

NOTES ON ASTEROIDS IN THE BRITISH MUSEUM (NATURAL HISTORY)

2. SOME ASTROPECTINID SPECIES

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(With Plate 6)

THE first Note in this series (John, 1948) began with the statement that the Asteroids in the British Museum (Natural History) were being revised. This, the second Note, will be the last in the series by the present author, who has since left the Museum staff. It is shorter than it was intended to be and deals only with the following six Astropectinid species:

<i>Lonchotaster tartareus</i> Sladen.	<i>Leptychaster antarcticus</i> Sladen.
<i>Dytaster exilis</i> Sladen.	<i>Leptychaster kerguelensis</i> Smith.
<i>Plutonaster agassizii</i> (Verrill).	<i>Craspidaster hesperus</i> (Müller & Troschel).

Lonchotaster tartareus Sladen

Lonchotaster tartareus Sladen, 1889, *Rep. Voyage Challenger* (Zool.), 30 : 104, pl. 16, figs. 1-5.

The only species and the only specimens of the genus *Lonchotaster* remain those described by Sladen in 1889, *L. tartareus* from 2,400 fathoms between the Canaries and the Cape Verde Islands, and *L. forcipifer* from nearly 2,000 fathoms in the Southern and Antarctic Oceans south-west of Australia. The large Astropectinid described by H. L. Clark (1916: 30) as *Lonchotaster magnificus* was referred to *Dipsacaster* by Fisher (1919: 150).

Fisher, both in 1917 (p. 170) and 1919 (p. 150), makes what are, in effect, minor corrections to Sladen's account of *L. tartareus*, saying there is a small spine on each marginal plate and one on most of the actinal intermediate plates; he refers to Sladen's figures as bearing out his statement. As for the superomarginal plates, Fisher is wrong and Sladen's account, with which his plate agrees, is correct: 'within the interbrachial arc and at the base of the rays in the large example, a small conical tubercle is present close to the upper end of the plate, but it is not found in the smaller specimens'. For the inferomarginals neither Sladen's account nor Fisher's is quite correct. In the larger specimens there are small spines, of diminishing size, as far out as about the thirtieth plate, but not beyond; they are present on the plates of the interbrachial arc of one of the smaller, entirely absent from the other.

Sladen's account of the spination of the actinal intermediate plates is correct, including the implication that there are no spines on those of the smaller specimens.

Dytaster exilis Sladen

Dytaster exilis Sladen, 1889, *Rep. Voyage Challenger* (Zool.), 30: 65, pl. 2, figs. 3 & 4; pl. 4, figs. 9 & 10 (figs. of var. *gracilis*); Wood-Mason & Alcock, 1891: 429; Alcock, 1893: 80.

The *Challenger* took the type of *D. exilis* off Valparaíso in the Pacific, those of its varieties *gracilis* and *carinata* in the Atlantic near Tristan da Cunha and off the Maryland coast of N. America respectively. The only subsequent records are those of *exilis* itself by Wood-Mason and Alcock from the Bay of Bengal, where it 'has several times been met with . . . between 1748 and 1924 fathoms on globigerina ooze'. They did not describe their specimens beyond giving the colour when fresh as salmon-pink.

One of their specimens, from St. 117, 1,748 fms., is in the British Museum. It is dry and small: $R = 47$ mm., $r = 9$ mm., $R:r$ is 5.2. The abactinal paxillae have four to ten finely thorny spinelets; there are no pedicellariae among them. The superomarginals number thirty-three. They are not confined to the lateral wall but encroach a little on the abactinal surface; those in the inter-brachial angle do so to the extent of 1 mm. This is a marked difference to the type of *exilis*; in the variety *gracilis*, on the other hand, they do encroach abactinally though not so strongly as in this specimen. When seen from the side the length of the plates is less than the height in the inter-brachial angle, greater than it in mid-arm, equal to it at the end of the arm. The large spines are missing from the plates at the ends of the arms which are abraded, but I am unable to say if they have merely been rubbed off.

The inferomarginals correspond to and are of the same size as the superomarginals as seen from the side. On the actinal surface their breadth is greater than their length on the inner part of the ray. In the interbrachial angle some of the marginal plates of both series carry two spines.

