

# REPORT ON THE ECHINOIDEA COLLECTED BY THE UNITED STATES FISHERIES STEAMER "ALBATROSS" DURING THE PHILIPPINE EX- PEDITION, 1907-1910. PART I. THE CIDARIDAE

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## INTRODUCTION

In presenting herewith the first part of the Report on the Echinoids, collected by the *Albatross* Philippine Expedition, the author begs to express his sincere thanks to the authorities of the United States Bureau of Fisheries, of the Department of Commerce, and of the United States National Museum for the privilege of working up this most important collection. Special thanks are due to Mr. Austin H. Clark, the Curator of Echinoderms in the United States National Museum, as also to Dr. H. L. Clark, Museum of Comparative Zoology, Harvard College, Prof. R. Koehler, Lyon, and Prof. L. F. de Beaufort, director of the Zoological Museum, Amsterdam, for much important help in various ways in connection with this work.

The work was begun several years ago, but had to be laid aside for some time on account of the author's absence during his expeditions to the Pacific in 1914-1916 and to the Kei Islands in the Malay Archipelago in 1922. The delay thus caused in the working up of the collection is, however, far outweighed by the fact that the ample echinoid material brought together by the author from various parts of the Pacific region has proved to be of the greatest importance for the study of the *Albatross* collection. Thus it may well be said that without the goniocidarids, collected by the author at the Kei Islands, it would hardly have been possible to have reached a satisfactory conclusion in regard to various small goniocidarids in the *Albatross* collection—*Rhopalocidaris hirsutispina*, var. *viridis*, *Schizocidaris serrata*, and *Schizocidaris fasciata*.

The present first part of the report on the *Albatross* echinoids deals only with the family Cidaridae. The number of species and varieties of this family represented in the collection amounts to 27. Of these, 6 species and 7 varieties are new to science, 2 of them representing

new genera and 1 a new subgenus. Two of the new species, *Histocidaris magnifica* and *Goniocidaris (Discocidaris) peltata*, are among the most magnificent cidarids known. Each of them is represented only by a single, fortunately very beautifully preserved, specimen. The new genus *Psilocidaris* is especially interesting, being evidently related both to the genus *Aporocidaris* and to the genus *Goniocidaris* (in the broad sense), and thus giving the clue to the true systematic position of *Aporocidaris*, the affinities of which were hitherto rather obscure.

The number of species (and varieties) of cidarids, collected by the *Albatross* in the Philippine seas, considerably exceeds that collected by the *Siboga* from the whole of the Malay region which amounted to 18 (19) species. Only 9 species are represented in both collections, while 18 species were taken only by the *Albatross*, as against 9 species taken solely by the *Siboga*. As several species of cidarids not represented in either the *Albatross* or the *Siboga* collections were taken by the author, mainly at the Kei Islands (also one at the Philippines), the total number of species of cidarids known from the Malayan and Philippine seas already amounts to more than 40. Since several of these are represented only by single specimens, it is safe to say that our knowledge of the cidarids of this region is still far from complete. We may well expect that a fair number of additional species will be brought to light there by further investigations, so that the total number of species of cidarids occurring in this region will very probably amount to about 50. Comparison between this number and the 8 (perhaps 10) species of cidarids known from the West Indies and 3 or 4 species known from the whole of the northeast Atlantic very strikingly demonstrates how extraordinarily richly the cidarids are represented in the Philippine-Malayan seas, evidently more richly than in any other part of the world.

# Order CIDAROIDEA

## Family CIDARIDAE

### Genus HISTOCIDARIS Mortensen

#### HISTOCIDARIS MAGNIFICA, new species

Plates 48-49; 76, figs. 1-3

*Locality.*—Station 5547; near Joló (Sulu); Tulayan Island (E.) bearing S. 38° E., 9.5 miles distant (lat. 6° 09' 20'' N., long. 121° 13' 40'' E); 283 meters; bottom temperature 13.50° C.; fine sand; September 15, 1909 (1 specimen, the type, Cat. No. E. 5547, U.S.N.M.).

#### Measurements

h. d.	v. d.	Apical system	Peristome	Number of—		Longest spines
				I. a.	A. pro I. a.	
77 mm...	57 mm..	30 mm. (39 per cent h. d.)	About 20 mm. (26 per cent h. d.)	12	11-12	About 100 mm.

*Description.*—The shape of the test is almost perfectly globular, though it is uncertain whether or not there is a slight flattening of the oral side, as it did not seem desirable to remove the perfectly preserved spines of the oral side in order to ascertain this, which for the description of the species is a rather unimportant detail.

The ambulacra are fairly broad, 10 mm. or 28.6 per cent of the interambulacra, which latter measure 35 mm. in breadth at the ambitus. The interporiferous zone is 3.3 mm. broad, thus almost exactly as broad as each poriferous zone. Both pores are unusually broad, separated only by a very narrow and scarcely projecting wall. The plates are very low, the pairs of pores therefore lying very closely one above another. Also the marginal series of tubercles is very crowded, the tubercles being nearly in contact, though rather small. (Fig. 1.) The marginal series is very regular. Inside the marginal series there is at the ambitus and farther downward a fairly regular series of smaller tubercles on each side; above the ambitus the inner series become irregularly alternating, totally disappearing in the upper part, where the interporiferous zone gradually becomes much narrower.

The primary tubercles of the interambulacra are strongly crenulate, the areoles nearly confluent, except the three upper ones, the following

three being separated only by a very narrow ridge, carrying a series of very small tubercles. The areoles are broad, transversely oval, and not deepened. The median area is fairly broad, slightly more than half as broad as the areoles. Outside the rather prominent scrobicular ring there are several very small tubercles, not regularly arranged, leaving a rather distinct bare median line, which is hardly at all sunken. In the corner between each two areoles there may be, at the ambitus, a single larger tubercle of the same size as those of the



FIG. 1.—PART OF AMBULACRUM OF HISTOCIDARIS MAGNIFICA, NEW SPECIES.  $\times 7.5$

scrobicular ring. The adradial part of the interambulacral plates carries outside the scrobicular ring some rather closely set smaller tubercles, leaving, however, a conspicuous bare margin.

The apical system is somewhat arched, in continuation of the regular arching of the test. The ocular plates are deeply sinuate on the outer edge, and are in contact with the periproct, excepting for the two joining the large madreporic plate. The genital plates are



FIG. 2.—PART OF APICAL SYSTEM OF HISTOCIDARIS MAGNIFICA, NEW SPECIES.  $\times 2.5$

narrow, with large genital openings, which lie entirely within the plate. Tubercles are few, as is usual in this genus, being confined mainly to the circumference of the genital pores, a single arched series occurring proximally on the genital plates, and to a half circle along the outer edge and one or two proximally on the ocular plates. The periproctal plates are rather closely tuberculated. (Fig. 2.) The peristome has not been examined in detail, as this could not be done without doing harm to the splendid specimen.

The primary spines at the ambitus are not very long, the longest preserved being only about 100 mm. in length by a thickness of 3.5 mm., not tapering. Possibly there may have been a few slightly longer, but it may be said with certainty that the longest can only very slightly have exceeded  $1\frac{1}{2}$  h. d. In the present specimen the upper spines taper to a point and are much shorter than those at the ambitus, though fully developed, as is evident from the character of their surface, which means that the specimen has reached its full size. The spines are perfectly smooth, shining, at most with a pair of indistinct longitudinal ridges, without any serrations. Even under the microscope no longitudinal striation is to be observed. The collar is short, 3–4 mm. in length, widening toward the milled ring. The oral primaries are of the typical form, curved, strongly serrate, with a smooth point, ending abruptly, not bifid as may be the case in some species (*elegans*, *acutispina*); but this may be due to the point being worn. The two proximal ones are fairly broad, the third is more slender, and the fourth is only recognizable as an oral primary through its strong lateral serration; the fifth and sixth still carry some small lateral serrations, being transitional forms. From the third onward the spines have the point slightly widened, longitudinally serrate, ending abruptly as if worn off. This also holds good for the longest spines at the ambitus, which are directed downward, partly even slightly curved. Evidently the animal has been walking on the points of all these spines, only the shorter spines above the ambitus being directed upwards.

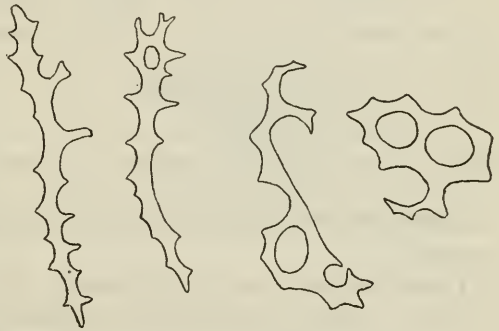


FIG. 3.—SPICULES FROM TUBE FEET OF *HISTOCIDARIS MAGNIFICA*, NEW SPECIES.  $\times 240$

The secondary spines surrounding the primaries are fairly robust, about 12 mm. long, broad, distinctly excavate on the outside, especially toward the end, which is not at all or only slightly narrowed. (Pl. 76, figs. 1–2.) This excavation is especially conspicuous on the spines below the ambitus. The ambulacral spines are about 8–10 mm. long, very slender, almost setaceous, and erect.

The pedicellariae have the heads about 5 mm. long; the valves (pl. 76, fig. 3) are slender, the blade being filled with the usual meshwork, with no depression above the apophysis. The smaller forms are not peculiar, all transition stages being found between the large and the small ones.

The spicules of the tube feet are rather small more or less fenestrated rods, and are irregularly scattered. Toward the end of the tube feet they become somewhat larger fenestrated plates. (Fig. 3.)

The color of test and secondary spines is dark brownish the primaries whitish-brownish with the collar somewhat darker.

*Remarks.*—This splendid large species is very markedly distinct from all the other species of this genus hitherto known; it does not seem very closely related to any of them.

**HISTOCIDARIS ACUTISPINA, new species**

Plate 50, figs. 1, 2; plate 52, fig. 2; plate 77, fig. 4

*Localities*.—Station 5429, near eastern Palawan; Fondeado Island (SE.) bearing N. 18° E., 15 miles distant (lat. 9° 41' 30'' N., long. 118° 50' 22'' E.); 1,401 meters; green mud; April 5, 1909 (a few primary spines, Cat. No. E. 1285, U.S.N.M.).

Station 5495, between Leyte and Mindanao; Diuata Point (N.) bearing S. 76° E., 9.4 miles distant (lat. 9° 06' 30'' N., long. 125° 00' 20'' E.); 1,785 meters; bottom temperature 11.28° C.; gray mud; August 2, 1909 (1 specimen, the type, Cat. No. E. 1275, U.S.N.M.).

*Measurements*

h. d.	v. d.	Apical system	Peristome	Number of—	
				I. a.	A. pro I. a.
20 mm ...	14 mm ...	10.5 mm. (52.5 per cent h. d.)...	8 mm. (40 per cent h. d.)....	7 (6)	8-9

*Description.*—In shape the test is rather low, with the sides gently curving.

The ambulacra are 3 mm. broad, the interporiferous zone being 1.2 mm. broad, thus slightly broader than each poriferous zone.

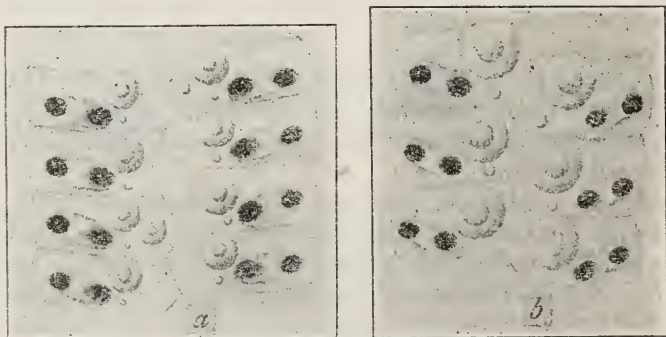


FIG. 4.—PART OF AMBULACRUM OF HISTOCIDARIS ACUTISPINA, NEW SPECIES (a) AND OF HISTOCIDARIS, SPECIES (b)  $\times 12$

The marginal series of tubercles is regular, the tubercles being small and relatively distant; within the marginal series there is only here and there a small tubercule, the zone being thus almost wholly naked; it is not sunken. The pores are subequal in size, the inner one only indistinctly the larger. The wall between the pores is very little prominent. (Fig. 4a.)

The primary interambulacral tubercles are distinctly crenulate; the areoles are confluent except for the two or three upper ones and are not deepened. The middle area is narrow, scarcely half as broad as the areole. There is thus hardly room for any tubercles except those of the scrobicular ring, which are small and little prominent. The outer adradial part of the interambulacral plates is very narrow, with no tubercles outside those of the scrobicular ring. There is a narrow naked median line in the interambulacra which is slightly depressed.

The apical system (fig. 5) is rather elevated; the oculars come near the periproct, which probably means that in adult specimens they are insert. Genital openings have only just been formed. The tubercles are few, and are confined mainly to the middle of the plates, as is usual in this genus. It appears that the interambulacral plates of the peristome have just begun to form.

The primary spines are very long, about four times the horizontal diameter. (Probably the length will prove to be relatively less in adult specimens.) They are very slender, scarcely tapering at all. Of the isolated spines from station 5429—which evidently belong to this species—the longest is 116 mm., with a thickness of 2 mm. They are very coarsely spinous through bearing spinules directed obliquely forward which may show a more or less distinct arrangement in three or four longitudinal series in the basal part, but otherwise are without any serial arrangement. (Pl. 52, fig. 2.) The surface of the spines is otherwise very smooth and shining, with only the faintest indication of a longitudinal striation when seen under the microscope. The collar is short, only 2-3 mm. in length, thickening only very inconsiderably downward. Some of the spines are more or less widened at the tip; one of them has a small thickening in the middle, due probably to some parasitic organism; the outer layer is partially lacking here. One of the spines has a terminal portion of nearly 20 mm. as yet undifferentiated. The oral primaries (in the specimen in hand only the three proximal ones) are as usual strongly serrate and curved; they are very slender.

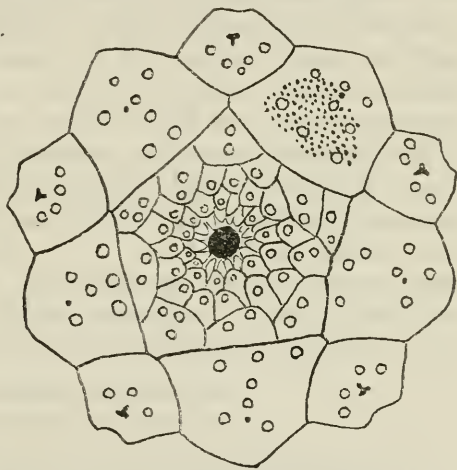


FIG. 5.—APICAL SYSTEM OF *HISTOCIDARIS ACUTISPINA*, NEW SPECIES.  $\times 5$

The secondary spines surrounding the primary spines are about 4 mm. long, flattened, very slender, and only very little broadened at

the base. Those of the ambulacra are simply setaceous, erect, almost as long as those around the primary spines.

The pedicellariae are up to about 3 mm. in length of head, with slender, elongate valves (pl. 77, fig. 4); the blade is filled with a close meshwork, with more or less distinct longitudinal crests; there is no depression above the apophysis.

The spicules of the tube feet are of the usual type.

The color of the test and secondary spines is light yellowish brown; the primaries are white, with the collar faintly yellowish brown like the test.

*Remarks.*—The highly characteristic primary spines make this species easily distinguishable from *H. elegans*, to which otherwise it is apparently the nearest related. Probably also the secondary spines and the apical system will be found to offer good distinguishing characters when once the adult form comes to hand, while the pedicellariae are not very different from some forms of those of *H. elegans*.

The spines of a specimen dredged off Somaliland by the German Deep-sea Expedition<sup>1</sup> (*Valdivia*), referred to *H. elegans* by Döderlein, to some degree resemble those of the present species; still this specimen hardly belongs here. It is noteworthy especially that the spinules on the spines are distinctly arranged in longitudinal series, as is not the case in the present species. Döderlein gives no information concerning the details of the structure of these spines.

#### HISTOCIDARIS ELEGANS (A. Agassiz)

Plate 52, fig. 1; plate 77, figs. 1-3

*Porocidaris elegans* A. AGASSIZ, *Challenger Reports*, Zoology, vol. 3, pt. 9, Echinoidea, 1881, p. 40, pl. 3.—H. L. CLARK, *Bull. Mus. Comp. Zoöl.*, vol. 51, No. 7, 1907, p. 227.

*Histocidaris elegans* TH. MORTENSEN, *The Danish Ingolf-Exped.*, vol. 4, pt. 1, Echinoidea, 1903, pp. 21, 30, 173.—H. L. CLARK, *Biol. Results Fishing Exper. F. I. S. Endeavour*, 1909-1914, vol. 4, pt. 1, 1916, p. 105; *Cat. Recent Sea-Urchins Brit. Mus.*, 1925, p. 37.

*Localities.*—Station 5446; eastern coast of Luzon; Atalaya Point, Batag Island, bearing S. 64° E., 5.3 miles distant (lat. 12° 43' 51'' N., long. 124° 59' 18'' E.); 540 meters; green mud; June 3, 1909 (1 specimen, Cat. Nos. E. 1307, E. 1308, U.S.N.M.).

Station 5450; eastern coast of Luzon; East Point, Batan Island, bearing S. 36° E., 9.2 miles distant (lat. 13° 23' 15'' N., long. 124° 00' 30'' E.); 734 meters; bottom temperature 5.72° C.; green mud and coral; June 4, 1909 (1 specimen, Cat. No. E. 1274, U.S.N.M.).

Station 5510; vicinity of northern Mindanao; Camp Overton Light bearing S. 68° E., 9.1 miles distant (lat. 8° 16' 00'' N., long. 124° 03' 50'' E.); 761 meters; bottom temperature 11.67° C.; gray mud and fine sand; August 7, 1909 (2 specimens, Cat. No. E. 1283, U.S.N.M.).

<sup>1</sup> *Ech. Deutsche Tiefsee-Exped.*, pl. 13, fig. 4.



Station 5512, vicinity of northern Mindanao; Camp Overton Light bearing S.  $76^{\circ}$  E., 14 miles distant (lat.  $8^{\circ} 16' 02''$  N., long.  $123^{\circ} 58' 26''$  E.); 801 meters; bottom temperature  $11.56^{\circ}$  C.; gray mud and fine sand; August 7, 1909 (4 specimens, Cat. No. E. 1366, U.S.N.M.).

Station 5528; between Bohol and Siquijor; Balicasag Island (C.) bearing N.  $15^{\circ}$  E., 5.8 miles distant (lat.  $9^{\circ} 24' 45''$  N., long.  $123^{\circ} 39' 15''$  E.); 790 meters; bottom temperature  $11.83^{\circ}$  C.; globigerina ooze; August 11, 1909 (1 broken test, Cat. No. E. 1261, U.S.N.M.).

Station 5571; north of Tawi Tawi; Simaluc Island (N.) bearing S.  $66^{\circ}$  E., 5.8 miles distant (lat.  $5^{\circ} 30' 45''$  N., long.  $120^{\circ} 07' 57''$  E.); 612 meters; bottom temperature  $11.28^{\circ}$  C.; sand and shells; September 22, 1909 (3 specimens, Cat. No. E. 1385, U.S.N.M.).

Station 5618; Molucca Passage; March Island bearing S.  $69^{\circ}$  E., 7.8 miles distant (lat.  $0^{\circ} 37' 00''$  N., long.  $127^{\circ} 15' 00''$  E.); 750 meters; gray mud; November 27, 1909 (1 specimen, Cat. No. E. 1296, U.S.N.M.).

Station 5656; Gulf of Boni, Celebes; Olang Point bearing N.  $67^{\circ}$  W., 14.5 miles distant (lat.  $3^{\circ} 17' 40''$  S., long.  $120^{\circ} 36' 45''$  E.); 871 meters; gray mud; December 19, 1909 (2 specimens, Cat. Nos. E. 1260, E. 1284, U.S.N.M.).

*Remarks.*—The specimens from station 5571 are too young to be identified with certainty, but in all probability they belong to this species; in any case they are young histocidarids.

