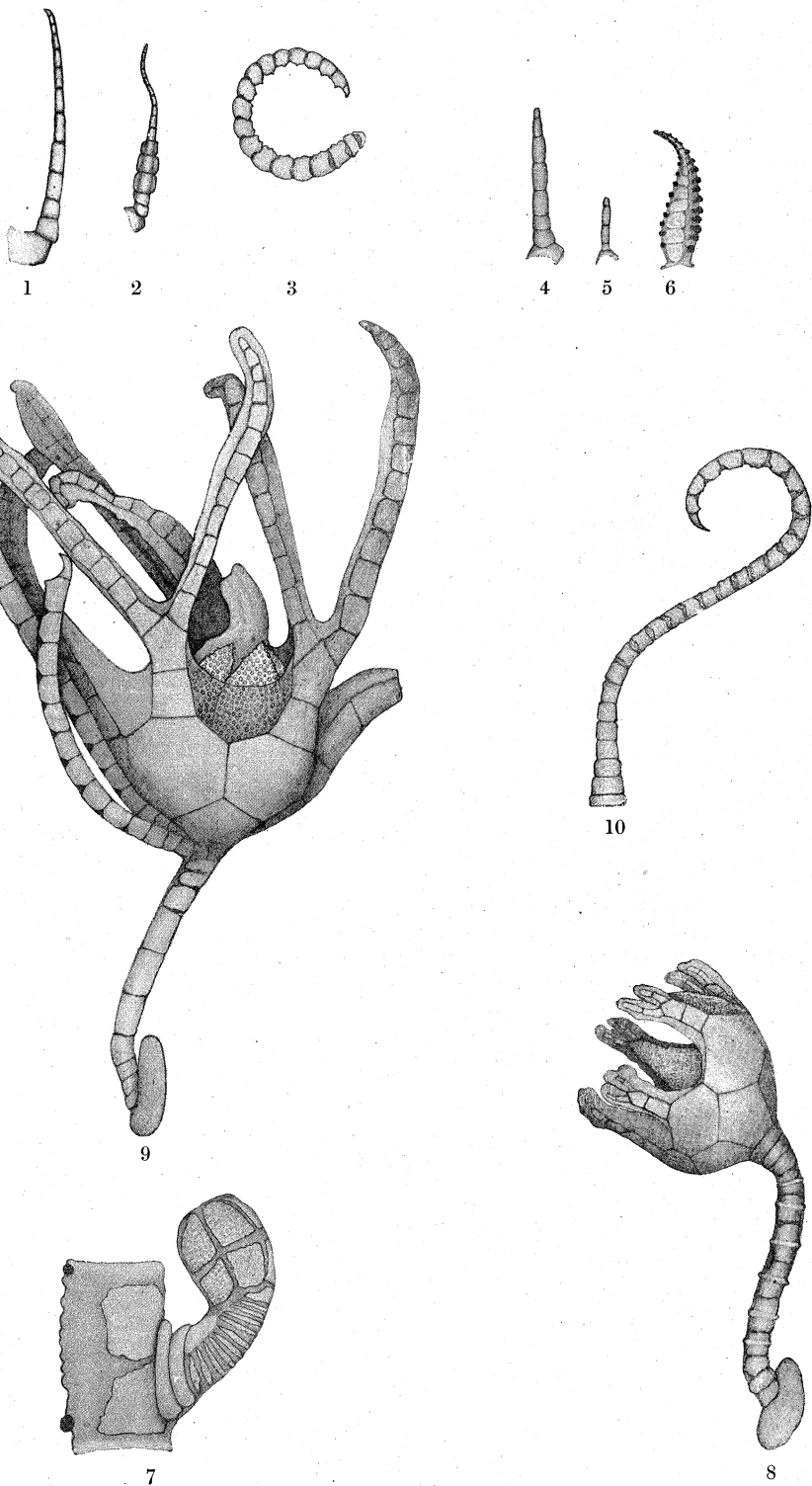
Fig. 6.—A distal pinnule.  $\times 10$ .

Fig. 7.—Youngest pentacrinoid larva.  $\times 35$ .

Fig. 8.—Pentacrinoid larva.  $\times 35$ .

Fig. 9.—Old pentacrinoid larva.  $\times 35$ .

Fig. 10.—A cirrus.  $\times 10$ .



EXPLANATION OF PLATE XLVIII.