The enlarged spine on the adambulacral plate first appears about half-way down the arm and arises more often from the second than the first comb of spines. The latter has ten, the former eight, spines, and they are followed by a third row as Sladen describes for *exilis*. The actinal intermediate plates extend to about the third inferomarginal. Each bears a group of widely spaced spines, up to fourteen on the largest. They and the spines of the marginal and adambulacral plates are finely thorny.

The madreporite is neither large nor conspicuous.

In the shape of the superomarginal plates, the absence of pedicellariae, and the occurrence of the enlarged spine on the adambulacral plates I see this specimen as nearer to the var. *gracilis* than to *exilis* itself. Experience with other species leads me to believe it possible that more specimens may serve to bridge the gap which now appears to exist.

Verrill (1895: 131) was not able to satisfy himself that *D. exilis* var. *carinata* was distinct from the young of his *D. grandis* (of which *D. madreporifer* Sladen is a synonym). A direct comparison leaves no doubt of its distinctness. In the first place the larger specimen described by Sladen cannot be regarded as young, having $R = 98$ mm. The paxillae of its disk are comparatively large, those of *grandis* conspicuously small; the pedicellariae on the actinal intermediate plates of *carinata* are larger and

of valves more highly modified than those of *grandis* (Plate 6, fig. 1); the adambulacral armature differs, for whereas *grandis* has only one row of strong furrow spines, *carinata* has two, the second being of the peculiar dagger-like form described by Sladen. Finally, the appearance of the two forms is quite different to the naked eye for, whereas *D. grandis* is distinguished by the strong high sides which the marginals give to its rays, in the var. *carinata* the marginals are comparatively poorly developed, their combined height being only a little more than half that of *grandis*, and the spines are correspondingly smaller (Plate 6, figs. 2 & 3).

Plutonaster agassizii (Verrill)

Archaster agassizii Verrill, 1880, *Amer. J. Sci.* **20**: 403.

Plutonaster rigidus Sladen, 1889, *Rep. Voyage Challenger* (Zool.), **30**: 91, pl. 14, figs. 3 & 4; pl. 15, figs. 3 & 4; Koehler, 1909: 19, pl. 4, fig. 6; pl. 10, figs. 5 & 6.

Plutonaster rigidus var. *semiarmata* Sladen, 1889, *Rep. Voyage Challenger* (Zool.), **30**: 94, pl. 14, fig. 5.

Plutonaster agassizii Verrill, 1894, *Proc. U.S. Nat. Mus.* **17**: 248; 1895: 131; 1899: 211, pl. 27, fig. 6.

Verrill (1880: 403) in his 'Notice of the remarkable Marine Fauna occupying the outer banks off the Southern Coast of New England' described the new species *Archaster agassizii*. Sladen (1889) made no reference to Verrill's paper in the *Challenger* Report. In 1894 (p. 248) Verrill placed his species in Sladen's genus *Plutonaster*; listed Sladen's *rigidus* and *rigidus* var. *semiarmata* and a part of his *bifrons*, all from off the coast of North America, as synonyms; and added to the description. In 1899 he described the species as occasionally having pedicellariae and gave a figure showing one.

Koehler (1909: 19) used Sladen's name, *rigidus*, for describing a series taken in mid-Atlantic in the latitude of the Azores, explaining that he did so because he could not be sure that Verrill's *agassizii* and Sladen's *rigidus* were the same. He found Verrill's description inadequate and his attempt to have photographs of his specimens compared with Verrill's had failed.

Dr. Austin Hobart Clark has generously made it possible for me to make the sort of comparison that Koehler wished to make by sending me six specimens of Verrill's species. They came from off New Jersey, 39° 58' 30" N., 70° 30' 00" W., 384 fms.

They show that *agassizii* and *rigidus* are one. Koehler had found that the var. *semiarmata* of Sladen could not be maintained, so variable is the occurrence of spines on the inferomarginal plates. Verrill (1894: 248) says that there may be all gradations from those having no marginal spines whatever to those that have a large spine on nearly every marginal plate of both series. Koehler does not record spines on the superomarginal plates and it may be assumed that they were not present in his specimens. There is none in the six specimens from Verrill before me, but in the type of Sladen's *rigidus* there is on one or two plates a single slightly enlarged granule such as I have seen to occupy a similar position from which a spine often arises in other asteroids.