The specimen from station 5618 with the horizontal diameter 38 mm. is a very typical *H. elegans*, its general shape and color and structure of the test and of the spines being in perfect agreement with specimens from the type locality, off Sydney, New South Wales. The pedicellariae are like those of the typical form. (Pl. 77, fig. 1.) In the specimen from station 5450, the pedicellariae are of a slightly different shape. (Pl. 77, fig. 3.) The specimens from stations 5512 and 5510 have the typical form of pedicellariae; the former are peculiar in being dark colored on the test and secondary spines; this may perhaps be due to their having been preserved together with crinoids, the pigment extracted from the crinoids having very often the result of giving specimens of various groups (echinoderms, corals, etc.), an unnatural dark color. Also the large broken specimen from station 5446 has the same dark color (and the same shape of pedicellariae). Concerning this latter specimen it is stated on the label "long spines, some of them yellow, others bleaching white; the short spines pale chrome yellow," so that here we have proof that the dark color is not natural and is due in some way to preservation.

The young specimens from station 5571 deserve special mention. The number of interambulacral plates is 5; only the upper tubercles are crenulate. The ambulacral plates on the upper part are 4 or 5 to each interambulacral plate, at the peristome only 1 or 2 to an

interambulacral plate. The pores are half vertically placed. The peristome (fig. 6) is especially interesting; it is naked except for five large buccal plates, each with two pores for the buccal tube feet, and one or two ambulacral plates, just detached from the ambulacra. The large buccal plates are apparently simple, but on closer inspection are seen to be divided by a fine median line into two lateral halves; thus they were originally paired, as was to be expected. As yet there are no interambulacral plates on the peristome. It is

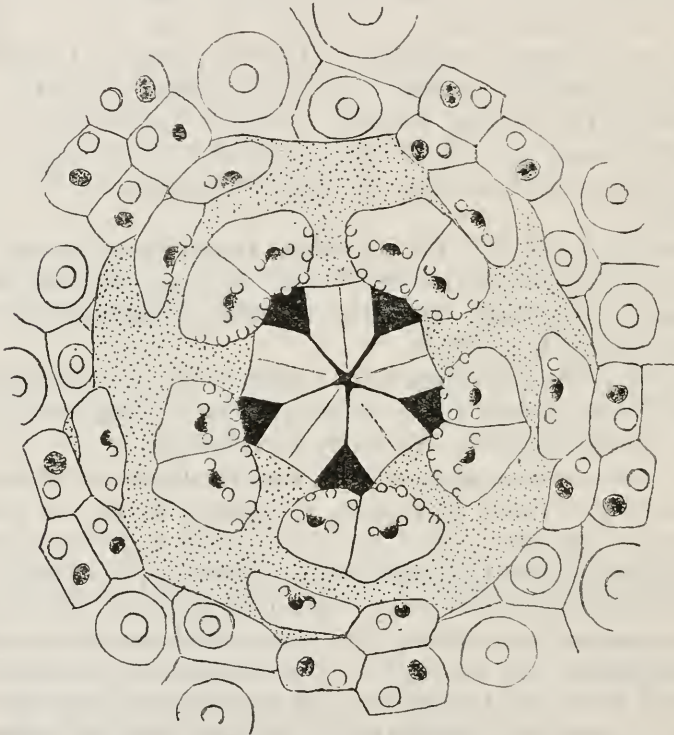


FIG. 6.—PERISTOME OF YOUNG SPECIMEN OF HISTOCIDARIS ELEGANS, OF 7 MM DIAMETER.  $\times 20$

important to notice that there is no trace of an unpaired primary interambulacral plate.

The apical system (fig. 7.) is very simple, perfectly regular, with very few tubercles and, of course, still without genital pores. The longest spines are 27 mm. in length, nearly four times the diameter of the test. The first 1 or 2 oral primaries already have their typical strongly serrate form. The pedicellariae are still only of the smaller form.

The character of the apical system especially shows that the specimens described as "*Cidaris (Histocidaris) elegans, juv.?*" by de Meijere<sup>2</sup> can hardly belong to the same species as the young spec-

<sup>2</sup> *Siboga Echinoidea*, p. 25, pl. 2, fig. 17; pl. 12, figs. 136-140.

imen here described. To which species they belong can not be determined at present; but it must also be kept in mind that the reference of the present small specimens to *H. elegans* is not beyond doubt either. H. L. Clark<sup>3</sup> points out that the pedicellariae of the *Siboga* specimens are peculiar; however, I find the pedicellariae in the young specimens from the *Albatross* collection very much like that figured by de Meijere, and also in larger specimens of undoubted *H. elegans* one may find small tridentate pedicellariae which are quite similar.

Genital pores are not yet developed in specimens of 14–16 mm. in horizontal diameter; but by the time they have reached a size of 24 mm. in horizontal diameter the pores have made appearance. The interradial plates of the peristome as a rule do not begin to appear until somewhat later, at a size of about 27 mm. horizontal diameter. In a specimen of 14 mm. horizontal diameter I find, however, one interradial plate on the peristome in one of the interradii, the others remaining naked.

One of the specimens from station 5656 is especially interesting. It is the largest of all, measuring 50 mm. in horizontal diameter, and is unusually high, 44 mm., being in fact quite egg shaped. (Pl. 52, fig. 1.) There are nine coronal plates. On several of the proximal ones the primary spine has been lost, and in its place a varying number of secondaries have developed. The specimen is a naked test, broken and in a poor state of preservation, but this is evidently not merely due to its having been roughly handled at the capture. Some of the areoles are perforated, which very probably means that the specimen was about to be devoured by some large gastropods at the moment when it came into the trawl. Nearly all the spines are lost, and most of the areoles are perfectly clean, which certainly can not be due to the rough treatment in the trawl. Apparently the specimen was already dead and had lost nearly all its spines when it was captured by the trawl. But it could only quite recently have died, as the intestine is still partly preserved and the peristomial membrane is still intact. Whether the specimen was killed by the mollusks or they only began to devour it after it was dead can not definitely be said, but the fact that most of the spines were already entirely lost, their muscles having completely disappeared, would rather indicate that the specimen had died of old age and then was about to be eaten by the gastropods.

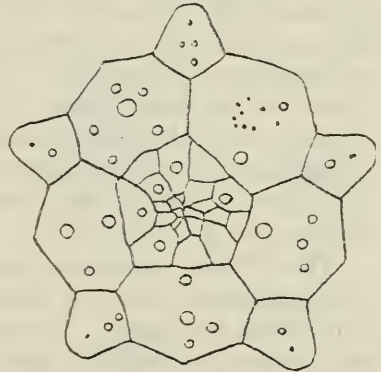


FIG. 7.—APICAL SYSTEM OF YOUNG HISTOCIDARIS ELEGANS, OF 7 MM. DIAMETER.  $\times 11$

<sup>3</sup> Bull. Mus. Comp. Zool., vol. 51, 1907, p. 227.

## HISTOCIDARIS, species

Plate 51, figs. 1, 2; plate 77, figs. 5-8

*Locality*.—Station 5664; Macassar Strait; Kapoposang Light bearing N. 66° E., 3.8 miles distant (lat. 4° 43' 22" S., long. 118° 53' 18" E.); 731 meters; bottom temperature 6.28° C.; hard bottom; December 28, 1909 (1 specimen, Cat. No. E. 1278, U.S.N.M.).

*Measurements*

h. d.	v. d.	Apical system	Peristome	Number of—	
				I. a.	A. pro I. a.
23 mm. ....	13 mm. ....	11 mm. (47.8 per cent h.d.)....	10 mm. (43.5 per cent h.d.)....	7	7-8

*Characters*.—The test is low, flattened above and below, with the sides arched. The ambulacra (pl. 51, fig. 1) are 2.5 mm. wide, and thus 22.7 per cent of the interambulacra, which are 11 mm. broad at the upper edge of the ambitus. The interporiferous zone is slightly wider than the poriferous zone. The series of marginal tubercles is very regular; the tubercles are rather small and not contiguous. The median area is entirely naked, with scarcely a single small tubercle. The pores are small, equal in size, and are separated by a distinctly elevated wall. (Fig. 4b.)

The primary interambulacral tubercles are distinctly crenulate. The areoles are not deep and are nearly circular, only the four lower ones being confluent. The median area is half as wide as an areole; the scrobicular ring of tubercles is rather prominent, the tubercles filling almost the whole space so that there is hardly room for a few small tubercles outside the scrobicular ring, and there is no naked sunken median line.

The apical system (fig. 8) is even more naked than usual in this genus. Each genital plate carries 2 or 3 tubercles at the genital pore and 2 or 3 rather large ones at the inner edge, the spines attached to the latter being rather stout and together with those of the anal system forming a dense cluster which closely covers the periproct. The genital pores are already developed, though rather small, which may mean either that it is a male specimen or that it is a female in which the pores have not yet reached their full size. Each ocular plate has 2 or 3 tubercles (spines); the ocular are all exsert.

The peristome is still without interambulacral plates.

The primary spines reach a length of at least 3 times the horizontal diameter, the exact length being uncertain, as the points are broken off. They are about 2 mm. wide at the base, and taper very slightly; whether the point itself is broadened can not be ascertained. They are provided with about 12 finely serrate longitudinal ridges, the

surface between the ridges being distinctly furrowed. The upper primaries carry in their basal part 4 to 6 distant, larger spinules on the adapical side (though not very distinctly shown in the figures). The collar is short, 2-3 mm. in length. The oral primaries are of the usual form, slender, and not very conspicuous. In the present specimen only the three proximal ones have the shape of oral spines. The secondary spines are scarcely 4 mm. long, rather broad, flat, not excavated, often ending in three small points. (Pl. 77, fig. 8.) They are appressed toward the base of the primaries. Those of the ambulacra are about 3 mm. long, narrow, but flattened, and not setaceous.

The large tridentate pedicellariae are short, robust, with the head scarcely more than 2 mm. long. The valves (pl. 77, fig. 5) are broad, nearly triangular, with the blade filled with a close meshwork but with a shallow depression above the apophysis. The small tridentate pedicellariae (pl. 77, figs. 6-7) are shorter and broader than is usual in this genus, with some longer teeth at the point of the blade. The spicules of the tube feet are not characteristic, being of the usual form.

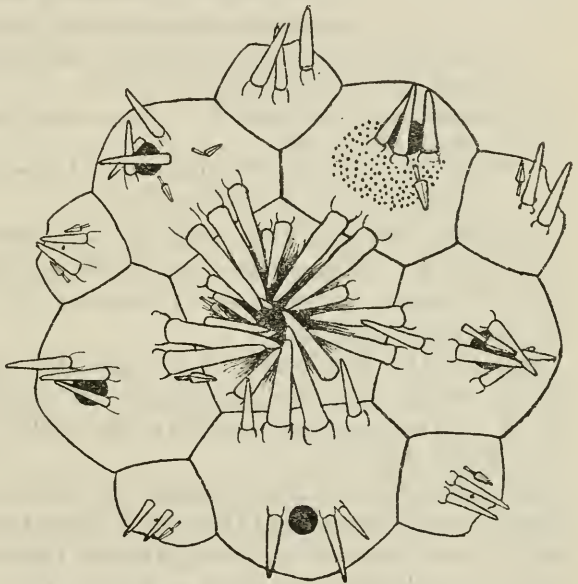


FIG. 8.—APICAL SYSTEM OF *HISTOCIDARIS*, SPECIES.  $\times 6$

The color of test and secondary spines is brown, the primary spines being white, excepting the collar, which is brownish, like the secondaries.

*Remarks.*—This specimen shows some resemblances to the form referred to by de Meijere,<sup>4</sup> to *Histocidaris misakiensis* (Yoshiwara). Especially the presence of some larger spinules on the adapical side at the base of the upper primary spines is a conspicuous point of resemblance. But in other regards, as in the very sparse tuberculation of the apical system, the shape of the secondary spines, and the pedicellariae, it differs so markedly from that form (which is otherwise entirely different from the true *H. misakiensis* of Yoshiwara,

<sup>4</sup> *Siboga* Echinoidea, p. 27, pl. 2, figs. 15, 16; pl. 12, figs. 141, 142.

and will be described in the author's monograph of the Cidaridae under the name of *Histocidaris recurvata*) that it is out of the question simply to identify it with that species, for the present, at least. Very probably it represents a separate species, but on the basis of the single evidently young specimen at hand it would seem undesirable to establish a new species in this rather perplexing genus. I therefore prefer to leave it unidentified, merely calling attention to its characters and leaving the question of its specific status for future decision when more satisfactory material will be available.

Genus PRIONOCIDARIS A. Agassiz

PRIONOCIDARIS GLANDULOSA (de Meijere)

*Cidaris (Cidaris) glandulosa* DE MEIJERE, Die Echinoidea der Siboga-Exped., 1904, p. 13, pl. 1, figs. 5, 6.

*Stephanocidaris glandulosa* H. L. CLARK, Bull. Mus. Comp. Zoöl., vol. 51, No. 7, 1907, p. 194.

*Prionocidaris glandulosa* TH. MORTENSEN, Deutsche Südpolar-Exped., 1901-1903, vol. 11, pt. 1, 1909, pp. 51, 53.

*Localities*.—Station 5140; vicinity of Joló (Sulu); Joló Light bearing S. 33° W., 6.1 miles distant (lat. 6° 08' 45'' N., long. 121° 03' 00'' E.); 139 meters; fine coral sand; February 14, 1908 (1 specimen, Cat. No. E. 1276, U.S.N.M.).

Station 5442; west coast of Luzon; San Fernando Point Light bearing N. 39° E., 8.4 miles distant (lat. 16° 30' 36'' N., long. 120° 11' 06'' E.); 82 meters; coral sand; May 10, 1909 (1 specimen, Cat. No. E. 1370, U.S.N.M.).

*Remarks*.—The specimens agree very closely with the typical *glandulosa* except for the fact that not a single large globiferous pedicellaria is to be observed on them, while in the typical form these were found in such great numbers as to give the incentive for the name "*glandulosa*." It is, however, a well-known fact that the large globiferous pedicellariae especially are subject to great variation in their occurrence in cidarids, so that no stress at all can be laid on this peculiarity in the present specimens.

In the larger specimen, which is from station 5140 and measures 24 mm. in horizontal diameter, some of the primary spines are rather distinctly curved upward; in the smaller specimen this feature is hardly indicated. The oral primaries are distinctly "capped" in the larger specimen, less so in the smaller. The primaries of the larger specimen are partly covered with foreign organism (serpulids, barnacles, etc.). This specimen is also remarkable in its color, the denuded test showing some large violet-purple patches in the median interambulacral area. The interporiferous zone of the ambulacra is deep purple. In the smaller specimen, which is from station 5442 and measures 18 mm. in horizontal diameter, this color is much less pronounced.

An interesting abnormality is shown by the larger specimen, in that there are two genital pores in genital plate 3.

**PRIONOCIDARIS BACULOSA, var. ANNULIFERA (Lamarck)**

Plates 53, 54.

*Cidaris annulifera* DE LORIO, Mém. soc. sci. nat. Neuchâtel, vol. 5, 1873, p. 25, pl. 3.

*Leiocardis pistillaris*, var. *annulifera* DÖDERLEIN, Jenaische Denkschr., vol. 8, 1902, p. 692, pl. 59, figs. 1-5.

*Cidaris (Cidaris) baculosa* DE MEIJERE, Die Echinoidea der Siboga-Exped. 1904, p. 9, pl. 2, figs. 9-12.

[Not *Phyllacanthus annulifera* A. AGASSIZ, Illustr. Cat. Mus. Comp. Zoöl., No. 7, pt. 3 (Mem. Mus. Comp. Zoöl., vol. 3), 1873, p. 387.]

*Localities*.—Station 5137; vicinity of Joló (Sulu); Joló Light bearing S. 61° E., 1.3 miles distant (lat. 6° 04' 25'' N., long. 120° 58' 30'' E.); 36 meters; sand and shells; February 14, 1908 (2 specimens, Cat. No. E. 1310, U.S.N.M.).

Station 5145; in the vicinity of Joló; Joló Light bearing S. 16° E., 0.85 mile distant (lat. 6° 04' 30'' N., long. 120° 59' 30'' E.); 42 meters; coral sand and shells; February 15, 1908 (2 small specimens, Cat. No. E. 1281, U.S.N.M.).

Station 5151; Tawi Tawi group, Joló Archipelago; Sirun Island (C.) bearing N. 58° E., 19.3 miles distant (lat. 5° 24' 40'' N., long. 120° 27' 15'' E.); 44 meters; coral sand and shells; February 18, 1908 (2 small specimens, Cat. No. E. 1279, U.S.N.M.).

Station 5160; Tawi Tawi group, Joló Archipelago; Tinakta Island (N.) bearing S. 72° W., 2.75 miles distant (lat. 5° 12' 40'' N., long. 119° 55' 10'' E.); 22 meters; sand; February 22, 1908 (1 young specimen, Cat. No. E. 1338, U.S.N.M.).

Station 5174; in the vicinity of Joló; Joló Light bearing E. 2.6 miles distant (lat. 6° 03' 45'' N., long. 120° 57' 00'' E.); 36 meters; coarse sand; March 5, 1908 (2 young specimens, Cat. No. E. 1381, U.S.N.M.).

Station 5355; North Balabac Strait; Balabac Light bearing S. 61° W., 16.6 miles distant (lat. 8° 08' 10'' N., long. 117° 19' 15'' E.); 80 meters; coral and sand; January 5, 1909 (1 young specimen, Cat. No. E. 1368, U.S.N.M.).

Station 5481; in the vicinity of Surigao Strait, between Samar and Leyte; Cabugan Grande Island (N.) bearing N. 86° W., 3.8 miles distant (lat. 10° 27' 30'' N., long. 125° 17' 10'' E.); 111 meters; sand, shells, and gravel; July 30, 1909 (2 large and old specimens, Cat. No. E. 1340, U.S.N.M.).

Station 5482; in the vicinity of Surigao Strait; Cabugan Grande Island (N.) bearing N. 87° W., 4.5 miles distant (lat. 10° 27' 30'' N., long. 125° 18' 00'' E.); 122 meters; broken shells, sand, and green

mud; July 30, 1909 (1 large specimen, Cat. Nos. E. 1311, E. 1312, U.S.N.M.).

Station 5641; Buton Strait; Kalono Point (W.) bearing N. 61° W., 3.4 miles distant (lat. 4° 29' 24" S., long. 122° 52' 30" E.); 71 meters; sand and shells; December 14, 1909 (4 specimens, Cat. No. E. 1270, U.S.N.M.).

*Notes.*—The material from station 5137 consists of two specimens with fusiform spinous primaries, and in addition a few detached spines. There are 2 young specimens from station 5145. From station 5151 there are 2 rather small specimens with fusiform spinous primaries, one of them with a parasitic gastropod (*Mucronalia*) at the edge of the peristome. The specimens from stations 5160, 5174, and 5355 are all young. The 2 specimens from station 5481 are large and old; the larger is 80 mm. in horizontal diameter, with cylindrical primary spines which are overgrown with barnacles and sponges. The specimen from station 5482 is large, with cylindrical primary spines. The 4 specimens from station 5641 partly have the primaries fusiform and strongly spinous at the base. (Pls. 53, 54.)

*Remarks.*—It is very tempting to distinguish as a separate variety the form which has the primary spines fusiform and strongly spinous in the basal portion (on the aboral side only), as its general appearance is very characteristic and very different indeed from that of the form with cylindrical spines. But so many transitional forms are met with and sometimes found together in the same locality (as for instance at station 5641) that no line of demarcation can be drawn between them, and we are thus forced to accept them as belonging within the variational range of the highly polymorphous variety *annulifera* of the highly polymorphous species *Prionocidaris baculosa*. The various forms are bound together by that eminently characteristic peculiarity, the red-spotted collar of the primary spines, which is otherwise nowhere met with among cidarids excepting, to some degree, in *Stylocidaris bracteata* (A. Agassiz).