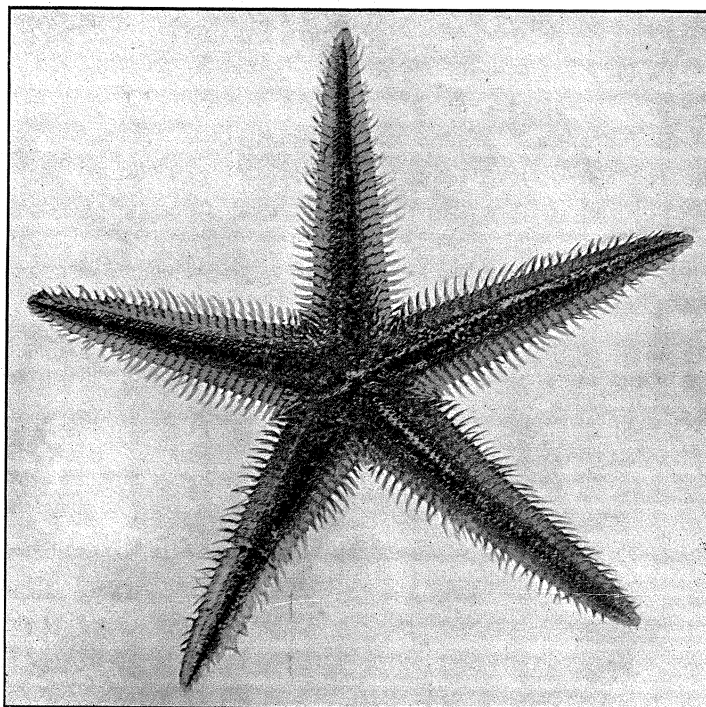
ASTEROIDEA.

*Astropecten pectinatus.*

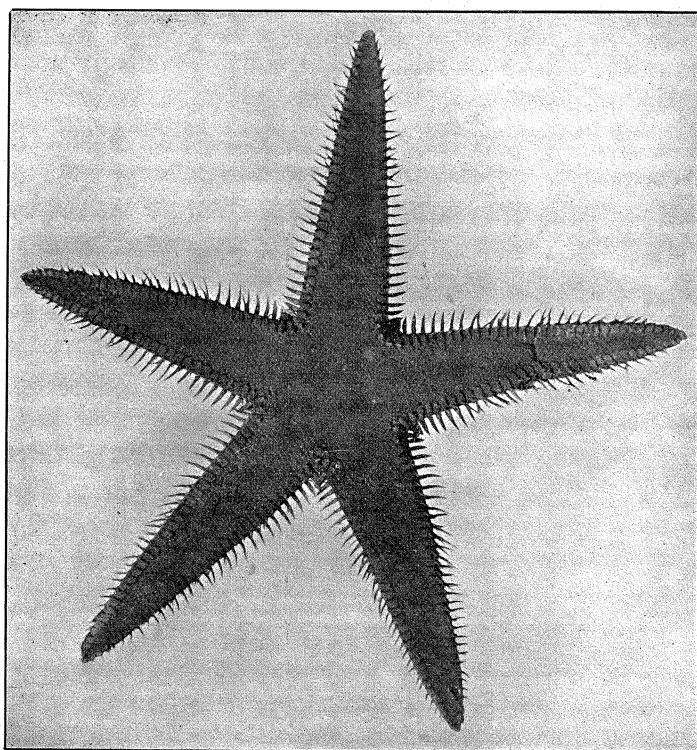
Fig. 1.—Full-grown animal.

Fig. 2.—The same, lower side.

One half natural size.



1



2

EXPLANATION OF PLATE XLIX.

ASTEROIDEA.

*Henricia heteractis.*

Fig. 1.—Full-grown animal.  $\times 1\frac{1}{2}$ .

Fig. 2.—An adambulacral plate with its armature.  $\times 20$ .

*Coscinasterias dubia.*

Fig. 3.—Large pedicellaria from disc.  $\times 70$ .

Fig. 4.—Small pedicellaria from a wreath around one of the dorsal spines.  $\times 70$ .

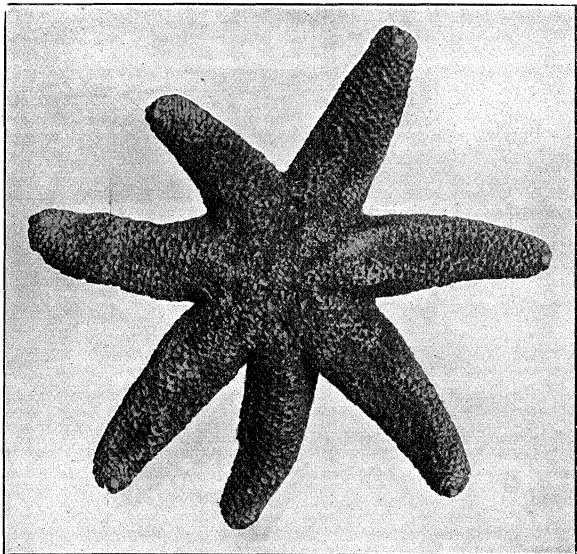
OPHIUROIDEA.