Koehler makes no mention of pedicellariae. I find a row of four to be present actinally in the midline of one interradius of one of Verrill's specimens, and a single

one in another interradius. They have four or five blades. The type of *rigidus* has some small groups of spines in the actinal intermediate areas which are pedicellaria-like in their disposition, but the 'blades' are short and coarse.

Sladen (p. 92) described the conical spinelet immediately behind the furrow spines on the outer adambulacral plates. Though Koehler did not mention it, it is to be assumed it was present since he identified his specimens with Sladen's species. It is present in Verrill's specimens, more strongly developed in some than in others.

$R:r$ is more than 3 in one of Verrill's specimens ($R = 49$ mm., $r = 15$ mm.); it is less than 3 in the remaining five in which R varies from 42 to 63 mm. and r from 17 to 22 mm.

Verrill included the small specimen which Sladen (p. 88) described with a query as *P. bifrons* in his synonymy of *agassizii*. It possesses a spine on each marginal plate, inferior and superior; there is a large spine behind the furrow series on each adambulacral plate. In view of its origin it is probably the young of *agassizii*, but it cannot be said with certainty that it is.¹

Leptychaster antarcticus Sladen and *L. kerguelensis* Smith

Leptychaster antarcticus Sladen, 1889, *Rep. Voyage Challenger* (Zool.), **30**: 190, pl. 31, figs. 3 & 4; pl. 32, figs. 7 & 8.

Leptychaster kerguelensis Smith, 1876, *Ann. Mag. Nat. Hist.* **17**: 110.

The type of *L. antarcticus*, and a second and smaller specimen taken with it ($R = 10.5$ mm., $r = 4.5$ mm.), are in the Museum collection. They are the only specimens recorded. Bell (1908: 9) thought them the young of *kerguelensis*, but he gave no good reasons for doing so.

Koehler (1917: 53) discussed the question and Fisher (1940: 83) referred to it, but, while not affirming that Bell was wrong, neither accepted his conclusion. It seemed well that I, with access to the types of both species, should re-examine them and other available specimens and report what I find.

The paxillae of the greater part of the swollen abactinal surface of the type of *antarcticus* have lost their spines. It may have happened during transport to and from a safe place in the Second World War. They appear to have been present when the *Challenger* figure (pl. 31, fig. 3) was made. While Sladen's written description is of his usual excellence, fig. 4, pl. 31, is a poor representation: it is, indeed, a misrepresentation of the mouth plates, which are as Sladen describes them in words. It is hoped that the photograph given here conveys a better idea (Plate 6, fig. 4).

Sladen's description of *kerguelensis* is of a large specimen of $R = 66$ mm.; though he listed smaller specimens and gave their sizes he did not otherwise describe them. He states (p. 192) that *kerguelensis* is distinguished from *antarcticus* by the longer and more cylindrically rounded rays, by the larger and more compact paxillae, by the smaller actinal intermediate areas, and, above all, by the characteristic adambulacral armature.

The smallest specimen of *kerguelensis* in the collection was taken with three larger

¹ A doubt is possible about its origin. On p. 87 Sladen gives it as St. 47, off the coast of N. America. On p. 88 he gives St. 47a. There was no *Challenger* station of that number but there was one by the *Porcupine* and it was in the Faroe Channel.

specimens (R up to 60 mm.) in 50 fms., off Marion Is. In it $R = 13.8$ mm. and $r = 5$ mm., so that it is slightly smaller than the type of *antarcticus* ($R = 15$ mm., $r = 6$ mm.). A direct comparison has been made between them. The rays of the *keruelensis* specimen are, in proportion, longer and more rounded, and the actinal intermediate areas are smaller; and the differences in proportion give a different facies to each specimen.

But the paxillae are similar in the two specimens and as Sladen described them for *antarcticus*, though his figure is not very good. It is, however, far better than is that of the paxillae of *keruelensis* (pl. 32, fig. 1). In only three of the fifteen Museum specimens are they as shown in that figure, with the spines represented by low rounded granules, tending to be polygonal where crowded. In the others they are much more spine-like and radiate apart. Though it is not necessarily the biggest specimens in which the paxillae spines are lowest and most crowded, it is in the smallest that they are most spine-like. In short, the distinction between *keruelensis* and *antarcticus* based upon the nature of their paxillae appears not to be real.