PRIONOCIDARIS BISPINOSA (Lamarck)

Plate 52, fig. 3

*Phyllacanthus annulifera* A. AGASSIZ, Illustr. Cat. Mus. Comp. Zoöl., No. 7, pt. 3 [Mem. Mus. Comp. Zoöl., vol. 3], 1873, p. 387.

*Rhabdocidaris bispinosa* DE LORIOI, Mém. soc. sci. nat. Neuchâtel, vol. 5, 1873, p. 33, pl. 5.

*Leiocidaris bispinosa* DÖDERLEIN, Jenaische Denkschr., vol. 8, 1902, p. 695, pl. 58, figs. 5–11.

*Cidaris (Stephanocidarid) bispinosa* DE MEIJERE, Die Echinoidea der Siboga-Exped., 1904, p. 4, pl. 1, fig. 4; pl. 2, fig. 14.

*Prionocidaris bispinosa* DÖDERLEIN Abhandl. Senckenb. naturf. Ges., vol. 34 1911, p. 240, pl. 9, figs. 1, 2.—TH. MORTENSEN, [Kgl. Sv. Vet. Akad., Handl., vol. 58, 1918, p. 6, pl. 3, fig. 1.



[Not *Cidarites annulifera* LAMARCK, Hist. nat. des animaux sans vertèbres, vol. 2, 1816.

Not *Stephanocidaris bispinosa* A. AGASSIZ, Illustr. Cat. Mus. Comp. Zoöl. No. 7, part 1 (Mem. Mus. Comp. Zoöl., vol. 3), 1872, p. 160; pt. 3, 1873, p. 393.]

*Localities*.—Station 5144; in the vicinity of Joló (Sulu); Joló Light bearing S. 50° W., 3.4 miles distant (lat. 6° 05' 00'' N., long. 121° 02' 15'' E.); 35 meters; coral sand; February 15, 1908 (1 specimen, Cat. No. E. 1325, U.S.N.M.).

Station 5148; in the vicinity of Siasi, Joló (Sulu) Archipelago; Sirun Island (N.) bearing S. 80° W., 3.8 miles distant (lat. 5° 35' 40'' N., long. 120° 47' 30'' E.); 31 meters; coral sand; February 16, 1908 (2 specimens, Cat. No. E. 1343, U.S.N.M.).

Station 5149; in the vicinity of Siasi; Sirun Island (W.) bearing N. 39° E., 2.4 miles distant (lat. 5° 33' 00'' N., long. 120° 42' 10'' E.); 18 meters; coral and shells; February 18, 1908 (1 specimen, Cat. No. E. 1341, U.S.N.M.).

Station 5164; Tawi Tawi group, Joló Archipelago; Observation Island bearing S. 82° W., 8 miles distant (lat. 5° 01' 40'' N., long. 119° 52' 20'' E.); 33 meters; green mud; February 24, 1908 (1 specimen, Cat. Nos. E. 1269, E. 1287, U.S.N.M.).

*Notes*.—The specimens from stations 5148 and 5149 are large, and that from station 5164 is young; the specimen from station 5144 is referable to var. *chinensis* Döderlein.

*Remarks*.—The large specimens from stations 5148 and 5149 are very interesting in showing that this species reaches a much larger size than was hitherto known, up to 78 mm. in horizontal diameter. These specimens have evidently reached their full size and with their primaries overgrown with barnacles and other organisms, give the impression of being very old. It is noteworthy that both the apical system and the peristome of these specimens are relatively much smaller than in medium-sized examples. Thus the apical system is 37.1–37.7 per cent of the horizontal diameter, as against 43–50 per cent in medium-sized specimens, and the peristome is 28.2–29.2 per cent of the horizontal diameter, as against about 34–45 per cent in medium-sized examples. Evidently this signifies that the apical system and the peristome cease growing some time before the growth of the test ceases. In accordance with this, the number of peristomial plates is not greater in these old specimens than in those of medium size.

Some of the primaries in the old specimens are distinctly flattened in the outer part (pl. 52, fig. 3), just as is the case in large specimens of *Prionocidaris baculosa*, var. *annulifera*. Further, the large specimens have the interporiferous zone of the ambulacra thickly set with

small tubercles, only one longitudinal series of smaller tubercles remaining distinct within the marginal series, while in smaller specimens in addition a second inner series of small tubercles is generally distinct.

### Genus PLOCOCIDARIS Mortensen

#### PLOCOCIDARIS VERTICILLATA (Lamarck)

*Phyllacanthus verticillata* A. AGASSIZ, Illustr. Cat. Mus. Comp. Zoöl., No. 7, pt. 3 [Mem. Mus. Comp. Zoöl., vol. 3], 1873, p. 392, pl. 1c, figs. 40-42; pl. 1f, fig. 3.—DÖDERLEIN, Die japanischen Seeigel, I, Familien Cidaridae und Saleniidae, 1887, p. 22, pl. 9, figs. 8, a-i.—H. L. CLARK, Bull. Mus. Comp. Zoöl., vol. 51, No. 7, 1907, p. 187.

*Plococidaris verticillata* TH. MORTENSEN, Deutsche Südpolar-Exped. 1901-1903, vol. 11, pt. 1, 1909, pp. 50, 53.

*Prionocidaris verticillata* DÖDERLEIN, Abhandl. Senckenberg. naturf. Ges., vol. 34, 1911, pp. 242, 243.

*Localities*.—Station 5159; Tawi Tawi group, Joló (Sulu) Archipelago; Tinakta Island (N.) bearing N. 82° W., 1.4 miles distant (lat. 5° 11' 50'' N., long. 119° 54' 00'' E.); 18 meters; coral sand; February 21, 1908 (1 specimen, Cat. No. E. 1280, U.S.N.M.).

Tataan, Simulac Island; February 19, 1908 (1 specimen, Cat. No. E. 1289, U.S.N.M.).

Batan anchorage; June 22, 1909 (1 specimen, Cat. No. E. 1383, U.S.N.M.).

### Genus EUCIDARIS Pomel

#### EUCIDARIS METULARIA (Lamarck)

*Cidaris metularia* H. L. CLARK, Bull. Mus. Comp. Zoöl., vol. 51, No. 7, 1907, p. 184.

*Eucidaris metularia* A. AGASSIZ and H. L. CLARK, Mem. Mus. Comp. Zoöl., vol. 34, No. 1, 1907, p. 5, pl. 1, figs. 3-7.—H. L. CLARK, Cat. Recent Sea-urchins Brit. Mus., 1925, p. 20.

*Localities*.—Station 5108; China Sea, off southern Luzon; Corregidor Light bearing N. 39° E., 22.5 miles distant (lat. 14° 05' 05'' N., long. 120° 19' 45'' E.); 23 meters; coral bottom; January 15, 1908 (5 specimens, Cat. No. E. 1371, U.S.N.M.).

Station 5249; Gulf of Dávao; Lanang Point bearing N., 1 mile distant (lat. 7° 06' 06'' N., long. 125° 40' 08'' E.); 41 meters; coral and sand; May 18, 1908 (1 specimen, Cat. No. E. 1369, U.S.N.M.).

Station 5257; eastern Illana Bay, southern Mindanao; Utara Point, Bongo Island, bearing N. 88° W., 7.7 miles distant (lat. 7° 22' 12'' N., long. 124° 12' 15'' E.); 50 meters; mud; May 22, 1908 (1 very young specimen, Cat. No. E. 1389, U.S.N.M.).

Philippines, with no further data (3 specimens, Cat. No. E. 1380, U.S.N.M.).

## Genus GONIOCIDARIS L. Agassiz and Desor.

## GONIOCIDARIS (DISCOCIDARIS) PELTATA, new species

Plates 55, 56; plate 74, figs. 4, 5; plate 78, figs. 9-12

*Locality.*—Station 5617; Dodinga Bay, Gillolo Island; Ternate Island (SE.) bearing S. 45° W., 7 miles distant (lat. 0° 49' 30'' N., long. 127° 25' 30'' E.); 239 meters; November 27, 1909 (1 specimen, the type, Cat. No. E. 1324, U.S.N.M.).

*Measurements*

h. d.	v. d.	Apical system	Peristome	Number of—		Longest spines
				I. a.	A. pro I. a.	
25 mm.	15 mm.	Ca. 12 mm. (c. 50 per cent h. d.)	11.5 mm. (46 per cent h. d.)	7-8	10-11	63 mm.

*Description.*—The test is rather high, flattened above, less flattened beneath. The sides are gently arched. The circumference is circular. The ambulacra are distinctly sinuate. The interporiferous zone is about twice the width of a pore zone. The marginal series of tubercles is very regular; the tubercles are not very conspicuous, but are very nearly contiguous; sometimes small miliary tubercles occur between adjoining tubercles. Within the marginal tubercles the plates are thickly set with very small miliaries, which are arranged more or less distinctly in transverse series. There is no distinct naked median vertical line; the horizontal sutures are deepened so as to form rather distinct grooves. The whole interporiferous area sinks slightly toward the middle line. The pores are somewhat sunken, the wall separating them being only slightly elevated. The ridge between the pore pairs is fairly high. (Pl. 74, figs. 4-5.)

In the interambulacra the areoles are fairly deep; only the two or three proximal ones are confluent. The scrobicular tubercles are slightly larger than the ambulacral marginal tubercles, half-moon shaped, and separated by small miliary tubercles. Alternating with the scrobicular tubercles there is a single tubercle about half their size outside the scrobicular ring, and the rest of the median part of the interambulacral plate is closely set with very small irregularly arranged miliary tubercles, which also occupy the midline, so as to leave only a vertical series of small slightly sunken grooves separated by miliary tubercles across the midline. The grooves formed by the horizontal sutures are very small and inconspicuous. On the adradial side of the plates there are also a few miliary tubercles outside the scrobicular ring. The median part of the interambulacra is only little more than half the width of a corresponding areole; it is scarcely sunken toward the middle line.

The apical system is about half the horizontal diameter of the test, and is not distinctly elevated and not thickened. The oculars are in part narrowly insert. Because of the danger of damaging the beautiful appearance of the specimen it was not determined whether all the oculars are insert; two of them certainly are, but a third apparently is not. For the same reason the serial number of these oculars could not be ascertained. The periproctal plates are apparently few and correspondingly large. The genital pores (male) are small, rather remote from the edge, and situated, on one of the plates at least, on a slight elevation. The plates of the apical system are rather closely covered with tubercles of various sizes. Especially there is a series of tubercles along the inner edge of the genital plates which are fairly large, bearing large flattened spines. The periproctal plates also each carry one or two similar tubercles and spines. (Fig. 9.)

The peristome is of about the same size as the apical system and is elevated somewhat in the form of a cone. There are about 8 ambu-

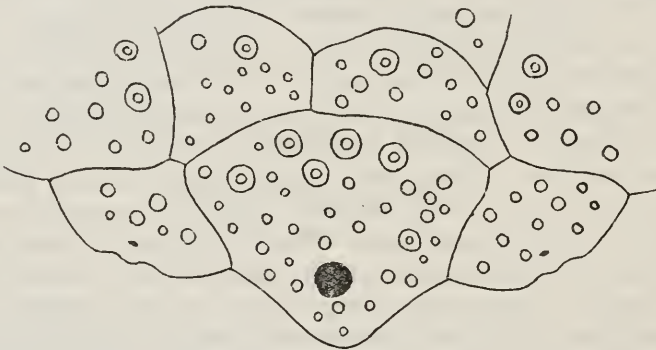


FIG. 9.—PART OF APICAL SYSTEM OF GONIOCIDARIS (DISCOCIDARIS) PELTATA, NEW SPECIES.  $\times 8$

lateral plates in a series. The ambulacra scarcely join at the mouth edge, thus leaving a rather free passage to the interradial plates, which number about 6 and are in a fairly regular series.

The primary spines are of an extraordinary development, recalling those of *Gonocidar* (*Discocidar*) *mikado*. The basal disk is very well developed, forming a large entire plate, usually only on the adapical side; but sometimes it is also united across the adoral side of the spine; in such cases it is, however, much narrower on the adoral side. This disk may be repeated one or more times farther out along the shaft of the spine; there is thus formed a series of disks, such as is known in *D. mikado*. The second disk may be as complete as the first, but the following are only indicated by the spinules being more or less widened, while they are not wholly coalesced. Farther out the spinules are simple, and at the same time more numerous, but not arranged in regular series, and they gradually decrease in size toward

the point of the spine, which may be broadened to a crown of various sizes, sometimes fairly large. The whole surface of the spine, with its disks and spinules, is covered by a close coating of rather long, coarse, not anastomosing, hairs. The spine as a whole tapers gently toward the point and is more or less distinctly curved downward. The collar is quite short; the milled ring is inconspicuous. The apical spines form rather large disks, of oval shape, with rather coarsely serrate edges. They are all eccentric, the adapical side being the larger on both inner and outer circle. The basal disk is scarcely indicated on these apical spines. The oral primaries are short, straight or nearly so, rather coarsely serrate along the sides and, excepting the first, also tuberculated on both the adoral and adapical sides; often they are somewhat widened at the point. The third is transitional to the ambital spines.

The scrobicular spines are about 2.5 mm. long, broad, flattened, slightly narrowing toward the straight cut end. They curve inward somewhat in their basal part, thus being slightly concave in side view; but they are otherwise flat, not concave on the outer side. The basal part is distinctly spiny. (Pl. 78, fig. 12.) The marginal ambulacral spines are somewhat shorter and narrower, with straight sides, not curved, but with spiny bases as in the scrobicular spines. Those near the peristome are rather distinctly broadened. The secondary spines are in general rather closely appressed. On the peristome the interradial spines are conspicuously smaller than those on the ambulacra. The miliary spines are very small and conical.

Large globiferous pedicellariae are found placed more or less regularly in the grooves of the interambulacra. They are of the usual globular shape, dark pigmented, and therefore the more conspicuous on the light test and among the much smaller miliary spines. The valves (pl. 78, fig. 9) are of the typical goniodarid form, but with the blade prolonged more or less conspicuously into a narrow tube, which bears the opening on its end. The stalk is quite short, and without a limb. The small globiferous pedicellariae (pl. 78, figs. 10-11) are rather abundantly developed, with narrow compressed valves which may be more or less elongate, sometimes so much so as to resemble tridentate pedicellariae, especially as in the more elongated examples (head up to 0.3 or 0.4 mm.) the valves are not joined in the basal part. That they are, however, only a special development of the small globiferous type is evident from the transitional forms; in these most elongate forms also the end tooth may still be distinct. The large coarse form of tridentatelike pedicellariae so characteristic of several goniodarids has not been observed.

The spicules of the tube feet are of the usual cidarid type.

The color of the primaries is pure white, as may be determined from one newly formed spine; in the others the white is more or less

concealed by foreign organisms and also by particles of mud. The test and secondaries are a more grayish white. The naked test is white.

Another younger specimen with the apical disks not yet developed was dredged by the author at the Kei Islands in 1922.

*Remarks.*—This very fine species recalls through the character of its primary spines *Goniocidaris* (*Discocidaris*) *mikado*, from which it differs, however, very conspicuously in several important points, especially in its spiny secondaries and very small and slender miliary spines. It seems evident, however, that the two species are rather closely related. On the other hand, the present species would appear to have some relation also to the *Petalocidaris* group, with which it agrees in having the secondary spines spiny at the base and in the valves of the large globiferous pedicellariae being more or less distinctly prolonged into a narrow tube. It is hard to say which of the characters are of the greater significance. I would, however, be inclined to consider the character of the primary spines the more important, and therefore I refer this species to the subgenus *Discocidaris* together with Japanese species *mikado*.

#### CYRTOCIDARIS,<sup>5</sup> new subgenus

*Characters.*—This new subgenus of *Goniocidaris* is distinguished by its unusually long and slender pointed secondary spines, which are smooth and flattened. The primary spines are long and slender, rather strongly spinous, and more or less distinctly curved downward. The oral primaries are very smooth, distinctly curved, and in general rather conspicuous.

*Genotype.*—The type of this new subgenus is *Goniocidaris* (*Cyrtocidaris*) *tenuispina*, new species, described below.

*Remarks.*—It may be questioned whether it would not perhaps be preferable to make this species the type of a separate genus instead of merely a subgenus of *Goniocidaris*. But as in the great genus *Goniocidaris* the secondary spines vary rather widely it seems to me better to regard it only as a subgenus, even though the differences separating it from the other species of *Goniocidaris* are really rather striking.

#### GONIOCIDARIS (CYRTOCIDARIS) TENUISPINA, new species

Plate 57, figs. 1, 2; plate 58, fig. 1; plate 59, fig. 2; plate 61, figs. 6–8; plate 63, fig. 5; plate 73, figs. 5, 6; plate 79, figs. 1–3

*Localities.*—Station 5348; Palawan Passage; Point Tabonan bearing S. 89° E., 33.5 miles distant (lat. 10° 57' 45'' N., long. 118° 38' 15'' E.); 685 meters; bottom temperature 13.56° C.; coral sand; December 27, 1908 (1 specimen, Cat. No. E. 1384, U.S.N.M.).

<sup>5</sup>From *κύρτος* = curved.

Station 5423; Joló (Sulu) Sea; Cagayan Island, Cagayanes Islands (S.) bearing S.  $11^{\circ}$  E., 4.8 miles distant (lat.  $9^{\circ} 38' 30''$  N., long.  $121^{\circ} 11' 00''$  E.); 929 meters; bottom temperature  $9.89^{\circ}$  C.; gray mud and coral sand; March 31, 1909 (7 specimens, Cat. Nos. E. 1373, E. 1379, U.S.N.M.).

Station 5487; between Leyte and Mindanao; San Ricardo Point, Panaon Island, bearing S.  $50^{\circ}$  E., 11.2 miles distant (lat.  $10^{\circ} 02' 45''$  N., long.  $125^{\circ} 05' 33''$  E.); 1,338 meters; bottom temperature  $11.28^{\circ}$  C.; green mud; July 31, 1909 (1 specimen, the type, Cat. No. E. 1335, U.S.N.M.).

Station 5488; between Leyte and Mindanao; San Ricardo Point, Panaon Island, bearing S.  $59^{\circ}$  E., 9 miles distant (lat.  $10^{\circ} 00' 00''$  N., long.  $125^{\circ} 06' 45''$  E.); 1,411 meters; bottom temperature  $11.28^{\circ}$  C.; green mud; July 31, 1909 (4 specimens, Cat. No. E. 1344, U.S.N.M.).

Station 5510; in the vicinity of northern Mindanao; Camp Overton Light bearing S.  $68^{\circ}$  E., 9.1 miles distant (lat.  $8^{\circ} 16' 00''$  N., long.  $124^{\circ} 03' 50''$  E.); 757 meters; bottom temperature  $11.67^{\circ}$  C.; gray mud and fine sand; August 7, 1909 (1 specimen, Cat. No. 1386, U.S.N.M.).

Station 5511; in the vicinity of northern Mindanao; Camp Overton Light bearing S.  $80^{\circ}$  E., 15.3 miles distant (lat.  $8^{\circ} 15' 20''$  N., long.  $123^{\circ} 57' 00''$  N.); 749 meters; bottom temperature  $11.67^{\circ}$  C.; gray mud and sand; August 7, 1909 (5 specimens, Cat. No. E. 1346, U.S.N.M.).

Station 5512; in the vicinity of northern Mindanao; Camp Overton Light bearing S.  $76^{\circ}$  E., 14 miles distant (lat.  $8^{\circ} 16' 02''$  N., long.  $123^{\circ} 58' 26''$  E.); 813 meters; bottom temperature  $11.56^{\circ}$  C.; gray mud and fine sand; August 7, 1909 (22 specimens, Cat. Nos. E. 1318, E. 1372, U.S.N.M.).

Station 5527; between Bohol and Siquijor; Balicasag Island (C.) bearing N.  $14^{\circ}$  W., 8.2 miles distant (lat.  $9^{\circ} 22' 30''$  N., long.  $123^{\circ} 42' 40''$  E.); 716 meters; bottom temperature  $11.83^{\circ}$  C.; globigerina ooze; August 11, 1909 (6 specimens, Cat. No. E. 1345, U.S.N.M.).