*Pectinura dyscrita.*

Fig. 5.—Side view of three arm-joints.  $\times 5$ .

Fig. 6.—Abactinal view.  $\times 5$ .

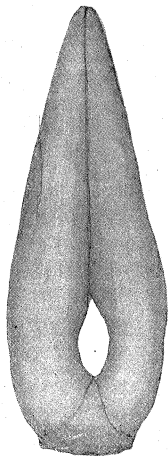
Fig. 7.—Actinal view.  $\times 5$ .



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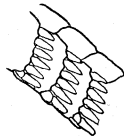
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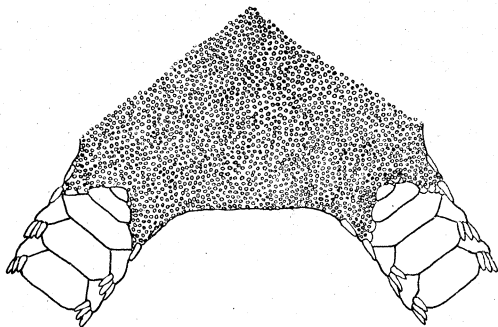
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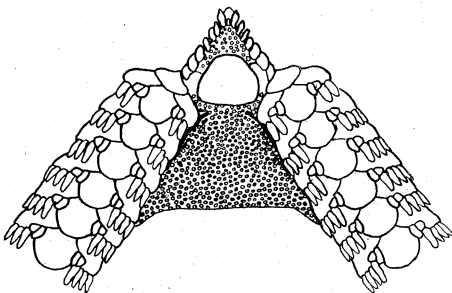
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6



7

A R. McCULLOCH, Photo.

H. L. CLARK (figs. 2-4) and VIOLET DANDRIDGE (figs. 5-7). Del.

EXPLANATION OF PLATE L.

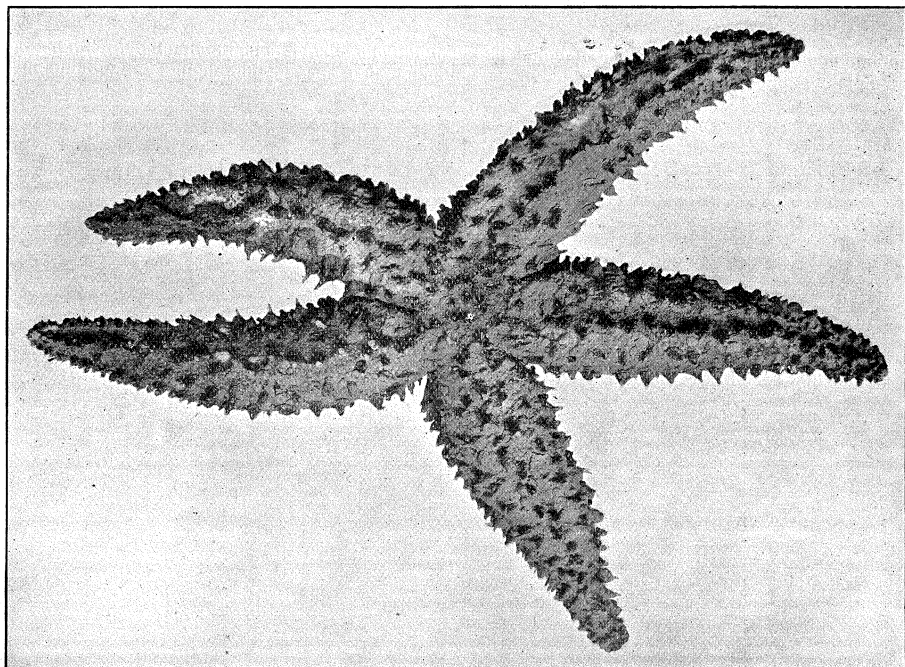
ASTEROIDEA.