The question of the adambulacral armature remains. It can only be said that Sladen's descriptions are correct and that his figs. 2 & 8, pl. 32, are good representations. It may be added that Koehler's eight specimens of *keruelensis* conformed with Sladen's description for that species, and that it is implicit in Fisher's account that his three specimens also did so.

And so, since no intermediate stages have been found, it seems best to go on regarding *keruelensis* and *antarcticus* as distinct species distinguished by their different adambulacral armature.

The three starfishes from the Cape which Bell (1905: 242) recorded as *L. keruelensis* are *Dipsacaster sladeni* Alcock, as Mortensen (1933: 237) pointed out. Bell (1908: 9) also recorded the species from the Ross Sea, including one specimen in which $R = 212$ mm. I cannot find that specimen; nor are there any Ross Sea specimens labelled *L. keruelensis*. There are several jars labelled by Bell '*Leptychaster* young' or 'very young', and I suppose them to be the young examples to which he referred. They are, however, not *Leptychaster* but *Odontaster*—and some other genera are included.

Craspidaster hesperus (Müller & Troschel)

Archaster hesperus Müller & Troschel, 1840, *Ber. preuss. akad. Wiss.*: 104.

Craspidaster hesperus Sladen, 1889, *Rep. Voyage Challenger* (Zool.), **30**: 177, pl. 17, figs. 5-7; pl. 18, figs. 1-4; Döderlein, 1921: 5 (for synonymy), 8, pl. 1, figs. 2-3.

Craspidaster glauconotus Bedford, 1900, *Proc. Zool. Soc. Lond.*: 290, pl. 24, figs. 8a, b; Döderlein, 1921: 8, pl. 1, figs. 4-6.

Craspidaster hesperus crassus Döderlein, 1921, *Siboga Exped. Monog.* **46 i**: 9, pl. 1, figs. 1 & 1a.

There are in the British Museum thirty-nine specimens. One is from an unknown locality, five are said to be from Japan but there can be no certainty of it, twenty-one from the Chusan Archipelago, one from Amoy, and another from Hong Kong (*Challenger*), two each from the Philippines (*Challenger*) and Batavia, and six specimens of Bedford's *glauconotus* from Malacca.

Döderlein had twelve specimens and took into account, for measurements, &c., three more. He recognized three sub-species differing from one another in the length

and width of the arm, the number, size, and spination of the marginal plates, and the number and nature of the actinal intermediate plates. Four of his specimens were from China and Japan, the remainder from East Indian or Malayan seas. The former had shorter and wider arms, and larger and—on the whole, and especially in the second row—fewer actinal intermediate plates. One of the Chinese specimens of unusually plump form, with massive marginals and having only one row of actinal intermediate plates, he made the type of a new sub-species, *crassus*; the remainder he regarded as typical *hesperus*. The Malayan examples, with longer more slender arms, more numerous marginals, smaller and more actinal intermediate plates—especially in the second row—and with, in the larger, spines on the ventral faces of the infero-marginals, he grouped with Bedford's specimens in the sub-species *glauconotus*.

The present collection bears out Döderlein's conclusions concerning the relation of $R : r$, and the number of marginal plates. In the twenty-one Chusan specimens R ranges from 8.5 to 42 mm. and the relation $R : r$ varies from 2.1 in the smaller to 3.5 in the larger. In the six specimens of *glauconotus* from Malacca the range of R is 18 to 67 mm. and of $R : r$ 3.2 to 4.6. There is no doubt that the latter are conspicuously longer-armed. They have, too, a larger number of superomarginal plates. Perhaps the most telling way of making a difficult comparison is to bring together (1) a number of specimens of roughly equal sizes, as follows:

Locality	R in mm.	$R : r$	No. of marginals
? Japan	34	3.2	24
Chusan	29.5	3.1	23
Timor (Döderlein) . .	29	3.6	26
Malacca (<i>glauconotus</i>) . .	31	4.4	33

and (2) a number of specimens with roughly equal numbers of marginal plates:

Locality	No. of marginals	R	$R : r$
? Japan	27	41	3.4
Chusan	30	42	3.5
Hong Kong	31	53	3.6
Philippines	31	37.5	3.8
Malacca (<i>glauconotus</i>) . .	33	31	4.4

The first list shows that Bedford's *glauconotus* is sharply marked off from the other specimens by the high value of $R : r$ and by the large number of marginal plates; the second, that a specimen of *glauconotus* with a given number of marginals is of much smaller major radius and has a markedly higher value of $R : r$ than specimens of *hesperus* with the same number of marginals.¹ Each list tells the same story, but by means of different specimens.