#### Measurements

h. d.	v. d.	Apical system	Peristome	Number of—		Longest spines
				I. a.	A. pro I. a.	
22 mm...	12 mm...	12 mm. (54.5 per cent h. d.)...	9 mm. (41 per cent h. d.)...	7-8	9-11	53 mm.
20 mm...	11 mm...	10 mm. (50 per cent h. d.)...	8 mm. (40 per cent h. d.)...	7-8	8-10	ca. 45 mm.
19.5 mm...	11.5 mm...	10.5 mm. (53.8 per cent h. d.)...	8 mm. (41 per cent h. d.)...	7	10-11	ca. 45 mm.
18 mm...	11.5 mm...	10 mm. (55.5 per cent h. d.)...	7 mm. (39 per cent h. d.)...	7	9	ca. 50 mm.
17 mm...	12 mm...	9 mm. (53 per cent h. d.)...	7 mm. (41 per cent h. d.)...	7	8-9	ca. 55 mm.
12 mm...	8 mm...	6 mm. (50 per cent h. d.)...	5 mm. (41.7 per cent h. d.)...	6-7	7-8	ca. 45 mm.

*Description.*—The test is rather low, flattened both above and below, sometimes less so above where the apical system may be somewhat elevated so as to give the test a subconical appearance. The sides are more or less arched. The circumference is circular or sub-pentagonal.

The ambulacra are rather distinctly sinuate. The interporiferous zone is about twice the width of a pore zone. The marginal series of tubercles is very regular, the tubercles being small and inconspicuous and not nearly contiguous; there are usually some small miliary tubercles between each two consecutive marginal tubercles. Within the marginal tubercle each plate usually carries one smaller tubercle at the lower edge of the plate and often in addition one placed higher up and nearer the midline of the zone. When only the lower one of these tubercles is present, a fairly distinct vertical series is formed

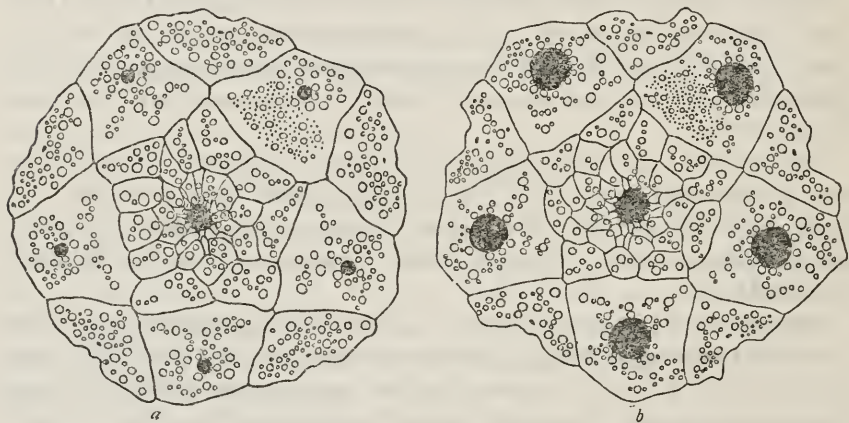


FIG. 10.—APICAL SYSTEM OF GONICIDARIS (CYRTOCIDARIS) TENUISPINA, NEW SPECIES. MALE (a) AND FEMALE (b).  $\times 6$

within the marginal series; when two inner tubercles are present the vertical arrangement is obscured. There is a rather conspicuous, naked, somewhat sunken middle part, and in general the ambulacra have a rather naked appearance. The horizontal grooves are fairly conspicuous, though merging into the sunken median part. The pores are equal sized, not sunken, separated by a rather narrow wall which rises into a fairly conspicuous tubercle; the ridge separating the adjoining pore pairs is low and inconspicuous. (Pl. 73, figs. 5-6.)

In the interambulacra the areoles are not very deep; the 3 or 4, rarely more, proximal ones are confluent; at most some of the small proximal ones are slightly transverse-oval. The scrobicular ring of tubercles is not very conspicuous; the tubercles, however, are distinctly larger than the marginal ambulacral tubercles. There is a rather broad, sunken, naked median part, leaving room for only a



narrow belt of small tubercles outside the scrobicular ring. On the adradial edge of the plates there is barely room for a single series of small tubercles alternating with the scrobicular ones. The groove at the median end of the horizontal sutures is fairly conspicuous, merging into the sunken vertical median part; also at the adradial end of the sutures there is a rather distinct indication of a groove. The whole of the horizontal suture between the uppermost interambulacral plates may be more or less distinctly sunken. The median area of the interambulacra is scarcely two-thirds the width of an areole.

The apical system (fig. 10) is usually a little more than half of the horizontal diameter, rather thin, and not raised above the level of the test; it sometimes forms a slight rounded elevation, which may almost be termed subconical; more often the periproct alone is a little elevated, the genital and ocular plates remaining flat. The oculars are of a characteristic triangular form, with an acute apex inward, which often reaches the periproct, the oculars thus being generally, but not always, narrowly insert. The female genital pores are large and near the edge of the plates, the male pores being much smaller and about in the middle of the plates. The madreporite is not enlarged. The whole apical system is usually pentagonal in outline. The periproct is rather small. All the plates of the apical system are rather sparsely covered with small tubercles of uniform size; even those on the inner edge of the periproctal plates are not larger, corresponding to the fact that the secondary spines surrounding the anal opening are not larger than the other spines on the apical system, contrary to what is otherwise very generally the case in cidarids. A rather broad edge is left bare on the genital plates.

The genital pores are about to appear in a specimen 9 mm. in horizontal diameter.

The peristome is distinctly smaller than the apical system, somewhat irregularly pentagonal in outline. There are only 5 or 6 ambulacral plates in a series. The ambulacra do not join at the mouth edge, thus leaving a free though narrow passage for the interradiial plates, which are more or less irregular, 2 to 4 in number. The peristomial plates in general are rather delicate.

The primary spines are long and slender, about three times the horizontal diameter, the ambital ones usually rather distinctly curved downward. They taper to a rather fine point. The basal disk is only indistinctly developed; usually there are only some larger spinules at the base which may be more or less flattened and broadened, so as to be united to some slight degree across the adapical side of the spine. But often these spinules are lacking, and then there is no trace of a basal disk. The shaft of the spine is otherwise set with rather sharp, outstanding spinules which are not curved outward, which show no regular serial arrangement, and which do not increase in size toward

the point of the spine. The surface of the shaft is covered with a dense coat of fine anastomosing hairs which end in a long free point. (Fig. 11.) The collar quite short, increasing in thickness downward. The milled ring is very inconspicuous. The apical spines have a well-developed terminal disk which is usually deeply indented on the edge, sometimes very much so, then resembling a delicate flower (pl. 59, fig. 2); more rarely the edge is entire. The disk is more or less eccentric, the eccentricity being most developed on the adapical side. In some of the specimens both circles of disks—that is, the uppermost spine in each vertical series—have developed. Sometimes the shaft of these apical spines is fairly long, but in most cases it is short, as is generally the case in *Goniocidarid*. The basal disk is not developed in these apical spines. The oral primaries are long and slender, distinctly curved, and perfectly smooth, or more rarely with a faint indication of lateral serrations.

The scrobicular spines are about 3 mm. long, narrow and slender and ending in a rounded point; they are flattened and entirely smooth. The marginal ambulacral spines are about 2 mm. long, very slender, and scarcely flattened, those nearest the peristome being slightly broadened toward the point. The miliary spines are slender and pointed.

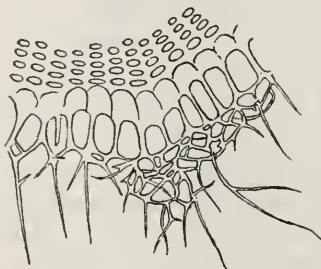


FIG. 11.—PART OF TRANSVERSE SECTION OF PRIMARY SPINE OF *GONIOCIDARIS* (*CYRTOCIDARIS*) *TENUISPINA*, NEW SPECIES.  $\times 72$

Large globiferous pedicellariae were not observed. The small globiferous pedicellariae are fairly numerous, and have slender compressed valves; the opening is narrow, more or less elongate, and slitlike; the end tooth is usually well developed. (Pl. 79, fig. 2-3.) A few large tridentate pedicellariae occur in some of the specimens. These are about 1.5 mm. in length of head, the stalk being much shorter. The valves are rather slender; they have the blade filled, as usual, with a coarse meshwork. (Pl. 79, fig. 1.) Although no transitional forms were found and no terminal slit is to be observed in the valves, there can be no doubt that these apparent tridentate pedicellariae are, as in other goniocidarids, only a special development of the small globiferous type. (Such transitional forms have been observed in the var. *tuberculata*.)

The spicules of the tube feet are of the usual form of irregular slightly spinous rods. The spicules of the intestine are of the tri-  
radiate type characteristic of goniocidarids.

The color of the test and of the secondaries is a yellowish white, the denuded test being entirely white. Only in the young specimen from station 5423 is there an indication of green on the apical sys-

tem. The primaries usually are of a slight pinkish tint. The specimens from station 5512 are darker, but they give very much the appearance that this is due to preservation.

*Notes.*—The specimen from station 5348 is young, and its identification is not quite certain.

Some of the specimens from station 5512 are infested with a kind of parasitic organism that rests in small circular holes at the base of the oral primary spines. Within these holes there is a rather thick fibrillar sack containing a thick-walled globular cyst. Within the cyst an organism can be seen, but what kind of an organism it is I have been unable to ascertain.

GONIOCIDARIS (CYRTOCIDARIS) TENUISPINA, var. TUBERCULATA, new variety

Plate 57, fig. 3; plate 59, fig. 1; plate 61, figs. 9–11; plate 73, figs. 7–8; plate 79, figs. 4–8

*Locality.*—Station 5219; between Marinduque and Luzon; Momog Island (NE.) bearing N. 35° 30' W., 12.25 miles distant (lat. 13° 21' 00'' N., long. 122° 18' 45'' E.); 969 meters; bottom temperature 10.44° C.; green mud; April 23, 1908 (22 specimens, and some fragments, Cat. Nos. E. 1265, E. 1374, the type, U.S.N.M.).

*Measurements*

h. d.	v. d.	Apical system	Peristome	Number of—		Longest spines
				I.a.	A. pro I.a.	
21 mm ...	13 mm ...	10.5 mm. (50 per cent h.d.)...	8 mm. (38 per cent h.d.)....	8	11-12	
20 mm ...	12 mm ...	10 mm. (50 per cent h.d.)....	7 mm. (35 per cent h.d.)....	7	12-14	34 mm.
18 mm ...	11 mm ...	8.5 mm. (47.2 per cent h.d.)...	6.5 mm. (36 per cent h.d.)...	7-8	10-11	37 mm.
7 mm ...	10 mm ...	8.5 mm. (50 per cent h.d.)....	6 mm. (35.3 per cent h.d.)...	7-8	10-11	47 mm.
13 mm ...	7.5 mm ...	7 mm. (53.8 per cent h.d.)....	5.5 mm. (42.3 per cent h.d.)...	7	9-10	32 mm.
12 mm ...	7 mm ...	6 mm. (50 per cent h.d.)....	5 mm. (41.7 per cent h.d.)...	6-7	8-10	28 mm.

*Characters.*—From the typical form these specimens, and some others from the same locality, differ in the following characters:

The ambulacra are more closely tuberculated; inside the marginal tubercle each plate carries 2 or 3 tubercles, which are not much smaller than the marginal one and are usually arranged in a fairly distinct transverse series running obliquely upward toward the median line. There is no distinct naked sunken median line, the grooves formed by the horizontal sutures just connecting along the median line. The wall between the pores is flatter than in the typical form. (Pl. 73, figs 7-8.)

In the interambulacra the naked median line is narrowed, and correspondingly the number of tubercles on the median part of the plates is rather conspicuously larger; the upper interambulacral plates in general are more closely tuberculated than in the typical form.

The most conspicuous difference, however, is found in the apical system, which is much more closely tuberculated than in the typical form; the shape of the oculars also is quite different. (Fig. 12, to compare with fig. 10.)

The primary spines are scarcely so long as in the typical form, generally not more than about twice the horizontal diameter, but otherwise they are not appreciably different; the secondary spines do not differ from those of the type.

In the pedicellariae no difference is found in the globiferous form, but the "tridentate" form is, as a rule, somewhat shorter and broader than in the type. (Pl. 79, figs. 7-8.) All transitional forms are found between the tridentate and the usual small globiferous type (pl. 79, figs. 4-6), so that no doubt can exist about the apparent tridentate being only transformed globiferous and not true tridentate pedicellariae. They may reach a size of about 1.2 mm. in length of head; the stalk is very short.

In regard to the color it is noteworthy that the primary spines are white, not of the pinkish tint usual in the typical form.

*Notes.*—Some broken specimens were found to contain mud with Foraminifera in their intestine. Some of them have an ophiuran (*Ophiacantha*, species)



FIG. 12.—APICAL SYSTEM OF GONIOCIDARIS (CYRTOCIDARIS) TENUISPINA, NEW SPECIES, VAR. TUBERCULATA, NEW VARIETY.  $\times 6$

clinging to their spines. One specimen is abnormal in having two genital pores in genital 5. (Pl. 61, fig. 11.)

*Remarks.*—It is evident that this form can not simply be identified with *Goniocidaris (Cyrtocidaris) tenuispina*; the shape of the oculars, the closer tuberculation of the apical system and of the ambulacra and interambulacra especially are fairly conspicuous differences. Possibly it ought to be regarded as a separate species. The differences are, however, not quite constant, as in the typical forms the oculars sometimes have very nearly the same form, and it would, therefore, seem the best course, for the present, to designate it only as a separate variety.

GONIOCIDARIS (CYRTOCIDARIS) TENUISPINA, var. MAJOR, new variety

Plate 58, fig. 2; plate 79, fig. 9

*Locality.*—Station 5259; off northwestern Panay; Caluya Island (S.) bearing S. 73° W., 12 miles distant (lat. 11° 57' 30'' N., long.

121° 42' 15'' E.); 570 meters; bottom temperature 9.61° C.; gray mud and globigerina ooze; June 3, 1908 (1 specimen, the type, Cat. No. E. 1351, U.S.N.M.).

*Measurements*

h. d.	v. d.	Apical system	Peristome	Number of—		Longest spines
				I. a.	A. pro I. a.	
29 mm...	18 mm...	14 mm. (48.8 per cent h. d.)	9 mm. (31 per cent h. d.)	8-9	12-13	55 mm.

*Characters.*—This specimen differs in certain respects both from the typical form and from the variety *tuberculata*.

In the first place its larger size is noteworthy, 29 mm. in horizontal diameter as against at most 22 mm. in the typical form. This does

not simply mean that it is older and therefore larger. It must be kept in mind that the species of *Goniodaris* develop the apical disks only on the uppermost spine in each series of primaries, and accordingly, when the disks



FIG. 13.—PART OF APICAL SYSTEM OF GONIODARIS (CYRTOCIDARIS) TENUISPINA, NEW SPECIES, VAR. MAJOR, NEW VARIETY.  $\times 6$

have been formed, the specimens must be assumed to have reached their full size. The specimen of the typical form in which the apical disks have appeared in all the series, not only in one series in each interambulacrum, measures only 22 mm. in horizontal diameter; but the specimen from station 5259 measures 29 mm. in horizontal diameter and has still only developed the first circle of the disks and thus evidently has not yet reached its maximum size. Then the primary spines are distinctly thicker than those of the typical form, 2.5 mm. in diameter at the base, against 1.5–1.8 mm. Also the spinules of the primaries are distinctly smaller than in the typical form; further, the fact that the spinules are distinctly larger in the outer part of the spine is a conspicuous difference from the type. The hair covering is somewhat denser but otherwise essentially like that of the type.

In regard to the test and the secondary spines I hardly find any noteworthy differences from the typical form; but the oculars are more elegant in outline and not triangular (fig. 13 to compare with fig. 10), and the scrobicular tubercles are slightly larger. The pedi-

cellariae are as in the type; but an example of the large globiferous form was also found in this specimen. It is of considerable interest in having the valves somewhat prolonged into a narrow tube, on the end of which the opening is situated (pl. 79, fig. 9). This recalls the form of large globiferous pedicellaria found in "*Petalocidaris*" and shows that this character is scarcely of generic value, the present form being otherwise in no way nearly related to the *Petalocidaris* group. The color is the same as in the typical form.

*Remarks.*—It does not seem justifiable simply to identify this specimen with the typical form, or with the variety *tuberculata* as described above. On the other hand the differences are not very important, so that it would not seem warranted to make this specimen the type of a separate species. So long as only this single specimen is available the proper course seems to be to designate it as a variety, var. *major*, of *Goniocidaris* (*Cyrtocidaris*) *tenuispina*.

#### RHOPALOCIDARIS, new genus<sup>6</sup>

*Diagnosis.*—A genus of Goniocidaridae with small but distinct grooves at the median end of the horizontal sutures, and with a broad, bare, sunken median space in both ambulacra and interambulacra. Primary spines without basal disk; apical primaries simple or, at most, with a very small terminal widening. Surface of primary spines covered with a well-developed coat of fine, not branching or anastomosing hairs. The primaries otherwise with rather coarse longitudinal ridges and furrows, more or less strongly spinous. Secondary spines club shaped, not appressed. Globiferous pedicellariae, both the large and small form, of the typical goniocidarid structure. Very small forms.

*Genotype.*—*Cidaris* (*Discocidaris*) *hirsutispinus* de Meijere.

*Remarks.*—It has been maintained by H. L. Clark<sup>7</sup> that this species is only the young of *Goniocidaris clypeata*. The study of adult specimens, collected partly by the *Albatross*, partly by the author during the Danish expedition to the Kei Islands in 1922, and the comparison with the type specimen from the *Siboga* expedition, kindly lent me by Prof. L. F. de Beaufort, the director of the Amsterdam Museum, does not leave the slightest doubt that *hirsutispinus* is a well-characterized species, and so far from being identical with *G. clypeata* it can not even be referred to the same genus, but must form the type of a new genus. The main character distinguishing this genus from the rest of the goniocidarids is the peculiar club-like shape of the secondary spines. Only in *Goniocidaris umbraculum* is there an indication of a similar club-like shape of the secondary spines, especially the

<sup>6</sup> From ῥόπαλον=club.

<sup>7</sup> The Cidaridae, p. 197.

small miliary spines; still in this case it is rather different from what obtains in *Rhopalocidaris*; and besides, *G. umbraculum* has at least the apical disks well developed. On the whole I think *Rhopalocidaris* a very well delimited genus, the more so as all the species (I have two other species of the same genus from Japan) agree in the characters pointed out as distinguishing the genus.

**RHOPALOCIDARIS HIRSUTISPINA, var. VIRIDIS, new variety**

Plate 61, fig. 2; plate 73, figs. 1, 2; plate 78, figs. 6-8

*Locality*.—Station 5543; in the vicinity of northern Mindanao; Tagolo Light bearing S. 75° W., 12.5 miles distant (lat. 8° 47' 15" N., long. 123° 35' 00" E.); 296 meters; bottom temperature 12.50° C.; sand; August 20, 1909 (1 specimen, the type, Cat. No. E. 1382, U.S.N.M.).

*Measurements*

h. d.	v. d.	Apical system	Peristome	Number of—		Longest spines
				I. a.	A. pro l. a.	
15 mm ...	10 mm ...	8 mm. (53.3 per cent h. d.) ...	7 mm. (46.6 percent h. d.) ...	8	5 (6)	15 mm.

*Description*.—The test is rather high, flattened above but not below; the sides are gently arched. The circumference is circular. The ambulacra are scarcely at all sinuate. The interporiferous zone is about twice the width of a pore zone. The marginal ambulacral series of tubercles is quite regular; the tubercles are rather small, but with a comparatively large, very distinct mamelon; they are not contiguous, and generally there is a small miliary tubercle between each two successive tubercles. Within the marginal tubercle there is another almost equally large tubercle at the lower edge of the plate, these inner tubercles thus alternating with the marginal ones. They do not, however, occur regularly, some plates here and there having only the marginal tubercle. The plates are otherwise entirely naked and sunken, thus forming a very conspicuous sunken median area, sharply delimited from the tuberculated part which forms like an elevated ridge, being also rather sharply delimited from the poriferous zone. The pores are equal sized, separated by a fairly broad and somewhat elevated wall; the ridge between the pore pairs is rather low. The whole pore zone is somewhat sunken. (Pl. 73, figs. 1-2.)