*Coscinasterias dubia.*

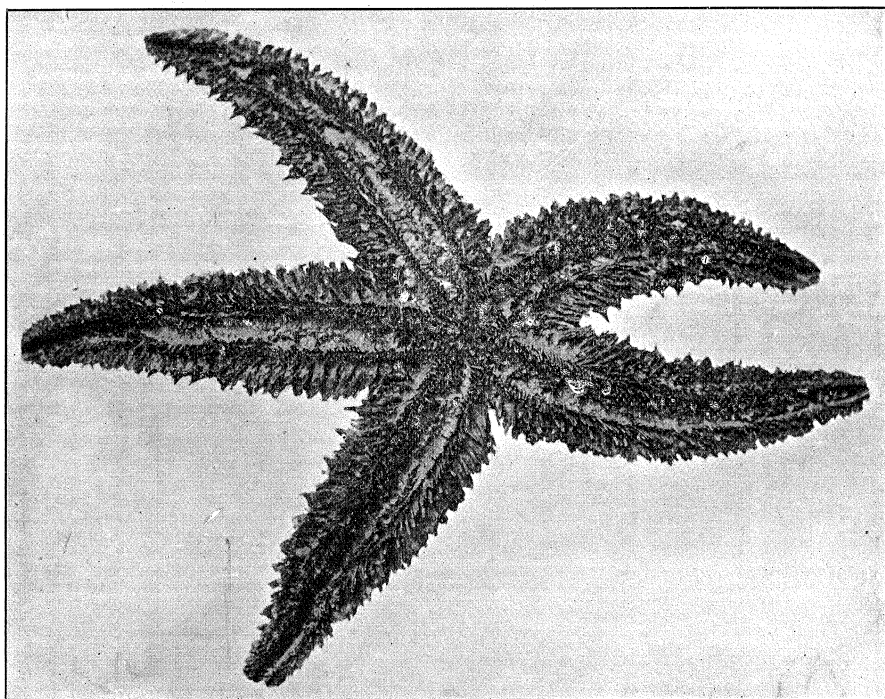
Fig. 1.--Abactinal view.

Fig. 2.—Actinal view.

Two-thirds natural size.



1



2

EXPLANATION OF PLATE LI.

OPHIUROIDEA.

*Ophiozoua gymnopora.*

Fig. 1.—Actinal view.  $\times 15$ .

Fig. 2.—Abactinal view.  $\times 15$ .

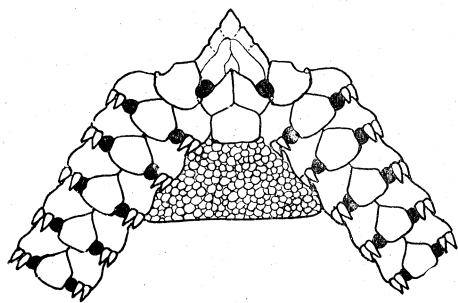
Fig. 3.—Side view of three arm-joints.  $\times 15$ .

*Ophiura ctenophora.*

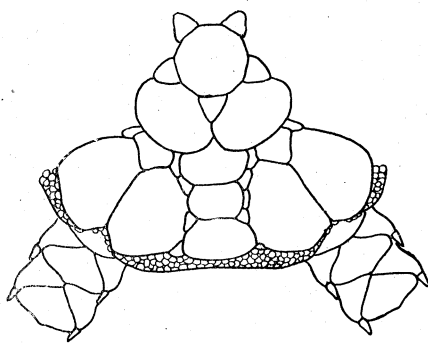
Fig. 4.—Actinal view.  $\times 4$ .

Fig. 5.—Abactinal view.  $\times 4$ .

Fig. 6.—Side view of base of arm.  $\times 4$ .



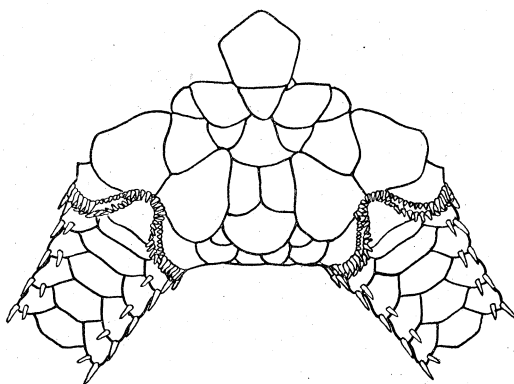
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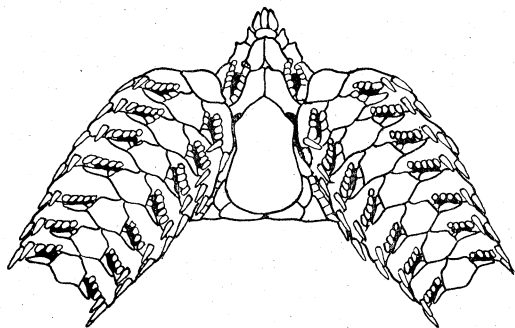
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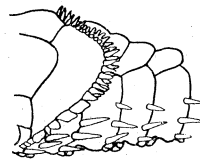
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5



4



6

EXPLANATION OF PLATE LII.

OPHIUROIDEA.

*Amphipholis australiana.*

Fig. 1.—Actinal view.  $\times 16$ .

Fig. 2.—Abactinal view.  $\times 16$ .