One of the Batavia specimens is roughly equal in size ($R = 57$ mm.) to one of those from Malacca ($R = 59$ mm.). $R : r$ is 4 in the former, 4.3 in the latter, and the relative numbers of marginal plates are 40 and 47.

¹ The large major radius of the Hong Kong (*Challenger*) specimen is because of its peculiarly massive marginals; compare the type of *crassus* which, with only 20–22 marginals, has $R = 46$ mm.

The spines on the lower surfaces of the inferomarginal plates and on the actinal intermediate plates afford a strong difference between Bedford's *glauconotus* and typical *hesperus*. They are well developed on each of the six specimens. They occur, strongly on the inferomarginal plates, poorly developed on the actinal intermediate plates, of the larger specimen ($R = 57$ mm.) from Batavia; there are traces of them on the actinal-intermediate plates only of the second Batavian specimen ($R = 57$ mm.). There are spines, varying in number but never numerous, on the lower surfaces of the inferomarginals of (1) the *Challenger* specimen from Hong Kong (an odd one or two), (2) the larger *Challenger* specimen from the Philippines (one on each of two rays), and (3) one of the Japan specimens (one on each of the first eight plates).

I find nothing to support Döderlein's implication that there is a real difference in the number of actinal intermediate plates of 'Chinese' and 'Malayan' specimens. He gives as a characteristic of some of the former that they have few and massive plates, sometimes only one row (var. *crassus*). It is true that in the British Museum collection six of the smaller specimens from Chusan ($R = 10-17$ mm.) have only one row, but since the remaining and larger specimens have two rows, and the largest specimens have the highest number of plates, this is clearly a matter of growth. The only other specimens with no second row of actinal intermediate plates are (1) one of *glauconotus* of no less than $R = 60$ mm. (no second row in two interradii; a single plate comprises the 'second row' in each of the other three); (2) the smallest specimen of *glauconotus* ($R = 18$ mm.); (3) Sladen's 'young phase' ($R = 22$ mm.) from the Philippine Islands. The largest *glauconotus* ($R = 67$ mm.) has six to eight plates in the first, three plates in the second, row. The specimen from an unknown locality is exceptional: it has $R =$ only 31 mm. and yet has seven to eight plates in the first row, three to four in the second, and it possesses a third row of one plate on either side.

Sladen described the occurrence of a thumb-like spine on the aboral margin of the adambulacral plates of his Hong Kong specimen and its absence from those from the Philippines. It was not present in the specimens from the Philippines seen by Fisher (1919: 60). Döderlein does not mention it.¹ It is (as Bedford says) present in *glauconotus*; I find it in each specimen from the smallest ($R = 18$ mm.) to the largest ($R = 67$ mm.). It is present in the specimen from an unknown locality and in that from Amoy, in three of those from Japan ($R = 35-41$ mm.), but it is absent from all but a few plates of the fourth ($R = 34$ mm.). It is not present in the two specimens from Batavia. It is absent from twenty of the twenty-one specimens from Chusan of $R = 8.5$ to 29.5 mm., but is present in the twenty-first which is conspicuously larger having $R = 42$ mm.

The conclusion appears to be that in the present state of our knowledge *glauconotus* should continue to rank as a sub-species distinguished by the length of its rays, the number of its marginals, and the presence of spines on the inferomarginal and actinal intermediate plates; but that *crassus* cannot be maintained. The species is seen to be variable: e.g. the Hong Kong specimen approaches Döderlein's *crassus* in its massive marginals and yet bears traces of spines, a *glauconotus* character, on some of them; the thumb-like spine of the adambulacral plate is absent from most small

¹ His fig. 6a on pl. 1 shows it to have been absent from his specimen from Lombok. Text-fig. 1 and the accompanying text do not make clear the possibility of its existence.

specimens but it is present in one *glauconotus*, $R = 18$ mm., and it may be entirely wanting on large specimens up to $R = 57$ mm.