In the interambulacra the areoles are small, circular, even the low-ermost ones being scarcely at all transverse-oval; the 4 or 5 proximal ones are confluent. The mamelon is relatively very large, the areole correspondingly narrow and not very deep. The scrobicular ring is rather inconspicuous; the scrobicular tubercles are not larger than

the marginal ambulacral tubercles; there are only about 12 of them on the upper plates. Outside the scrobicular tubercles there is another circle of tubercles of about the same size, alternating with the former, and on the median part of the plate still 2 or 3 tubercles medially to the second circle and alternating with them; these last-mentioned tubercles are of the same size as the others. A broad median portion of the plates is left bare and sunken, slightly deepest at the horizontal sutures, representing the usual grooves. At the adradial end of the sutures there is a slight indication of a groove. The median area is about one and one-half times as broad as an areole.

The apical system (fig. 14) is slightly more than half the horizontal diameter of the test. It is flat, scarcely raised around the anal opening. The ocular plates are widely exsert; the line of junction



FIG. 14.—APICAL SYSTEM OF *RHOPALOCIDARIS HIRsutISPINA* (DE MEJERE), VAR. *viridis*, NEW VARIETY.  $\times 8$

of the genital plates is rather conspicuously sunken, the genital plates thus being somewhat elevated in the middle. The genital pores (female) are large, nearly 1 mm. in diameter, rather distant from the edge. The periproct is small, with few plates. The whole of the apical system is uniformly, but not very closely, covered with small tubercles of almost equal size; the spines of the apical system also are of almost equal size all over. The tubercles

(and spines) are a little more dense around the genital opening.

The peristome is somewhat smaller than the apical system, and is slightly raised in the form of a cone. There are 8 or 9 ambulacral plates in a series; the ambulacra join at the mouth edge. The interradial plates are 3 or 4 in number.

The primary spines are only as long as the horizontal diameter of the test. They are comparatively coarse and thick, about 1.5 mm. in diameter, tapering only very slightly and ending in a simple rounded point. In the proximal part they are provided with outstanding, fairly large spinules, arranged quite irregularly, between which the surface is covered with rather coarse, unbranched, not anastomosing hairs (pl. 78, figs. 8, *a*, *b*); some of the hairs may be thickened, form-



ing a transition to the spinules. The outer half, or a little more, of the spine is without hairs or spinules, rather coarsely furrowed, the ridges being more or less irregular, the surface of the spine thus acquiring a more or less distinctly meandric aspect. The apical spines are not different from the ambital ones. The oral primaries are short, almost straight, with rather coarsely serrate edges. The fourth is transitional to the ambital primaries.

The secondary spines are all distinctly club-shaped, with finely serrate ridges. (Pl. 78, fig. 6.) They are about 1 mm. long and are rather erect.

Only the small globiferous form of pedicellariae is present; these are very inconspicuous, scarcely exceeding 0.2 mm. in length of head, the stalk being up to 0.5 mm. long. The valves (pl. 78, fig. 7) are rather slender, though not compressed, with a relatively large opening and a strong end tooth. The spicules are coarsely spiny, somewhat larger than usual, but otherwise of the typical cidarid form.

In color the apical system is distinctly greenish, the green color continuing some way over the test. The primaries are pinkish in the basal part, this color gradually paling outwardly so that the points are white.

*Remarks.*—That this specimen is nearly related to *hirsutispina* (de Meijere) is beyond doubt. It differs, however, from that species in some features, for instance in the conspicuous green color (*hirsutispina* is not at all green), in having the primary tubercles larger, and in addition in some minor points in the apical system and in the ambulacra. It is evident that these differences forbid simply identifying the present form with *hirsutispina*. The question is only whether it should be regarded as a separate species or only as a variety of *hirsutispina*. With the scanty material at present available (only one adult specimen of *hirsutispina*, besides the type specimen which is not yet adult) it is impossible to reach a definite solution of the question, as it is impossible to judge of the constancy of the characters pointed out. I am rather inclined to think that the form from the Philippines will prove to be a separate species, but for the present it may suffice to designate it only as a variety of *hirsutispina*.

#### Genus SCHIZOCIDARIS Mortensen

*Diagnosis.*—A genus of Goniocidaridae with small but distinct grooves at the median end of the horizontal sutures. Primary spines without a basal disk; the apical primaries simple, not with the point widened into a disk. Surface of primary spines covered with a coat of fine hairs, widened at the top into large fenestrated plates, which coalesce so as to form a complete closed roof all over the spine, rest-

ing on the basal part of the hairs as upon columns. The surface of the primaries thus apparently smooth and shining. Secondary spines flattened, smooth. Small globiferous pedicellariae of the usual goniocidarid type, with a large end tooth. Large globiferous pedicellariae unknown.

*Genotype*.—*Schizocidaris assimilis* Mortensen.

*Remarks*.—This genus, which was established by the author in the *Ingolf* Echinoidea<sup>8</sup> was based on the peculiar character of the pedicellariae; it was rejected by Döderlein and H. L. Clark, these authors maintaining that the single character of the pedicellariae alone can not justify the establishment of a separate genus. With this argument I quite agree; nevertheless *Schizocidaris* is a perfectly valid genus. The study of the rich material of *S. assimilis* which I collected at the Kei Islands during the Danish expedition in 1922, together with that collected by the *Albatross*, has shown that, while the character of the pedicellariae appears not to hold good for the other species, other much more valuable characters are found which distinguish this group of species from all other goniocidarids, especially the peculiar structure of the primary spines.

The type of this genus is the species which I named *Schizocidaris assimilis*, found by the *Challenger* at the Kei Islands (station 192) and referred by A. Agassiz to *Gonocidaris florigera*. To the same genus belongs the species which I designated<sup>9</sup> as *Discocidaris* (?) *serrata*, not having then observed its close affinity to *S. assimilis*. The species *serrata*, which was taken by the *Challenger* in the Philippine Sea between Mindoro and Luzon (station 204) and likewise referred by A. Agassiz to *Gonocidaris florigera*, was rediscovered by the *Albatross*. Another species, *fasciata*, new species, was also found by the *Albatross* in the Philippines, so that we now know three distinct species of the genus *Schizocidaris*.

#### SCHIZOCIDARIS SERRATA (Mortensen)

Plate 61, fig. 1; plate 74, figs. 1, 2; plate 78, fig. 1

*Gonocidaris florigera* (part) A. AGASSIZ *Challenger* Reports, Zoology, vol. 3, pt. 9, Echinoidea, 1881, p. 46, pl. 1, figs. 7-11.

*Discocidaris* (?) *serrata* MORTENSEN, The Danish *Ingolf*-Exped., vol. 4, pt. 1, Echinoidea, 1903, pp. 25, 29, pl. 10, figs. 6, 7.

*Locality*.—Station 5415; between Cebu and Bohol; Lais Point Light bearing N. 24° W., 7.2 miles distant (lat. 10° 07' 50'' N., long. 123° 57' 00'' E.); 161 meters; bottom temperature 16.89° C.; fine sand; March 24, 1909 (1 specimen, Cat. No. E. 1375, U.S.N.M.).

<sup>8</sup>Part 1, pp. 25, 28, 1903.

<sup>9</sup>*Ingolf* Echinoidea, pt. 1, pp. 25, 29.

## Measurements

h. d.	v. d.	Apical system	Peristome	Number of—		Longest spines
				I. a.	A. pro l. a.	
20 mm.---	13 mm.--	10 mm. (50 per cent h. d.)---	8 mm. (40 per cent h. d.)---	8	8-9	34 mm.
18 mm.---	11 mm.--	10 mm. (55 per cent h. d.)---	7.5 mm. (41.7 per cent h. d.)---	8-9	9-10	25 mm.

NOTE.—The larger of the specimens measured is from *Challenger* station 204, the smaller from *Albatross* station 5415.

*Description.*—The test is flattened above and below, with the sides beautifully arched; the circumference is circular. The ambulacra are very little sinuate. The interporiferous zone is about twice the width of a pore zone. The marginal series of tubercles is very regular, the tubercles being small and not contiguous. Within the marginal tubercle each plate carries a number of small tubercles which are not regularly arranged, covering the whole plate and leaving only the horizontal edges free, which are sunk so as to form distinct grooves, narrowly connected through the likewise sunken vertical suture. The whole interporiferous zone is otherwise flat, scarcely at all sloping toward the midline of the area. The pores are rather small, equal sized, and rather distant, being separated by a fairly broad wall which rises into a low rounded tubercle. The ridge separating the adjoining pore pairs is low. The whole pore zone is scarcely at all sunken (pl. 74, figs. 1-2).

In the interambulacra the areoles are rather low, the subambital slightly transverse-oval; the three or four proximal ones are confluent. The horizontal suture between the uppermost plates is more or less deepened. The scrobicular ring is inconspicuous, with the tubercles not much larger than the marginal ambulacral tubercles. The median part of the plates is closely covered with small tubercles which are rather distinctly arranged in horizontal series. The inner end of the horizontal sutures are deepened so as to form a fairly conspicuous groove; the adradial end of the sutures also shows an indication of a groove. The vertical median suture is narrowly naked and slightly sunken, the whole median interambulacral area sloping gently toward the median line. The width of the median area is about two-thirds of an areole.

The apical system is from 50 to 55 per cent of the horizontal diameter, slightly raised in the middle, but not thickened so as to rise with its edges above the level of the test as is the case in some other gonio-cidarids, for instance, *Discocidaris mikado*. The oculars are widely exert in the *Albatross* specimen, while in the specimen from *Challenger*

station 204 they are all insert. The genital pores are rather distant from the edge. The periproctal plates are few, and the whole periproct is small. All the apical plates are closely covered by tubercles of uniform size (fig. 15).

The peristome is markedly smaller than the apical system, only from 40 to 41.7 per cent of the horizontal diameter as against from 50 to 55 per cent of the horizontal diameter, and quite flat. There are eight or nine ambulacral plates in a series. The ambulacra do not quite join at the mouth edge; there are three or four interradial plates in a series.

The ambital spines are about one and one-half times the horizontal diameter (it appears that the point is broken in most of those of the *Albatross* specimen). They are slightly fusiform at the base, more so



FIG. 15.—PART OF APICAL SYSTEM OF SCHIZOCIDARIS SERRATA (MORTENSEN).  $\times 8$

in the *Challenger* specimens, then taper very gently to a rather fine point. They are beset more or less closely with anteriorly directed but usually almost straight spinules, two lateral series of which may be somewhat more conspicuous than the rest; but generally an arrangement of the spinules in longitudinal series is very indistinct. In general the spinules are in the main confined to the adapical side of the spine; more rarely they are also well developed on the adoral side. The point of the spines is not widened into a small crown. The surface of the spines is apparently quite smooth and shining; in reality it is covered by a coat of hairs, which anastomose at their ends so as to form a complete, closed, very finely fenestrated roof, which rests upon the basal part of the hairs as upon columnus (figs. 16, a-c). The apical spines are not different from the ambital, merely somewhat shorter. The oral primaries are slender, smooth, merely

with some lateral serrations which are not very conspicuous; they are straight or at most very slightly curved. The fourth is transitional to the ambital spines.

The scrobicular spines are about 2 mm. long, smooth, thin, and flat, or with a slight indication of being excavated toward the end, which is straight cut; the sides are very nearly parallel. The marginal ambulaeral spines are of the same general shape, but more narrow and more slender; they may be slightly widened toward the point; those near the peristome are scarcely different from the ambital, as is the case in some gonioecidarids. The miliary spines are slender, conical, with finely serrate ridges.

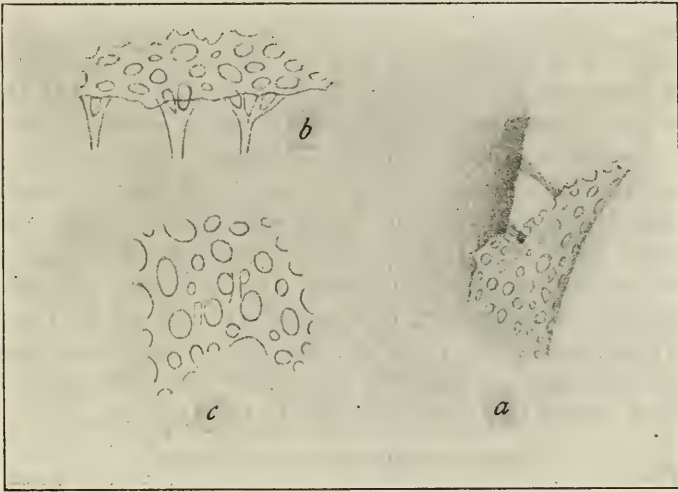


FIG. 16.—DETAILS OF HAIR-COVERING OF PRIMARY SPINES OF SCHIZOCIDARIS SERRATA MORTENSEN. *a*. PART OF SPINULE WITH THE FENESTRATED OUTER LAYER FORMED BY THE HAIRS; TWO COLUMNS ARE SEEN TO CONNECT THE OUTER LAYER WITH THE COMPACT MASS OF THE SPINULE. *b*. PART OF THE OUTER LAYER, HALF IN PROFILE, SHOWING THREE SUPPORTING COLUMNS. *c*. PART OF THE OUTER LAYER, SEEN FROM THE INSIDE.  $\times 120$

Only the small globiferous form of pedicellariae is found, and these are not very numerous or very conspicuous, scarcely exceeding a size of 0.2 mm. in length of head, while the stalk may be as much as 0.6–0.7 mm. The valves (pl. 78, fig. 1) are of the usual gonioecidarid type, with a conspicuous end tooth; the opening is rather unusually short; the form with the long, narrow slitlike opening so characteristic of *S. assimilis* has not been found in this species.

The spicules of tube feet are very numerous, slender, and more spiny than in *S. assimilis*.

In color the primary spines are white (when clean), the test and secondaries yellowish white. The apical system is greenish, the green color being in the main confined to the genital plates and to the inner

periproctal plates, but continuing a little way on to the interambulacra, where the green is located mainly at the upper and lower edge of the areoles. The ocular plates and the ambulacra are white. A very conspicuous feature of the *Albatross* specimen is the dark brownish color of the tube feet, which makes them appear as very distinct radiating lines, especially on the peristome and the oral side of the test. In the *Challenger* specimen this coloration is much less conspicuous, probably faded; in one of those in the British Museum it is, however, quite distinct.

*Occurrence.*—The only other locality from which the species is known, is lat.  $12^{\circ} 43' N.$ , long.  $122^{\circ} 10' E.$ , 100–115 fathoms (*Challenger* station 204), very close to the place where it was found by the *Albatross*.

*Remarks.*—It is evident that this species is very closely related to *assimilis* from the Kei Islands. In fact, were it not that the pedicellariae are so conspicuously different, I would consider them to be one and the same species, the other differences, the less strongly spiny primaries, the much more closely tuberculated interporiferous zone of the ambulacra, and the color, being scarcely more than might well be supposed to be within the range of variation of a single species. However, judging from the material available, the differences are real, and quite conspicuous; it is, therefore, at least for the present necessary to regard them as distinct species. Should they ultimately prove to be identical (which I do not expect they will) the name *ser-rata*, as the first of the two, is the one to be retained.

SCHIZOCIDARIS FASCIATA, new species

Plate 61, fig. 3; plate 74, fig. 3; plate 78, fig. 2

*Locality.*—Station 5547; near Joló (Sulu); Noble Point, Tulayan Island (E.) bearing S.  $38^{\circ} E.$ , 9.5 miles distant (lat.  $6^{\circ} 09' 20'' N.$ , long.  $121^{\circ} 13' 40'' E.$ ); 283 meters; bottom temperature  $13.50^{\circ} C.$ ; fine sand; September 15, 1909 (1 specimen, the type, Cat. No. E. 1387, U.S.N.M.).

Measurements

h. d.	v. d.	Apical system	Peristome	Number of—		Longest spines
				I. a.	A. pro I. a.	
8 mm. ....	4 mm. ....	4 mm. (50 per cent h. d.) ....	4 mm. (50 per cent h. d.) ....	6-7	5-6	15 mm.

*Description.*—The test is low, flattened above and below, with the sides arched; the circumference is circular.

The ambulacra are nearly straight. The interporiferous zone is about twice the width of the pore zone. The marginal series of tubercles is regular, the tubercles rather small, not contiguous. Within the marginal tubercle each plate carries a small tubercle at the lower edge, the rest of the plate being smooth and rather sunken. The horizontal sutures are slightly deepened, but it can not be said that the grooves are distinct; rather they go together with the whole of the sunken median part. In places there is a small tubercle between the marginal tubercles. The pores are small, equal sized, separated only by a narrow wall which is scarcely raised. The ridge between the adjoining pore pairs is rather low (pl. 74, fig. 3).

In the interambulacra the areoles not very deep, the 3 or 4 proximal ones confluent; only the lowermost are slightly transverse-oval. The scrobicular ring is not very conspicuous, the tubercles being scarcely larger than the marginal ambulacral ones. Outside the scrobicular ring there are only a few secondary tubercles, the median part of the plates being otherwise naked and somewhat sunken. The horizontal sutures are deepened so as to form rather conspicuous grooves. There is no indication of grooves at the adradial end of the sutures, and the scrobicular tubercles leave no naked portion on the adradial side of the plates. The horizontal sutures between the upper areoles are not deepened. The median part of the interambulacra is about as wide as an areole.

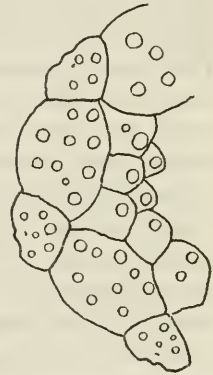


FIG. 17.—PART OF APICAL SYSTEM OF SCHIZOCIDARIS FASCIATA, NEW SPECIES.  $\times 12$

The apical system is exactly half the horizontal diameter and is rather elevated. The ocular plates are narrowly insert. The whole apical system is covered, though not very closely, with small tubercles of uniform size. The genital pores are not yet developed (fig. 17). The peristome is of the same size as the apical system, and is slightly elevated. There are 7 or 8 ambulacral plates in a series; the ambulacra join at the mouth edge so as to exclude the interradiial plates from the mouth edge. There are 2 or 3 of the latter in each interradiial space.

The longest ambital spines are nearly twice the horizontal diameter. They are nearly cylindrical, tapering only very slightly toward the point which is broadened into a small crown. At the base there are a few larger spinules, placed mainly at the sides; they do not unite so as to form a disk. Otherwise the spine is covered by rather numerous smaller spinules, arranged fairly distinctly in longitudinal series. As usual the spinules are smaller on the adoral than on the adapical side of the spine. The surface of the spine is otherwise

covered by the smooth coat of hairs typical of *Schizocidaris*; it is somewhat more open-meshed and, therefore, less shining than usual. The collar as usual is very short, scarcely as long as the very inconspicuous milled ring. The apical spines are still in an immature condition. The oral primaries are slender and straight, with a few rather coarse lateral serrations. The third-fourth is transitional to the ambital spines.

The scrobicular spines are only about 1 mm. long; they are thin and flat with straight sides and straight cut ends. The marginal ambulacral spines are in the main of the same shape, but narrower and more slender; those near the peristome do not differ from the others. The miliary spines are of the usual slender form.

Only the small globiferous form of pedicellariae is represented. This is rather characteristic, the valves and also the opening being unusually short; the end tooth is very prominent (pl. 78, fig. 2). They are in general very small, with the head scarcely more than 0.1 mm. long and the stalk about 0.3–0.4 mm. long. In spite of this small size they are fairly conspicuous, partly because the head is rather thick, partly because they are somewhat brownish.

The spicules of the tube feet are of the usual spinous form.

In color the primaries are white, with 2 or 3 fairly distinct broad bands of pink. The secondaries and test are yellowish white. On the denuded test the genital plates are seen to be of a faint greenish color, the test being otherwise white.