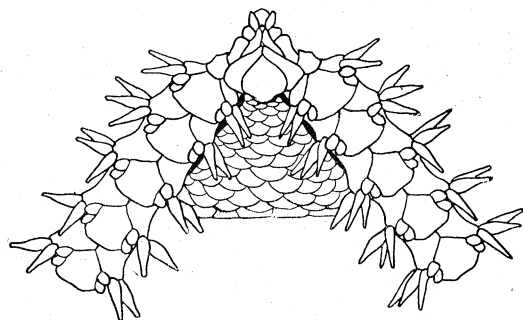
Fig. 3.—Side view of two arm-joints.  $\times 16$ .

*Ophiacantha heterotyla.*

Fig. 4.—Actinal view.  $\times 14$ .

Fig. 5.—Abactinal view.  $\times 14$ .

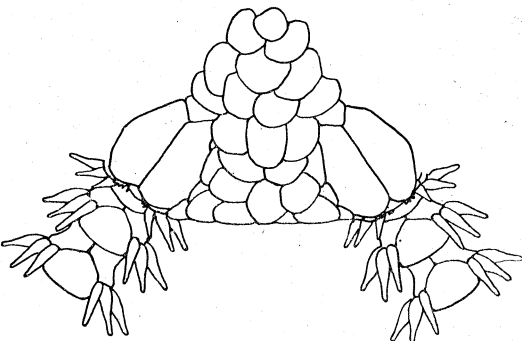
Fig. 6.—Side view of second and third arm-joints.  $\times 14$ .



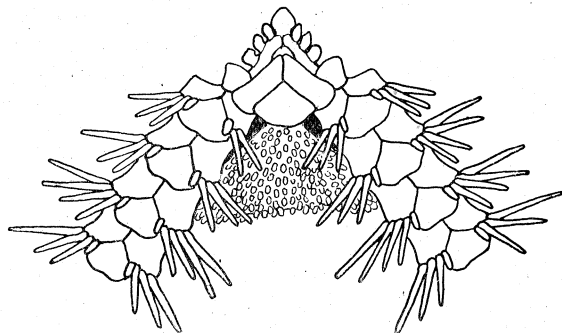
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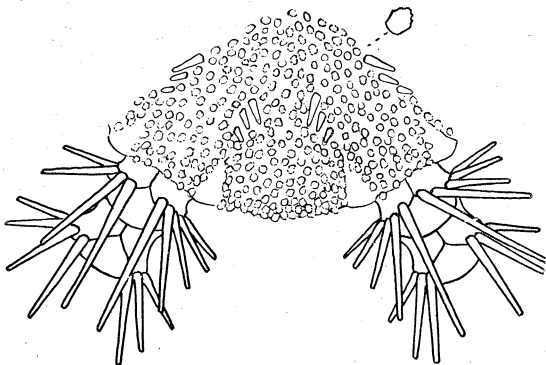
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5

EXPLANATION OF PLATE LIII.

OPHIUROIDEA.

*Ophiopristis axiologus.*

Fig. 1.—Actinal view.  $\times 15$ .

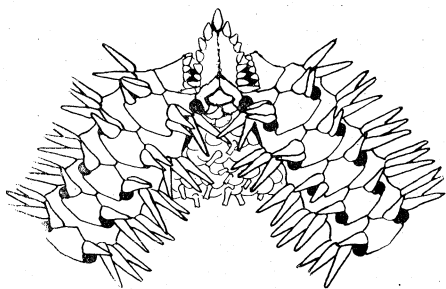
Fig. 2.—Abactinal view.  $\times 15$ .

Fig. 3.—Side view of three arm-joints.  $\times 15$ .

*Ophiothrix ancestra.*

Fig. 4.—Abactinal view of disc and arm bases.  $\times 7$ , with some of the disc-stumps and spinelets more highly magnified.

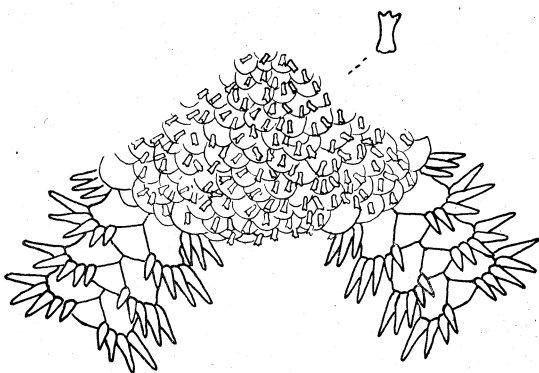
Fig. 5.—Ventral view of three arm-joints.  $\times 7$ .