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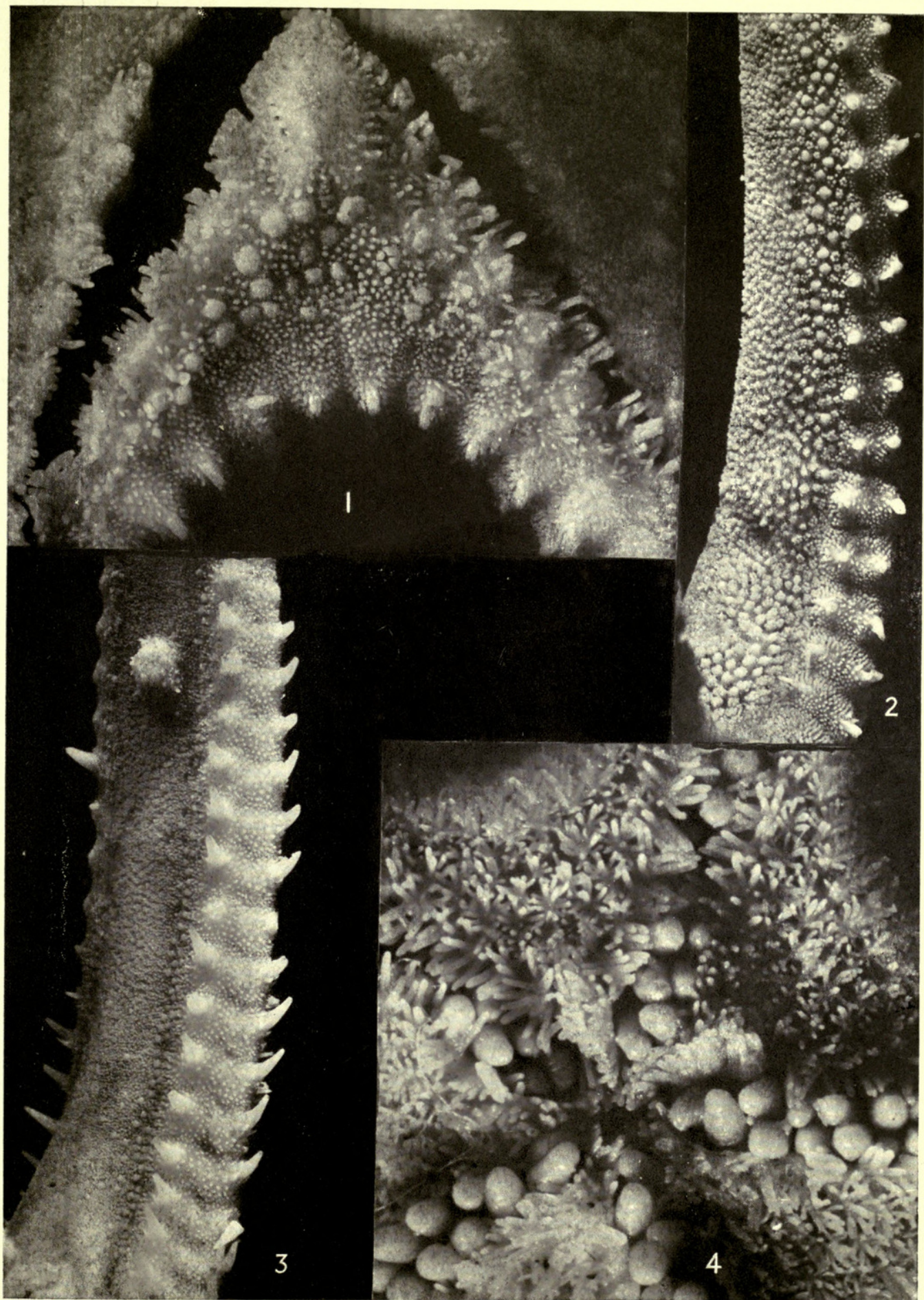
PLATE 6

FIG. 1. *Dytaster exilis* var. *carinata*, type, mouth-angle and actinal-intermediate area, $\times 5$.

FIG. 2. *Dytaster exilis* var. *carinata*, type, side view of the proximal portion of arm, $\times 4$.

FIG. 3. *Dytaster grandis*, cotype, side view of proximal portion of arm, $\times 4$.

FIG. 4. *Leptychaster antarcticus*, type, under surface of disk, $\times 10$.





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