*Remarks.*—In spite of the young age of the specimen, the genital pores being not yet developed, it offers such conspicuous characters in its primary spines and in its pedicellariae that there can be no doubt that it represents a distinct species of the genus *Schizocidaris*. The characters of the test must be expected to differ in adult specimens from what is found in the present young specimen; but the characters of the ambital spines and of the pedicellariae will evidently be quite sufficient for recognizing the species in its adult form.

#### PSILOCIDARIS, new genus<sup>10</sup>

*Diagnosis.*—Apical system more than half the horizontal diameter; peristome much smaller. Interambulacra with 6 or 7, ambulacra with rather numerous plates; a rather conspicuous sunken median line and fairly distinct grooves at the horizontal sutures in the interambulacra, but not in the ambulacra. Primary spines very long and slender, without basal disk; apical spines without terminal widening. Surface of primaries with short conical stumps. Secondary spines slender, setaceous, not appressed. Globiferous pedicellariae with slender valves in apparently both the large and small form.

<sup>10</sup> ψιλός = thin.



*Genotype*.—*Psilocidaris echinulata* Mortensen.

*Remarks*.—This genus apparently stands midway between *Goniodaridaris* (subgenus *Cyrtodaridaris*) and *Aporodaridaris*, thus connecting the latter with the goniodaridaris.

PSILOCIDARIS ECHINULATA, new species

Plate 60, figs. 1, 2; plate 61, figs. 4, 5; plate 63, fig. 4; plate 73, figs. 3, 4; plate 78, figs. 3-5

*Localities*.—Station 5127; Joló (Sulu) Sea, in the vicinity of southern Panay; Nogas Island (W.) bearing N.  $11^{\circ} 30' E.$ , 22 miles distant (lat.  $10^{\circ} 02' 45'' N.$ , long.  $121^{\circ} 48' 15'' E.$ ); 1,751 meters; bottom temperature  $10.05^{\circ} C.$ ; gray mud and globigerinae; February 4, 1908 (1 specimen, the type, Cat. No. E. 1334, U.S.N.M.).

Station 5429; in the vicinity of eastern Palawan; Fondeado Island (SE.) bearing N.  $18^{\circ} E.$ , 15 miles distant (lat.  $9^{\circ} 41' 30'' N.$ , long.  $118^{\circ} 50' 22'' E.$ ); 1,400 meters; green mud; April 5, 1909 (spines only, Cat. No. E. 1277, U.S.N.M.).

Measurements

h. d.	v. d.	Apical system	Peristome	Number of—		Longest spines
				I. a.	A. pro I. a.	
21 mm...	13 mm...	12.5 mm. (59.5 per cent h. d.)	7 mm. (33.3 per cent h. d.)	6	16-17	93 mm.
21 mm...	13 mm...	12 mm. (57 per cent h. d.)	6.5 mm. (30 per cent h. d.)	6-7	14-16	65 mm.

*Description*.—The test is low, gently vaulted above, somewhat flattened below, distinctly sunken toward the peristome. The sides are beautifully arched; the circumference is circular.

The ambulacra are rather distinctly sinuate. The interporiferous zone is about twice the width of a pore zone. The marginal series of tubercles is very regular; the tubercles are small and not contiguous. Within the marginal tubercle each plate carries a single tubercle about half as large as the marginal one, which is situated at the lower edge of the plate. There are thus four regular longitudinal series of tubercles in the interporiferous zone, filling it up nearly completely and leaving only a narrow naked sunken median line. The horizontal sutures are without distinct grooves. The pore zone is distinctly sunken; the pores are of about equal size, rather close together, the narrow wall separating them being only slightly raised. The ridge separating the pore pairs is narrow and only slightly elevated (pl. 73, figs. 3-4).

In the interambulacra the areoles are rather large, only slightly deepened, and well separated; only the 2 or 3 small proximal ones are confluent; even the lowermost ones are almost circular. The

tubercle is rather small with the boss low; there is no trace of crenulation, but there are more or less distinct radiating furrows in the areole. The scrobicular ring of tubercles is rather inconspicuous, the tubercles being only a little larger than the marginal ambulacral tubercles. Outside the scrobicular ring the plate is covered by miliary tubercles of uniform size, leaving a rather conspicuous naked sunken median line, with a fairly distinct groove at the inner end of the horizontal sutures. On the adradial side of the scrobicular ring there are also some miliary tubercles. The median area is very narrow, only about one-third the width of an areole.

The apical system is rather unusually large, more than half the horizontal diameter and somewhat elevated. The ocular plates are all widely exsert; the madreporite is not enlarged. The periproct is rather small, with a moderate number of small periproctal plates. The whole apical system is closely covered with small tubercles of



FIG. 18.—PART OF APICAL SYSTEM OF *PSILOCIDARIS ECHINULATA*, NEW SPECIES.  $\times 6$

uniform size, leaving a narrow bare zone along the inner edge of the genital plates. The genital pores are large and are situated close to the outer edge of the plates (fig. 18). The peristome is only about half the size of the apical system and is distinctly sunken.

There are only 3 or 4 ambulacral plates in a series; the ambulacra join at the mouth edge. The interradiial areas are very small with only 1 or 2 small plates each.

The primary spines are very long, four or five times the diameter of the test; even the longest spine in the best specimen has the point broken; in the second specimen not one of the ambital spines is complete. These spines are straight, very slender, cylindrical, tapering very gently to the (apparently) fine point. They are covered with small spinules which are erect or only very slightly curved distally; these are only very indistinctly arranged in about 8 longitudinal series; they rise directly from the surface of the spine, not from distinct ridges, and remain of the same size throughout the entire length of the spine. The surface of the spine is otherwise covered by very small, simple conical "hairs." There is no indication of a basal disk. The collar is about 1 mm. long, thickening toward the very inconspicuous milled ring. The apical spines are of full length, and there is no indication of apical disks. The oral primaries are very slender,

smooth, with merely the point curved. The fourth is transitional to the ambital spines.

The secondary spines are in general slender. The scrobicular spines are about 3 mm. long, flattened, gently narrowing toward the rounded point; the marginal ambulacral spines are about 2 mm. long, very slender, and setaceous; the proximal ones are broadened and concave at the point. The miliary spines are simply setaceous. The secondaries are in general erect, only the scrobicular ones being somewhat appressed, but not forming a close mail around the base of the primaries.

Large globiferous pedicellariae were not observed. Small globiferous pedicellariae are rather abundantly developed; they are partly of the usual form, partly much elongated, so as to resemble tridentate pedicellariae, and partly of a somewhat coarser type (pl. 78, figs. 3-5). All of them have only a short and inconspicuous end tooth, which is sometimes scarcely at all distinct. The large coarse tridentate form, often found in goniocidarids, has not been observed here. The spicules are of the usual form—simple, slightly spiny rods.

In color the primaries are whitish with a pale pinkish tint, especially in the basal part. The secondaries are yellowish white. The skin of the test is of a yellowish-red tint, while the naked test is perfectly white.

*Remarks.*—This species to some degree resembles *Goniodaridaris* (*Cyrtodaridaris*) *tenuispina*, but differs so markedly from it, especially in the character of its primary spines, that it is out of question to include them in the same genus. On the other hand, it recalls to a still more marked degree the genus *Aporodaridaris* in its very long and slender spines, its large apical system, etc. But it also is very conspicuously different from the species of that genus, especially in the much more numerous ambulacral plates and the pedicellariae, so that it seems equally unjustifiable to refer it to *Aporodaridaris*. The only possible course, therefore, seems to be to make it the type of a separate genus, *Psilodaridaris*. The fact that it is about equally closely related to *Goniodaridaris* (*Cyrtodaridaris*) on the one hand and to *Aporodaridaris* on the other affords proof that the affinities of *Aporodaridaris* must be with the goniodaridids, and we thus get a very satisfactory solution of the hitherto rather obscure question concerning the relationships of the genus *Aporodaridaris*.

### Genus **STYLOCIDARIS** Mortensen

#### **STYLOCIDARIS EFFLUENS**, new species

Plate 59, fig. 3; plate 62, figs. 1, 2; plate 65, figs. 1-4; plate 75, figs. 1, 2; plate 80, figs. 1-6

*Localities.*—Station 5194; off northern Cebu; Chocolate Island bearing N. 66° W., 8 miles distant (lat. 11° 15' 30" N., long. 124

11' 00'' E.); 270 meters; bottom temperature 13.61° C.; green mud; April 3, 1908 (2 specimens, Cat. No. E. 1330, U.S.N.M.).

Station 5402; between Leyte and Cebu; Capitancillo Island Light bearing S. 37° W., 16.1 miles distant (lat. 11° 11' 45'' N., long. 124° 15' 45'' E.); 343 meters; bottom temperature 13.22° C.; green mud; March 16, 1909 (15 specimens, Cat. No. E. 1319, U.S.N.M.).

Station 5403; between Leyte and Cebu; Capitancillo Island Light bearing S. 46° W., 15.7 miles distant (lat. 11° 10' 00'' N., long. 124° 17' 15'' E.); 333 meters; bottom temperature 13.17° C.; green mud; March 16, 1909 (30 specimens, Cat. Nos. E. 1264, E. 1272, U.S.N.M.).

Station 5404; Dupon Bay, Leyte; Ponson Island (N.) bearing S. 79° E., 6.8 miles distant (lat. 10° 50' 00'' N., long. 124° 26' 18'' E.); 347 meters; bottom temperature 13° C.; mud; March 17, 1909 (5 specimens, including the type, Cat. No. E. 1316, U.S.N.M.).

Station 5410; in the vicinity of Dupon Bay, Leyte; Bagacay Point Light bearing S. 37° W., 7.2 miles distant (lat. 10° 28' 45'' N., long. 124° 05' 30'' E.); 704 meters; green mud; March 18, 1909 (8 specimens, Cat. No. E. 1297, U.S.N.M.).

Station 5411; between Cebu and Bohol; Lais Point Light bearing N. 35° E., 4.7 miles distant (lat. 10° 10' 30'' N., long. 123° 51' 15'' E.); 265 meters; bottom temperature 12.89° C.; green mud; March 23, 1909 (4 specimens, Cat. No. E. 1315, U.S.N.M.).

Station 5412; between Cebu and Bohol; Lais Point Light bearing N. 21° E., 5.5 miles distant (lat. 10° 09' 15'' N., long. 123° 52' 00'' E.) 296 meters; bottom temperature 12.67° C.; green mud; March 23, 1909 (3 specimens, Cat. No. E. 1299, U.S.N.M.).

Station 5415; between Cebu and Bohol; Lais Point Light bearing N. 24° W., 7.2 miles distant (lat. 10° 07' 50'' N., long. 123° 57' 00'' E.); 161 meters; bottom temperature 16.89° C.; fine sand; March 24, 1909 (4 specimens, Cat. No. E. 1300, U.S.N.M.).

Station 5416; between Cebu and Bohol; Lais Point Light bearing N. 12° E., 2.9 miles distant (lat. 10° 11' 30'' N., long. 123° 53' 30'' E.); 274 meters; bottom temperature 12.44° C.; green mud; March 25, 1909 (1 specimen, Cat. No. E. 1298, U.S.N.M.).

Station 5417; between Cebu and Bohol; Lais Point Light bearing N. 10° E., 3.5 miles distant (lat. 10° 10' 00'' N., long. 123° 53' 15'' E.); 302 meters; bottom temperature 12.44° C.; gray mud and sand; March 25, 1909 (3 specimens, Cat. No. E. 1306, U.S.N.M.).

Station 5418; between Cebu and Bohol; Lais Point Light bearing N. 16° E., 5.6 miles distant (lat. 10° 08' 50'' N., long. 123° 52' 30'' E.); 291 meters; bottom temperature 12.44° C.; gray mud and sand; March 25, 1909 (8 specimens, Cat. No. E. 1313, U.S.N.M.).

Station 5508; in the vicinity of northern Mindanao; Camp Overton Light, Iligan Bay, bearing S. 6° E., 4.9 miles distant (lat. 8° 17' 24'' N., long. 124° 11' 42'' E.); 493 meters, bottom temperature

11.83° C.; green mud and fine sand; August 5, 1909 (1 specimen, Cat. No. E. 1314, U.S.N.M.).

Station 5516; in the vicinity of northern Mindanao; Point Tagolo Light, Mindanao, bearing S. 80° W., 9.7 miles distant (lat. 8° 46' 00'' N., long. 123° 32' 30'' E.); 319 meters; bottom temperature 12.39° C.; globigerinae; August 9, 1909 (1 specimen, Cat. Nos. 1294, E. 1295, U.S.N.M.).

Station 5517; in the vicinity of northern Mindanao; Point Tagolo Light bearing S. 83° W., 10.5 miles distant (lat. 8° 45' 30'' N., long. 123° 33' 45'' E.); 309 meters; bottom temperature 12.39° C.; globigerinae; August 9, 1909 (3 specimens, Cat. No. E. 1282, U.S.N.M.).

Station 5522; in the vicinity of northern Mindanao; Point Tagolo Light bearing S. 39° W., 6 miles distant (lat. 8° 49' 00'' N., long. 123° 26' 30'' E.); 420 meters; bottom temperature 11.28° C.; globigerinae; August 10, 1909 (1 specimen).

Station 5536; between Negros and Siquijor; Apo Island (C.) bearing S. 26° W., 11.8 miles distant (lat. 9° 15' 45'' N., long. 123° 22' 00'' E.); 510 meters; bottom temperature 11.95° C.; green mud; August 19, 1909 (13 specimens, Cat. No. E. 1273, U.S.N.M.).

#### Measurements

h. d.	v. d.	Apical system	Peristome	Number of—		Longest spines
				I. a.	A. pro I. a.	
42 mm.	28 mm.	20 mm. (47.6 per cent h. d.)	19 mm. (45.2 per cent h. d.)	7	13-15	82 mm.
38 mm.	25 mm.	18 mm. (47.4 per cent h. d.)	17.5 mm. (46 per cent h. d.)	7	16-18	77 mm.
34 mm.	23 mm.	18 mm. (52.9 per cent h. d.)	16 mm. (47 per cent h. d.)	6	15-16	c. 50 mm.
32 mm.	20 mm.	16 mm. (50 per cent h. d.)	14 mm. (43.7 per cent h. d.)	6-7	14-16	52 mm.
31 mm.	20 mm.	15 mm. (48.4 per cent h. d.)	14 mm. (45.1 per cent h. d.)	6	14-16	55 mm.
31 mm.	18 mm.	15 mm. (48.4 per cent h. d.)	14 mm. (45.1 per cent h. d.)	6-7	14-15	53 mm.
30 mm.	20 mm.	15 mm. (50 per cent h. d.)	13.5 mm. (45 per cent h. d.)	6	14-15	65 mm.
29 mm.	16.5 mm.	12.5 mm. (43 per cent h. d.)	13 mm. (45 per cent h. d.)	6	13-14	
29 mm.	21 mm.	14.5 mm. (50 per cent h. d.)	12.5 mm. (43.1 per cent h. d.)	6 (7)	15-16	
27 mm.	14.5 mm.	12.5 mm. (46.3 per cent h. d.)	11.5 mm. (42.6 per cent h. d.)	5-6	13-16	54 mm.
21 mm.	12 mm.	11 mm. (52.4 per cent h. d.)	9 mm. (42.9 per cent h. d.)	6	12-13	55 mm.

*Description.*—The test is usually somewhat elevated above and flattened below, sometimes also flattened above; the sides are regularly arched, and the circumference is circular or more or less distinctly subpentagonal.

The ambulacra are usually distinctly sinuate. The interporiferous zone is about twice the width of a poriferous zone. The marginal series of tubercles is very regular, only now and then there is found a tubercle somewhat smaller or larger than the normal. The marginal tubercles are in general rather small and inconspicuous, little or not at all raised above the pore zone, whereas the interporiferous zone is generally slightly sunken toward the mid line. The tubercles are almost contiguous but there is still room left for some minute

tubercles (of pedicellariae) between them, indeed often a regular series. Within the marginal tubercle each plate usually carries one or two much smaller tubercles at the lower edge, forming fairly regular longitudinal and, when two of them are present, horizontal series. The rest of the interporiferous zone is naked; sometimes, however, there is a tubercle near the median corner of the plate, or there may be two tubercles just within the marginal one, placed one at the lower edge, the other higher up; in such cases the regular serial arrangement of the inner tubercles is lost, and the naked character of the interporiferous zone much reduced. The pores are mostly about of equal size, but sometimes the inner pore is rather distinctly the larger. They are rather distant, with the wall between them fairly broad, low, and rounded; the ridge separating the adjoining pore pairs is low and rounded. The pores, generally speaking, might almost be termed semiconjugate (pl. 75, figs. 1-2). The pore zone is not sunken. The ambulacral plates are low and rather numerous. There is a considerable variation in the ambulacra. While the usual, and what would appear to be the more typical and normal, condition is that the space between the two series of marginal tubercles is fairly broad and naked, this space sometimes is so narrow as scarcely to give room for more than the one small tubercle within each marginal tubercle, or it may even be wider than usual, so as to give room for a regular series of up to five small tubercles at the lower edge of each plate.

In the interambulacra there are 6, more rarely 7, coronal plates in a series, the upper ones in each series more or less irregular, prolonged upward at the adradial edge, often to such a degree that the uppermost (rudimentary) plate is wholly excluded from the adradial edge. The tubercles are in general small and inconspicuous, the boss low and without a trace of crenulation. The areoles are only very little sunken. At most the 2 or 3 proximal ones are confluent, but more often even the lowermost ones are separated by a distinct series of tubercles; the proximal ones are rather distinctly transverse-oval. Above the ambitus the distance between the areoles usually increases considerably, thus giving room for several miliary tubercles between the neighboring scrobicular circles. The uppermost tubercle (and correspondingly the uppermost primary spine) in each series is more or less rudimentary, the areole widening irregularly on the adapical side, becoming effluent and more or less indistinct. The scrobicular ring of these upper areoles is likewise more or less rudimentary, extending toward the adapical side and here often quite open, and evidently obliterating. The scrobicular ring of the ambital tubercles is not raised and is relatively inconspicuous, even though these tubercles are about twice as large as the marginal ambulacral tubercles. Outside the scrobicular ring the plates are covered more or less closely with very small miliary tubercles, leaving a fairly distinct naked

median line. On the adradial side of the scrobicular ring also there are several miliary tubercles, the scrobicular tubercles not coming very close to the edge. The median part is about half the width of an areole, scarcely at all sunken toward the mid line.

The apical system is usually about half the horizontal diameter, though rather variable in size, from 43 to 53 per cent of the horizontal diameter; it is usually somewhat elevated toward the middle. The oculars are usually insert, sometimes very narrowly so, sometimes more broadly; they are usually rather broad, more or less deeply excavated in the outer edge, the inner edges being more or less S-shaped. The genital plates are usually much narrower in their outer than in their inner part. The genital pores are small, rather distant from the outer edge. The periproct is of medium size, with a moderate number of plates. The whole apical system is rather densely covered with small tubercles of uniform size, only those at the inner edge of the genitals and on the periproctal plates being sometimes comma-shaped (fig. 19).

The peristome is usually somewhat smaller than the apical system, rarely a little larger, and quite flat. There are 10 or 11 ambulacral plates in a series, and 5 or 6 interradial plates in a fairly regular series; usually the ambulacra do not join at the peristomial edge, but the interradial plates do not reach to the mouth edge, even where the way is left open for them.

The primary spines are more or less slender, about one and one-half to two times the horizontal diameter, or even a little longer; they taper gradually to a simple blunt point. There are usually 9 or 10 sharp, rather coarsely serrate ridges, the surface being otherwise not very densely covered by short, very fine, not anastomosing hairs, which do not conceal the normal fine longitudinal striation. The collar is short, thickening toward the not very conspicuous milled ring. The oral primaries are very slender, straight, smooth, or very finely serrated longitudinally. The third or fourth is transitional to the ambital spines.

The secondary spines are slender and flattened; the scrobicular spines are about 4 mm. long, usually distinctly concave on the outside, sometimes with nearly straight edges, sometimes distinctly broader in the basal part and narrowing toward the slightly rounded point. The marginal ambulacral spines are much narrower and more simply spiniform. The miliary spines are flattened and pointed. The secondary spines are scarcely appressed.