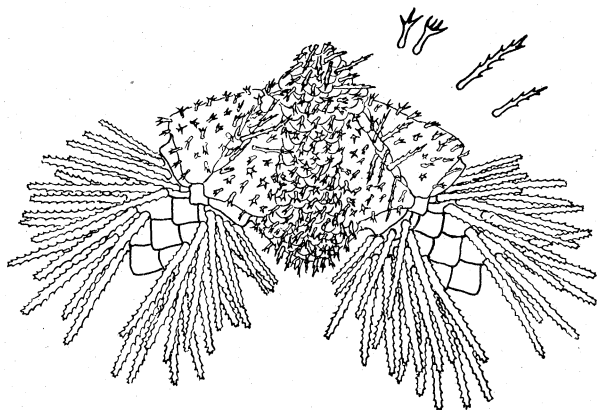
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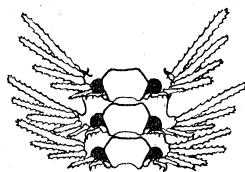
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5

EXPLANATION OF PLATE LIV.

ECHINOIDEA.

*Stephanocidaris bispinosa.*

Fig. 1.—Side view. Slightly reduced.

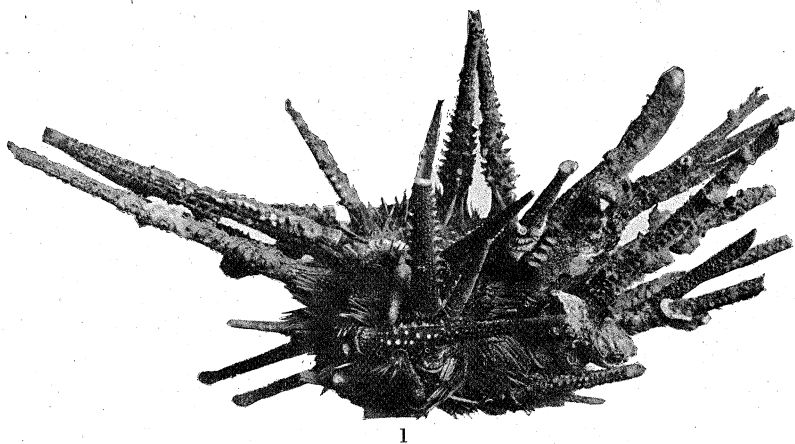
OPHIUROIDEA.

*Astroporpa australiensis.*

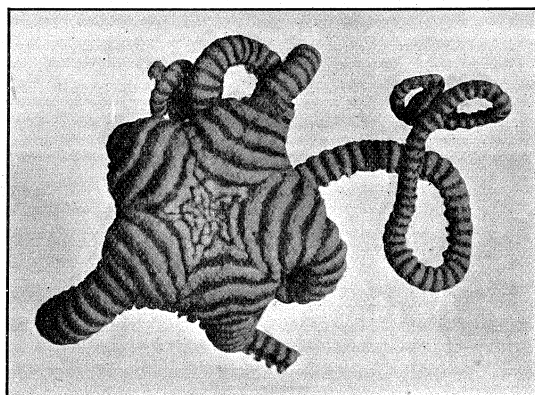
Fig. 2.—Abactinal view.  $\times 2\frac{1}{2}$ .

*Astrothrombus rugosus.*

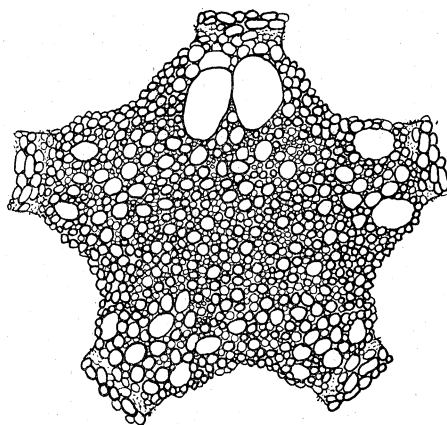
Fig. 3.—Abactinal view of disc and bases of the five arms.  $\times 6$ .



1



2



3

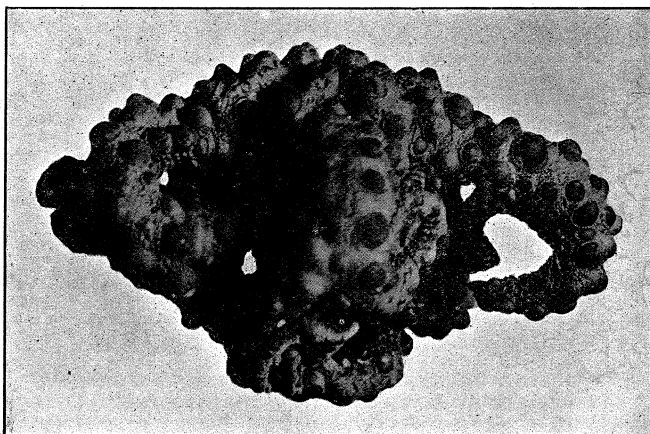
EXPLANATION OF PLATE LV.

OPHIUROIDEA.

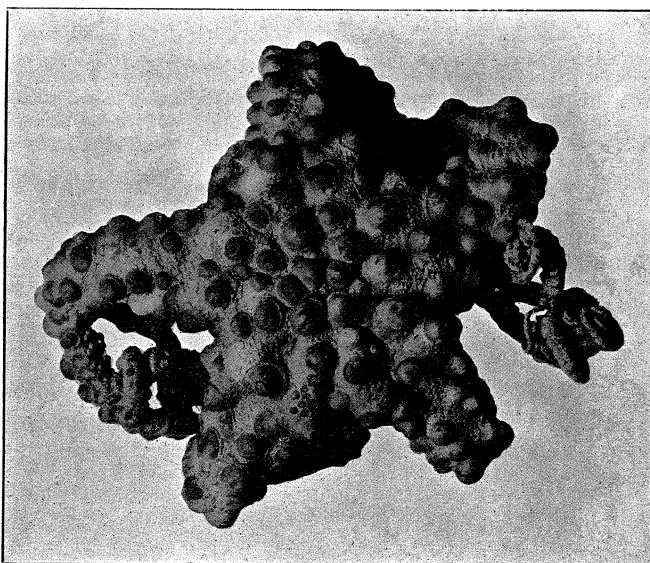
*Conocladus amblyconus.*

Fig. 1.—Side view.  $\times 2\frac{1}{2}$ .

Fig. 2.—Abactinal view.  $\times 2\frac{1}{2}$ .



1



2

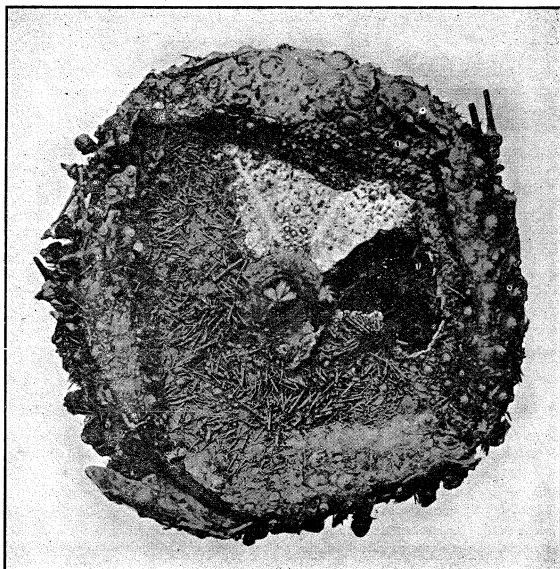
EXPLANATION OF PLATE LVI.  
ECHINOIDEA.

*Chætodiadema tuberculatum.*

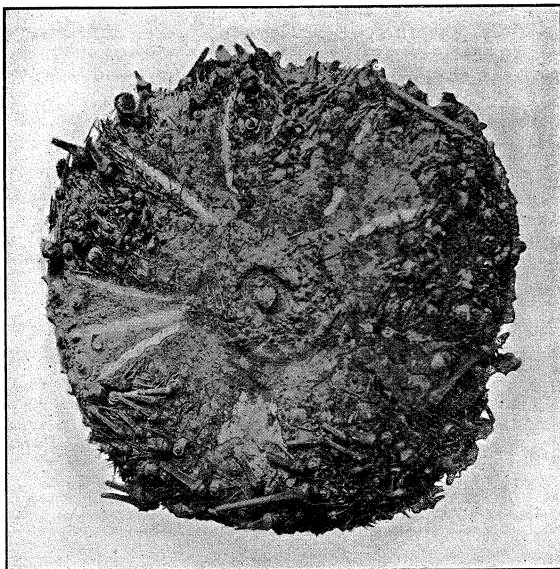
Fig. 1.—Actinal view.

Fig. 2.—Abactinal view.

Slightly enlarged.