Large globiferous pedicellariae are very rarely observed; they were detected only in one specimen (station 5517). They are of the typical form with no end tooth (pl. 80, fig. 4) and with a limb on the stalk. Small globiferous pedicellariae of two different forms occur; one (pl. 80, fig. 6) is the ordinary typical form of the usual structure,

with the valves of regular shape, with a rather small terminal opening and a small but distinct end tooth. These usually have a long stalk, up to about 2.5 mm. in length, which makes them quite conspicuous, though the head scarcely exceeds 0.5 mm. in length. The other form

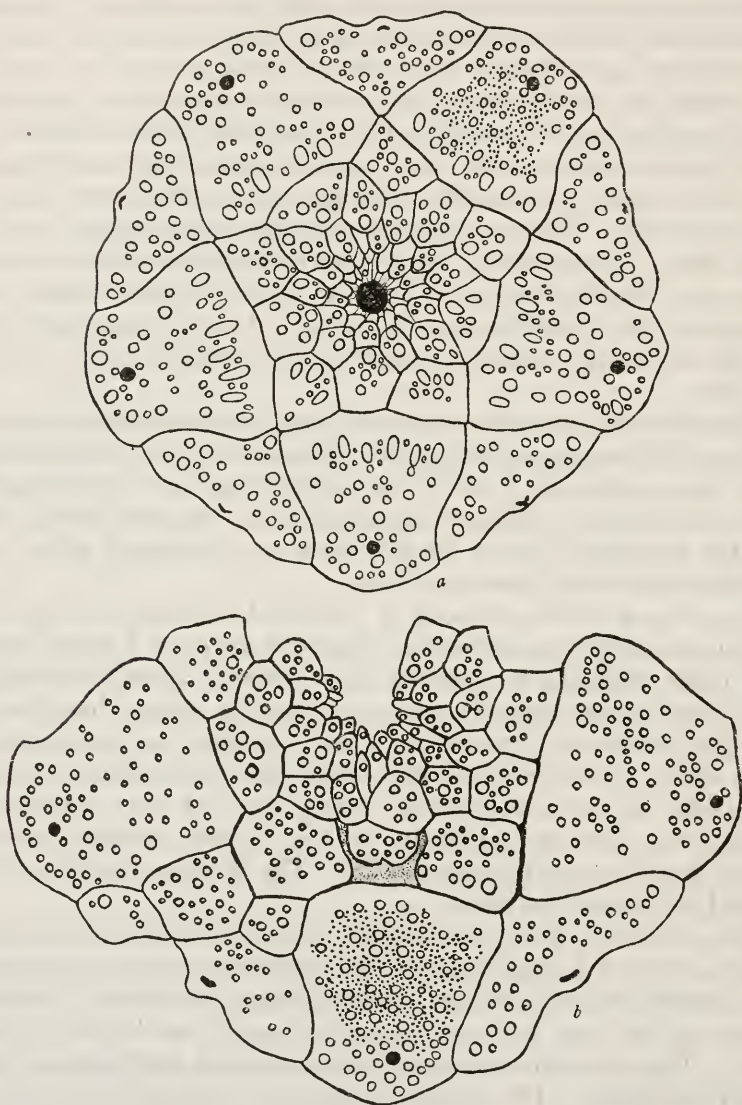


FIG. 19.—APICAL SYSTEM OF *STYLOCIDARIS EFFLUENS*, NEW SPECIES. IN *b* ONE OF THE OCULARS IS ABNORMALLY DIVIDED INTO SEVERAL SMALLER PLATES. *a*×6, *b*×4

(pl. 80, figs. 1-3) is very short stalked; the head, which is about 0.8 mm. long, is inclosed in a rather thick, apparently glandular skin; the valves are slender, with irregular serrate crests, and a small more or less irregular terminal opening, sometimes with a fairly distinct



end tooth. This form, which occurs only between the scrobicular spines on the upper side of the test, usually bending inward over the base of the large spine muscles, is quite evidently a specialization of the small globiferous pedicellariae; indeed, transitional forms sometimes occur; one might even be tempted to regard them as abnormal small globiferous forms, but their fairly regular occurrence in the places designated both in this and in other species of *Stylocidaris* rather necessitates regarding them as a special form of pedicellariae, apparently characteristic of the genus *Stylocidaris*. They are usually few in number and are found on by no means all specimens. The tridentate pedicellariae (pl. 80, fig. 5) are numerous, fairly conspicuous, up to 1 mm. in length of head, with the stalk of very variable length, sometimes quite short, sometimes as long as 4 mm. The valves are very slender, widely gaping, and joining only near the end. The blade is narrow and deep, usually with a series of cross beams in the lower part; the edges are very finely serrate.

The spicules of the tube feet are simple, slightly spinous rods; in the intestinal wall there are numerous small irregular plates, or sometimes only a few more or less regular triradiate spicules.

In color the primary spines are whitish; the secondaries have a more or less conspicuous greenish or reddish longitudinal stripe. The test is whitish, only the apical system having a darker, greenish-brown or reddish tint, especially on the inner part of the genital plates and on the periproct.

*Notes.*—In the intestine I have found only detritus with unidentifiable remains of bottom organisms.

The small size of the eggs (only 0.1 mm. in diameter) and of the female genital openings would seem to indicate that this species has pelagic larvae.

Abnormalities are not rare, especially in the ambulacra; in one specimen ocular II and genital 1 are broken up into smaller plates (fig. 19*b*); in another genital 1 has two pores. A specimen from station 5410 is remarkable in having Amb. I double in its whole length (pl. 59, fig. 3). A parasitic gastropod (*Stylifer*?) sometimes is found in the primary spines, which are then usually transformed into globose galls, rarely growing out to anything like their normal length. The spines also are often overgrown with foreign organisms, mollusks (*Crepidula*), serpulids, barnacles, etc. In two specimens a very interesting case of regeneration was observed; one or two of the oral primaries have for some reason or other been lost, and instead of a new primary spine and tubercle some secondary spines and tubercles have been formed within the space of the original primary areole.

Some of the numerous specimens collected by the *Albatross* differ from the form which I regard as the typical one in that their primary

spines are stouter and the tubercles and areoles on the upper plates are more normally developed. In some of them also the ocular plates are smaller than usual, and the ambulacra have a narrow interperiferous zone. Had these specimens been found alone, together with the typical form, I should not have hesitated to regard them as a separate species. But the rich material at hand shows all transitional forms, so that it becomes quite impossible to distinguish the form with the stouter spines even as a variety.

*Remarks.*—The closest relationships of the present species are with *Stylocidaris tiara* (Alcock). It agrees with that species in the general character of the primary spines, which are in both provided with relatively few (7 or 8 in *tiara*, 9 or 10 in *effluens*) sharp prominent ridges, the surface of the spines otherwise being set with very short simple hairs; but these ridges are entire in *tiara*, while in *effluens* they are more or less coarsely serrate. Also in *tiara* the upper areoles are more or less effluent; but then the larger ambital tubercles are finely, but rather distinctly, crenulate in *tiara*, which they are not in *effluens*. Otherwise the characters of the two species are very much the same, but the differences indicated are sufficient to prove that they can not be regarded as identical.

It does not appear that *S. effluens* is more closely related to any other recent species. The peculiar effluent character so conspicuous in some specimens of this species recalls to some degree the fossil *Stereocidaris sceptrifera* (Mantell).<sup>11</sup> The character of the effluence of the areoles in this fossil form is, however, different from that of the recent form, and there is absolutely no close relationship between the recent and the fossil species.

#### STYLOCIDARIS REINI (Döderlein)

Plate 66, fig. 2; plate 67, fig. 2

*Cidaris (Dorocidaris) reini* DÖDERLEIN, Die japanischen Seeigel, I, Familien Cidaridae und Saleniidae, 1887, p. 7, pl. 4, figs. 1-7; pl. 8, figs. 4, a-d.

*Cidaris (Cidaris) reini* DE MEIJERE, Die Echinoidea der Siboga-Exped., 1904, p. 5, pl. 1, figs. 2-3; pl. 11, figs. 103-108.

*Dorocidaris reini* A. AGASSIZ and H. L. CLARK, Mem. Mus. Comp. Zoöl., vol. 34, No. 1, 1907, p. 10, pl. 3, figs. 1-14.

*Tretocidaris reini* H. L. CLARK, The Cidaridae, 1907, p. 207.

*Stylocidaris reini* H. L. CLARK, Cat. Recent Sea-urchins Brit. Mus., 1923, p. 24.

*Localities.*—Station 5367; Verde Island passage; Malabrigo Light bearing N. 81° E., 8 miles distant (lat. 13° 34' 37'' N., long. 121° 07' 30'' E.); 329 meters; sand; February 22, 1909 (8 specimens, Cat. No. E. 1317, U.S.N.M.).

Station 5617; Dodinga Bay, Gillolo; Ternate Island (SE.) bearing S. 45° W., 7 miles distant (lat. 0° 49' 30'' N., long. 127° 25' 30'' E.);

<sup>11</sup> See Th. Wright, Monograph of the British Fossil Echinodermata from the Cretaceous Formations, 1862-1882, pl. 6, fig. 1.

239 meters; coral; November 27, 1909 (1 specimen, Cat. No. E. 1331, U.S.N.M.).

*Notes.*—The specimen from station 5617 is notable for the fine pinkish color of the median stripe on the secondary spines, which gives the whole specimen a general pinkish hue; the apical system is not conspicuously darker than the rest of the specimen. The primary spines are very finely developed, white, with a pinkish base and with the serrate ridges very distinct and with scattered small wartlike elevations between the ridges; they are slightly swollen in the basal part. The hairs covering the general surface of the spine are very small and simple, as in the typical form. (See below, under the var. *cladothrix*.) This specimen measures 34 mm. in horizontal diameter; the longest primaries are 56 mm. in length, and 3.5 mm. thick at the base.

The specimens from station 5367 are small, not exceeding 25 mm. in horizontal diameter, with slender spines; they are inconspicuously colored whitish yellow, with the apical system darker.

**STYLOCIDARIS REINI, var. CLADOTHRIX, new variety**

Plate 65, figs. 5-7; plate 66, fig. 1; plate 67, fig. 1; plate 75, fig. 4

*Localities.*—Station 5212, east of Masbate; Panalangan Point bearing S. 54° 30' E., 14.5 miles distant (lat. 12° 04' 15'' N., long. 124° 04' 36'' E.); 197 meters; bottom temperature 15.50° C.; gray sand and mud; April 20, 1908 (9 specimens, Cat. Nos. E. 1361, E. 1362, E. 1367, U.S.N.M.).

Station 5392, between Sámar and Masbate, Tubig Point bearing N. 49° E., 5 miles distant (lat. 12° 12' 35'' N., long. 124° 02' 48'' E.); 247 meters; green mud and sand; March 13, 1909 (5 specimens, Cat. Nos. E. 1332, the type, E. 1333, U.S.N.M.).

Station 5398, between Masbate and Leyte, Gigantangan Island (S.) bearing S. 45° E., 2.7 miles distant (lat. 11° 35' 12'' N., long. 124° 13' 48'' E.); 208 meters; green mud; March 15, 1909 (1 specimen, Cat. No. E. 1378, U.S.N.M.). (See under var. *rubida*.)

*Characters.*—These specimens, which are all in a poor state of preservation, differ from the typical form in the shape of the hairs covering the surface of the spines. While in the typical form these are very small and simple, they are in the present form much larger, rather coarse, and bush-shaped (figs. 20 *a-b*).

These hairs are only distinguishable on clean, fully formed, and not too old and worn spines. Generally the spines are so dirty (from the contents of the trawl) or overgrown with foreign organisms that it is necessary to clean them by treating them with sodium hypochlorite and then rinsing them under a rather strong jet of water. In this way it is easy to get them perfectly clean, with the hair covering preserved in its full beauty, this word being not at all exaggeration.

This offers a rather striking character differentiating the two forms, so that it is tempting to regard the form with the bush-shaped hairs as a separate species, the more so as there are also some other differences. For instance, the secondary spines are rather more slender, especially the marginal ambulacral spines, and also more greenish than in the typical form. The primaries are white, or faintly banded with red, as in the typical form. The interporiferous area also is in general broader and more densely covered with miliary tubercles than in the type (pl. 75, fig. 4). Some of the specimens have the upper arcoles more or less effluent, recalling the condition generally found in *S. effluens*. In fact, had I only these *Albatross* specimens at my disposal I should hardly have hesitated to regard this form as a separate species. However, the several specimens of both the typical form and of the variety which I have myself collected in the Japanese, Philippine, and Moluccan seas (at the Kei Islands) offer such an intermingling of all characters that I find it quite impossible to give any reliable characters other than the one pointed out above; that

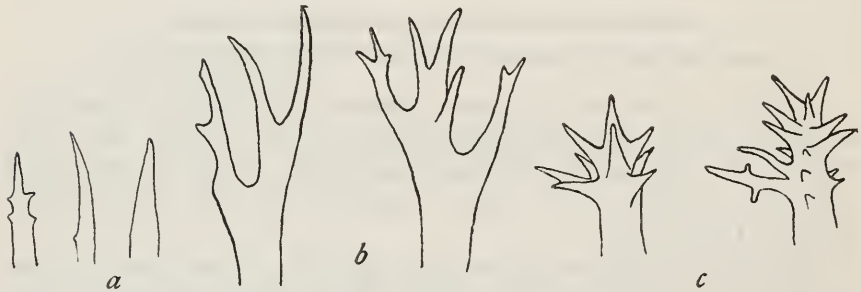


FIG. 20.—HAIRS FROM THE PRIMARY SPINES OF *STYLOCIDARIS REINI* (DÖDERLEIN) (a), *ST. REINI*, VAR *CLADOTHRIX*, NEW VARIETY (b), AND *ST. ANNULOSA*, NEW SPECIES (c).  $\times 115$

is, the difference in the shape of the hairs on the surface of the primary spines; but also in this character intermediate forms occur, which it is difficult, or rather, impossible, to refer definitely to one form or the other. Thus in spite of the conspicuous difference when forms pronouncedly illustrative of the two types are compared, I hold it unjustifiable to give the form with the bush-shaped hairs more than varietal rank.

It may be mentioned that generally speaking the typical form has more slender primaries with somewhat less numerous serrate ridges than the variety, which generally has the primaries somewhat swollen at the base and the serrations more numerous, the serial arrangement often being indistinct. But in the *Albatross* specimens of the variety the serrations form distinct longitudinal series and the primaries are in general slender, whereas in the specimen of the typical form from station 5617, on the contrary, the primaries are swollen at the base (pl. 66, fig. 2). It should also be especially pointed out that the number of miliary tubercles in the interporiferous zone of the ambulacra

varies to such a degree that no reliable distinguishing character can be found here.

Some of the specimens carry sea anemones, besides serpulids, sponges, and other organisms, on their spines.

**STYLOCIDARIS REINI, var. RUBIDA, new variety**

Plate 63, figs. 2, 3; plate 74, figs. 6, 7

*Locality*.—Station 5398; between Masbate and Leyte; Gigantangan Island (S.) bearing S.  $45^{\circ}$  E., 2.7 mile distant (lat.  $11^{\circ} 35' 12''$  N., long.  $124^{\circ} 13' 48''$  E.); 208 meters; green mud; March 15, 1909 (3 specimens, Cat. Nos. E. 1376, the type, E. 1377, U.S.N.M.).

*Characters*.—This form again is especially characterized by its primary spines and their hair covering. In the largest specimen, measuring 24 mm. in horizontal diameter, the longest spines are 60 mm. in length, thus two and one-half times the horizontal diameter, and very conspicuously banded with red and greenish white; the collar is greenish. They are very slightly thickened at the base, gradually tapering to a rather fine point. The spinules are arranged in distinct longitudinal series, but, especially on the adapical side where the spinules are somewhat larger than on the adoral side of the spine, so distant from each other as not to form distinct ridges, each spinule rising separately from the flat surface of the spine; especially on the red bands these white spinules stand out very distinctly; their base is rather broad, the spinule itself ending in a rather sharp point. The surface of the spine otherwise is covered with a coat of fine, short, simple hairs, which are more or less distinctly gathered into small groups, much as in the typical form.

The secondary spines are flat, not concave on the outer side as is usually the case in the typical form; the marginal ambulacral spines are rather broader than is usual in the typical form. In regard to the test it is noteworthy that the interporiferous zone is rather naked, there being only a single small tubercle on each plate within the marginal tubercle; this is placed at the lower edge of the plate (pl. 74, figs. 6, 7). There appear to be no other points of difference from the typical form.

While the larger specimen, to which the above description refers, differs rather markedly from the typical form, especially in its primary spines, a second specimen, nearly as large, 23 mm. in horizontal diameter (poorly preserved with all the spines broken), shows the characters pointed out above to a much smaller degree, being, in fact, quite intermediate between the variety and the typical form. A third specimen, of only 14.5 mm. in horizontal diameter, has the primaries of the same conspicuous red color as in the largest specimen, but is otherwise, of course, too young for a real comparison. The spinules of the primaries are disposed so as to form true ridges. Finally, a

fourth small specimen from the same station 13.5 mm. in horizontal diameter has bush-shaped hairs on the primaries, and therefore must be referred to the variety *cladothrix*.

*Remarks.*—These facts seem to show the impossibility of giving this form more than varietal rank, none of the characters of the spines or the test being quite reliable as distinguishing features, and the pedicellariae showing no differences from those of the typical form. The discovery of a specimen of the variety *cladothrix*, together with the variety *rubida*, may also perhaps be taken as an indication of the small value to be attached to these varieties. Of course there would be nothing astonishing in getting two distinct varieties in the same haul, but on seeing the specimens together one would be rather inclined to regard them all as identical.

STYLOCIDARIS ANNULOSA, new species

Plate 63, fig. 1; plate 64, figs. 1-3; plate 65, fig. 8; plate 75, fig. 3; plate 80, figs. 7-11

*Localities.*—Station 5278; China Sea, in the vicinity of southern Luzon; Malavatuau Island (N.) bearing S. 23° E., 8.5 miles distant (lat. 14° 00' 10'' N., long. 120° 17' 15'' E.); 186 meters; bottom temperature, 15.33° C.; fine sand, mud, and shells; July 17, 1908 (2 specimens, Cat. No. E. 1328, the type, U.S.N.M.).

Station 5369; in the vicinity of Marinduque Island; Tayabas Light (outer) bearing N. 50° W., 8.8 miles distant (lat. 13° 48' 00'' N., long. 121° 43' 00'' E.); 194 meters; broken shells; February 24, 1909 (9 specimens, Cat. Nos. E. 1268, E. 1327, E. 1329, U.S.N.M.).

Measurements

h. d.	v. d.	Apical system	Peristome	Number of—		Longest spines
				I. a.	A. pro I. a.	
39 mm.	25 mm.	16 mm. (41 per cent h. d.)	11 mm. (28.2 per cent h. d.)	7-8	16-17	
38 mm.	23 mm.	16.5 mm. (46 per cent h. d.)	11.5 mm. (32.0 per cent h. d.)	7	16-17	ca. 70 mm. (?)
31 mm.	19 mm.	13.5 mm. (43.5 per cent h. d.)	10.5 mm. (34 per cent h. d.)	6-7	16-17	76 mm.
27 mm.	17 mm.	13.5 mm. (50 per cent h. d.)	9.5 mm. (35.2 per cent h. d.)	6	16-17	ca. 75 mm.

*Description.*—The test is rather flattened above and below, sometimes gently vaulted above. The sides are regularly arched or, in the largest specimen, somewhat more vertical. The circumference is circular, in the largest specimen slightly subpentagonal.

The ambulacra are rather distinctly sinuate. The interporiferous zone is about twice the width of a pore zone. The marginal series of tubercles is perfectly regular; the tubercles are small and inconspicuous, nearly contiguous. Within the marginal tubercle each plate carries a single, much smaller, tubercle at the lower edge, the rest

of the plate remaining naked except for a very small miliary tubercle; the interporiferous area thus is rather naked; it may be somewhat sunken toward the middle line. The pore zone is scarcely at all sunken; the pores are equal in size, and are separated by a fairly broad and slightly raised wall; the ridge separating the adjoining pore pairs is low and rounded (pl. 75, fig. 3).