1



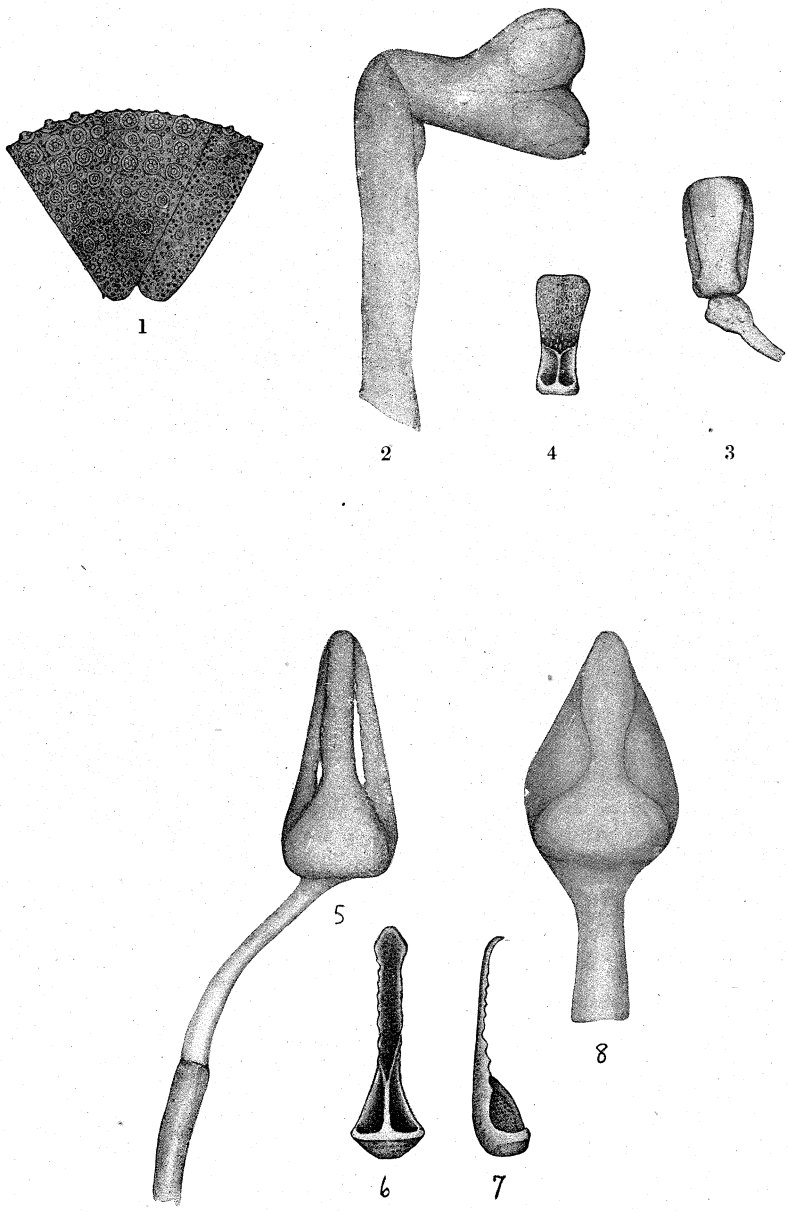
2

EXPLANATION OF PLATE LVII.

ECHINOIDEA.

*Chætodiadema tuberculatum.*

- Fig. 1.—Actinal view of an interambulacrum and an ambulacrum;  
natural size.
- Fig. 2.—A “claviform pedicellaria.”  $\times 70$ .
- Fig. 3.—A triphyllous pedicellaria.  $\times 70$ .
- Fig. 4.—Valve of a triphyllous pedicellaria.  $\times 70$ .
- Fig. 5.—A tridentate pedicellaria.  $\times 70$ .
- Fig. 6.—Valve of same.  $\times 70$ .
- Fig. 7.—Same as fig. 6, seen from side.  $\times 70$ .
- Fig. 8.—A very large pedicellaria, incompletely developed  $\times 70$ .



## EXPLANATION OF PLATE LVIII.

### ECHINOIDEA.

#### *Fibularia nutriens.*

- Fig. 1.—An ophicephalous pedicellaria.  $\times 400$ .  
Fig. 2.—Another, open, from another point of view.  $\times 400$ .  
Fig. 3.—Valve of a tridentate pedicellaria  $\times 400$ .  
Fig. 4.—Tip of a spine.  $\times 400$ .  
Fig. 5.—A female, natural size, from above.  
Fig. 6.—The same.  $\times 8$ .  
Fig. 7.—Another from the side.  $\times 8$ .  
Fig. 8.—The same as fig. 7, from below.  $\times 8$ .  
Fig. 9.—A male, from above.  $\times 8$ .  
Fig. 10.—Interior view, abactinal half of test removed, showing intestine and lantern in position.  $\times 8$ .  
Fig. 11.—The same, with intestine and lantern removed, to show mouth and auricles.  $\times 8$ .

### HOLOTHURIOIDEA.

#### *Molpadia dissimilis.*

- Figs. 12-15.—Calcareous tables from body wall ; four discs, and a spire seen from the side.  $\times 70$ .  
Figs. 17-21.—Tables from the caudal appendage ; four discs, and a spire seen from the side.  $\times 70$ .

#### *Molpadia productamensis.*

- Figs. 22-26.—Calcareous tables from body wall ; three discs, and two spires seen from the side.  $\times 70$ .  
Figs. 27-30.—Tables from caudal appendage ; three discs, and a spire seen from the side.  $\times 70$ .