In the interambulacra the areoles are very large and flat, scarcely at all deepened, showing a rather unusually distinct radial striation, but without a trace of crenulation; the boss is very low, the mamelon of ordinary size. At most the two proximal areoles are confluent, and only these proximal ones are more or less transverse oval. In the fourth or fifth the upper edge of the areole is generally straight, whereas the rest of it remains circular. The scrobicular ring is rather conspicuous, the tubercles being fairly large, three or four times as large as the marginal ambulacral tubercles. Outside the scrobicular ring there are some few miliary tubercles, leaving a narrow naked median space and also a narrow naked space on the adradial edge. The median area is very narrow, only about one-third the width of an areole.

The apical system is about 41 to 50 per cent of the horizontal diameter, relatively more in the smaller specimens than in the larger. The oculars are all rather widely exsert; only in one specimen ocular I is very narrowly insert. The oculars have the shape of a more or less acute triangle, with the inner sides nearly straight. The genital plates are rather high; the madreporite is not enlarged; the genital pore is near the edge; the female genital pores are small. The periproct is rather small, with a moderate number of periproctal plates. The whole apical system is more or less thickly covered with small fairly uniformly sized tubercles, some of which are more or less comma-shaped (fig. 21).

The peristome is conspicuously smaller than the apical system, about 28 to 35 per cent of the horizontal diameter, and like the apical system relatively larger in the smaller specimens. There are 9 or 10 ambulacral plates in a series in the largest specimen, but only from 6 to 8 in the specimen 27 mm. in horizontal diameter. In the largest specimen the pore series is slightly irregular, some of the pores being pushed slightly aside for want of space. The ambulacra do not join at the mouth edge, leaving a free passage for the interradiial plates, which are from 3 to 6 in number and more or less irregular.

The primary spines are about two and one-half to three times as long as the diameter of the test, slender, 2 to 3 mm. thick, cylindrical, tapering very gradually to a rather fine point; the longer ambital spines are rather distinctly curved in the basal part. They are set with about 12 to 15 longitudinal series of low, rounded spinules which are generally not united at their base, thus not forming longitudinal

ridges, excepting in the outer part of the spine. The surface of the spine is otherwise covered with sparse, low, bush-shaped hairs (fig. 20c). The collar is about 3 mm. long, increasing very slightly in thickness toward the very prominent milled ring. The apical primaries in adult specimens are apparently much shorter than the ambital ones, when fully formed. The oral primaries are very slender, smooth, and straight; the fourth is transitional to the ambital spines.

The secondary spines are very slender and pointed; the scrobicular ones are about 7 mm. long, flattened, with a slight concavity on the outer side in the basal part, made somewhat more conspicuous by a dark-colored median stripe (pl. 80, fig. 7); the marginal ambulacral spines are about 4 mm. long, almost setaceous. The miliary spines

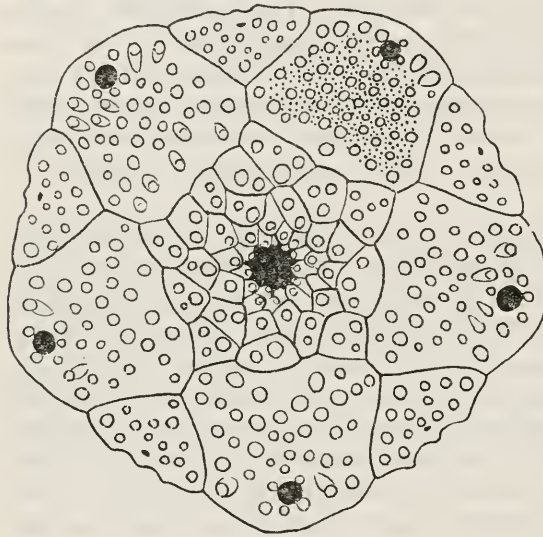


FIG. 21.—APICAL SYSTEM OF *STYLOCIDARIS ANNULOSA*, NEW SPECIES.  $\times 6$

are likewise comparatively long and slender and are pointed. The secondary spines, even the scrobicular and marginal ambulacral spines, are generally erect; but this may probably, to some degree at least, be due to preservation.

The large globiferous pedicellariae which were observed only on the larger specimen from station 5278 (the type specimen) are of the usual form, with a well-developed limb on the stalk (pl. 80, fig. 9).

The small globiferous pedicellariae are usually very long stalked, the stalk being up to 5 mm. in length and rather thick; the head is up to 1 mm. long; the valves are of the usual form, with a small, but distinct, end tooth (pl. 80, fig. 8). Tridentate pedicellariae are usually rather conspicuous, with the head up to 2.5 mm. long and the stalk of a length similar to that of the small globiferous. The valves (pl. 80, fig. 10) are very slender, separated for most of their length; the edge is somewhat irregularly widened at the base, otherwise finely serrate.

The spicules of the tube feet are of the usual form of simple more or less spinous rods. In the intestine they are partly irregular, fenestrated plates, partly, in the esophagus and the adoral part of the intestine, small triradiate bodies (pl. 80, fig. 11a-b).



The primary spines have numerous narrow red bands which are separated by broader whitish or greenish bands. The red color almost disappears on the adoral side of the spine, which is nearly white. The secondary spines are whitish, with a more or less conspicuous greenish brown median stripe. The naked test is whitish, the upper side darker. The genital plates and the periproct are rather dark, greenish brown, against which color the white oculars stand out very markedly (pl. 64, fig. 2). The greenish-brown color continues more or less on to the interambulacra; the primary tubercles are grayish green. From the outer edge of the oculars, which is also greenish brown, this color continues along the series of marginal ambulacral tubercles and the adjoining part of the pore zone almost to the oral side of the test. The interporiferous zone of the ambulacra is otherwise white, or at least whitish.

*Notes.*—The intestine of a specimen opened was completely empty thus giving no information in regard to the food. The small size of the female genital openings and of the eggs, which are about 0.1 mm. in diameter, indicate that the species has probably a pelagic larva. The spines are rather heavily overgrown by bryozoans and barnacles, mainly *Scalpellum*. Some of the primaries carry at the outer end a conspicuous tuft of a peculiar ctenostomatous bryozoan, with a small head on a long simple stalk. These tufts are usually confined to the adoral side of the spine and hang downward.

*Remarks.*—This species, so very well characterized through its peculiar large flat areoles, its long banded spines, and its unusually slender secondary spines, besides the characteristic coloration, is not very closely related to any other known species of *Stylocidaris*; the nearest relationships would seem to be with *S. reini*, but it is not very near that form. All the specimens at hand are remarkably uniform in their main characters.

### Genus STEREOCIDARIS Pomel

#### STEREOCIDARIS GRANDIS Döderlein

*Stereocidaris grandis* DÖDERLEIN, Die japanischen Seeigel, I, Familien Cidaridae und Salioidae, 1887, p. 3, pl. 1, figs. 1–6; pl. 2, figs. 1–11; pl. 8, figs. 2, a–m.—DE MEIJERE, Die Echinoidea der Siboga-Exped., 1904, p. 17.—A. AGASSIZ and H. L. CLARK, Mem. Mus. Comp. Zoöl., vol. 34, No. 1, 1907, p. 22, pl. 5, figs. 18–20, pls. 33, 36.—H. L. CLARK, Bull. Mus. Comp. Zoöl., vol. 51, No. 7, 1907, p. 220; Cat. Recent Sea-urchins Brit. Mus., 1925, p. 26.

*Localities.*—Station 5281; China Sea, in the vicinity of southern Luzon; Malavatuan Island (N.) bearing S. 84° W., 4.3 miles distant (lat. 13° 52' 45'' N., long. 120° 25' 00'' E.); 367 meters; bottom temperature 10.22° C.; dark gray sand; July 18, 1908 (1 specimen, Cat. No. E. 1303, U.S.N.M.).

Station 5283; China Sea, in the vicinity of southern Luzon; Malabatuan Island (N.) bearing N. 64° W., 8.75 miles distant (lat. 13° 48' 30'' N., long. 120° 28' 40'' E.); 512 meters; bottom temperature 8.22° C.; dark gray sand; July 18, 1908 (1 specimen, Cat. Nos. E. 1349, E. 1350, U.S.N.M.).

Station 5325; off northern Luzon; Hermanos Island (N.) bearing N. 86° E., 16.75 miles distant (lat. 18° 34' 15'' N., long. 121° 51' 15'' E.); 409 meters; bottom temperature 11.78° C.; green mud; November 12, 1908 (4 specimens, Cat. No. E. 1347, U.S.N.M.).

Station 5326; off northern Luzon; Hermanos Island (N.) bearing N. 69° E., 8 miles distant (lat. 18° 32' 30'' N., long. 122° 01' 00'' E.); 420 meters; bottom temperature 13.00° C.; mud; November 12, 1908 (1 specimen, Cat. No. E. 1348, U.S.N.M.).

Station 5392; between Samar and Masbate; Tubig point bearing N. 49° E., 5 miles distant (lat. 12° 12' 35'' N., long. 124° 02' 48'' E.); 247 meters; green mud and sand; March 13, 1909 (1 specimen, Cat. Nos. E. 1301, E. 1302, U.S.N.M.).

Station 5459; east coast of Luzon; Legaspi Light bearing S. 88° W., 14.3 miles distant (lat. 13° 10' 21'' N., long. 123° 59' 54'' E.); 367 meters; June 8, 1909 (2 specimens, Cat. No. E. 1288, U.S.N.M.).

Station 5527; between Bohol and Siquijor; Balicasag Island (C.) bearing N. 14° W., 8.2 miles distant (lat. 9° 22' 30'' N., long. 123° 42' 40'' E.); 716 meters; bottom temperature 11.83° C.; globigerina ooze; August 11, 1909 (1 specimen, Cat. No. E. 1304, U.S.N.M.).

*Remarks.*—The identification of these specimens with *Stereocidaris grandis* I must regard as provisional, as I have a suspicion that some confusion has taken place with regard to that species and *S. microtuberculata* (Yoshiwara); the latter would rather seem to be the true *S. grandis*, while the form here called *S. grandis*, so far as I can judge, in conformity with H. L. Clark and de Meijere, should probably receive a new name. The question can not, however, be settled until after a renewed examination of the type material. It may only be pointed out on this occasion that the main character distinguishing *grandis* from *microtuberculata*, according to Clark<sup>12</sup> the width of the ambulacra, namely, 25 to 33 per cent of the interambulacra in *grandis* and only 18 to 25 per cent in *microtuberculata*, does not hold very well. From the measurements given by Döderlein<sup>13</sup> it is seen that in his original specimens of *S. grandis* the ambulacra are only 23 to 28 per cent of the interambulacra. A careful comparison of a specimen identified by H. L. Clark as *microtuberculata* with Döderlein's description and figures of his *S. grandis* seems to me to leave but very little doubt that they are identical.

<sup>12</sup>The Cidaridae, p. 218.

<sup>13</sup>Jap. Seeigel, p. 49.

The specimen from station 5527 has the primaries somewhat thickened above the collar, then tapering gradually to the rather fine point which is not widened into a crown in those few that are intact; they are of a faint pinkish tint. The specimen measures 30 mm. in horizontal diameter, the longest spines being about 70 mm. in length. Possibly this will ultimately prove to represent a separate variety or even species. For the present I can, however, only regard it as belonging, together with the other specimens here mentioned, to *S. grandis*.

The specimen from station 5392 is abnormal in having genital 1 divided into two almost equal halves, each with its genital pore.

STEREOCIDARIS GRANDIS, var. RUBRA, new variety

Plate 68, figs. 1, 2

*Locality*.—Station 5135; in the vicinity of Joló (Sulu); Joló Light bearing S. 46° W., 11.9 miles distant (lat. 6° 11' 50'' N., long. 121° 08' 20'' E.); 294 meters; bottom temperature 14.11° C.; fine coral sand; February 7, 1908 (1 specimen, the type, Cat. No. E. 1336, U.S.N.M.).

*Measurements*

h. d.	v. d.	Apical system	Peristome	Width of—		Number of—		Longest spines
				I. a.	A.	I. a.	A. pro I. a.	
5.2 mm.	29.5 mm.	23 mm. (44.2 per cent h. d.).	22 mm. (42.3 per cent h. d.).	25 mm.	5.5 mm.	5-6	24-25	55 mm.

*Characters*.—In its general characters this specimen is so very like the typical *S. grandis* that there would be no reason to keep it separate were it not for its very conspicuous red color. Not only the spines, primaries, secondaries, and miliaries are of a deep red, but the naked test also is intensively red, even down to the peristome; the red color is also found in the areoles, in the ambital ones only as radiating streaks, while the uppermost complete areole is wholly red; the upper part of the boss and the mamelon remain white. In the ambulacra the interporiferous zone is also intensively red, nearly down to the peristome, while the pore zone remains whitish.

As the typical form may also have a more or less conspicuous reddish tint on the apical system and in the uppermost part of the interambulacra, it is rather probable that this color difference is not sufficiently reliable to permit us to regard this form as a separate species, and, at least so long as only this single specimen is known, it would seem best to regard it only as a variety of *S. grandis*.

## STEREOCIDARIS MICROTUBERCULATA Yoshiwara

Plates 69, 70

*Cidaris (Stereocidaris) microtuberculata* YOSHIWARA, Annot. Zool. Jap., vol. 2, 1898, p. 57; Zool. Mag. Tokyo, vol. 18, 1906, pl. 1, figs. 6, 7.

*Stereocidaris microtuberculata* H. L. CLARK, Bull. Mus. Comp. Zoöl., vol. 51, No. 7, 1907, p. 220, pls. 1, 2.—A. AGASSIZ and H. L. CLARK, Bull. Mus. Comp. Zoöl., vol. 51, No. 5, 1907, p. 112.

*Localities*.—Station 5162; Tawi Tawi group, Joló (Sulu) Archipelago; Tinagta Island (S.) bearing N.  $71^{\circ}$  W., 5.4 miles distant (lat.  $5^{\circ} 10' 00''$  N., long.  $119^{\circ} 47' 30''$  E.); 420 meters; bottom temperature  $11.61^{\circ}$  C.; coarse sand and broken shells; February 22, 1908 (1 specimen, Cat. Nos. E. 1363, E. 1364, U.S.N.M.).

Station 5475; east coast of Luzon; San Bernadino Light bearing S.  $27^{\circ}$  W., 11 miles distant (lat.  $12^{\circ} 55' 25''$  N., long.  $124^{\circ} 22' 12''$  E.); 356 meters; bottom temperature  $15.17^{\circ}$  C.; shells; June 24, 1909 (1 specimen, Cat. No. E. 1271, U.S.N.M.).

*Notes*.—These two specimens differ a little from the typical form from the Sagami Sea in the character of the primaries. While in the three specimens I have seen of the typical form the longitudinal ridges of the primaries are very narrow and only very slightly serrate, leaving a rather broad space between them which is covered with a spongy coat of fine anastomosing hairs, the ridges in the present form are broader and more densely serrate; the space between the ridges is thus narrower than in the typical form, but the hair covering is otherwise in the main the same. It is further remarkable that, especially in the larger specimen from station 5475, the ridges are so very much worn as to be scarcely recognizable as such, and the spines look very smooth, almost as if polished; the spines are on the whole very clean. It seems rather puzzling, how they could have become thus worn.

The primaries of the larger specimen are rather distinctly compressed, especially toward the end, which is somewhat widened and obliquely cut, as if they had been used for walking. The primaries are white, slightly darker on the collar. The scrobicular spines and the spines around the anal and the genital openings are of a slight greenish tint; the miliary spines are otherwise of a slight brownish tint. In the second specimen the scrobicular spines do not show any greenish tint; in this specimen a pair of developing apical primaries are of a deep violet tint.

The primaries are rather long and slender; in the larger specimen, which is 53 mm. in horizontal diameter, the longest spines are 85 mm. in length; in the second specimen, which is 36 mm. in horizontal diameter, the spines are up to 63 mm. long. On the latter a specimen of the little synaptid *Taeniogyrus cidaridis* Ohshima is wound around one of the spines.

The differences pointed out above between these specimens and the typical form are so slight that I do not think it justifiable to designate them as a separate variety.

Specimens of this species were taken by the author at the Kei Islands (1922), it being thus evidently widely distributed over the Malayan region.

STEREOCIDARIS INDICA Döderlein

*Stereocidaris indica* DÖDERLEIN, Zool. Anzeiger, vol. 23, 1901, p. 19.—DE MEIJERE, Die Echinoidea der Siboga-Exped., 1904, p. 18, pl. 1, fig. 1; pl. 11, figs. 119, 120; pl. 12, fig. 121.—DÖDERLEIN, Wiss. Ergeb. d. Tiefsee-Exped., vol. 5, Lief. 2, 1906, p. 104; pl. 10, figs. 1, 2; pl. 11, figs. 1-6; pl. 12, figs. 3-10; pl. 36, figs. 5-9; pl. 37, figs. 2-7.—H. L. CLARK, Bull. Mus. Comp. Zoöl., vol. 51, No. 7, 1907, p. 218; Cat. Recent Sea-urchins Brit. Mus., 1925, p. 26.

*Localities.*—Station 5119; Verde Island Passage; Sombrero Island bearing S. 80° E., 18.9 miles distant (lat. 13° 45' 05'' N., long. 120° 30' 30'' E.); 720 meters; bottom temperature 6.50° C.; green mud and sand; January 21, 1908 (4 specimens, Cat. Nos. E. 1321, E. 1322, U.S.N.M.).

Station 5300; China Sea, in the vicinity of southern Luzon; (lat. 20° 31' 00'' N., long. 115° 49' 00'' E.); 484 meters; gray mud and sand; August 8, 1908 (1 specimen, Cat. No. E. 1352, U.S.N.M.).

Station 5348; Palawan passage; Point Tabonan bearing S. 89° E., 33.5 miles distant (lat. 10° 57' 45'' N., long. 118° 38' 15'' E.); 685 meters; bottom temperature 13.56° C.; coral sand; December 27, 1908 (1 specimen, Cat. No. E. 1388, U.S.N.M.).

Station 5445; east coast of Luzon; Atalaya Point, Batag Island, bearing S. 64° E., 3.6 miles distant (lat. 12° 43' 05'' N., long. 125° 01' 00'' E.); 700 meters; bottom temperature 6.83° C.; green mud and sand; June 3, 1909 (1 specimen, Cat. No. E. 1323, U.S.N.M.).

Station 5450; east coast of Luzon; East Point, Batan Island, bearing S. 36° E., 9.2 miles distant (lat. 13° 23' 15'' N., long. 124° 00' 30'' E.); 745 meters; bottom temperature 5.72° C.; green mud and coral; June 4, 1909 (1 specimen, Cat. No. E. 1293, U.S.N.M.).

Station 5591; Sibuko Bay, Borneo; Mabul Island (NW.) bearing N. 6° W., 3.1 miles distant (lat. 4° 11' 48'' N., long. 118° 38' 20'' E.); 475 meters; September 29, 1909 (1 specimen, Cat. No. E. 1305, U.S.N.M.).

Station 5592; in the vicinity of Sibuko Bay, Borneo; Silungan Island (M.) bearing N. 1° W., 6.4 miles distant (lat. 4° 12' 44'' N., long. 118° 27' 44'' E.); 557 meters; bottom temperature 6.28° C.; green mud; September 29, 1909 (2 specimens, Cat. No. E. 1365, U.S.N.M.).

*Remarks.*—The specimens correspond with the var. *africana* or *integra* of Döderlein. They all have cylindrical primaries, without any indication of elevated crests and without terminal broadening. There are, however, a few minor differences. The test is more or less sunken toward the peristome; the number of ambulacral plates corresponding to an interambulacral plate at the ambitus is about 20

(otherwise 12-17 in this species); tridentate pedicellariae are usually fairly numerous but sometimes very scarce or even absent (apparently otherwise absent in this species). Possibly these differences will ultimately necessitate distinguishing these specimens as a separate variety (or species?); but in view of the great variability of *Stereocidaris indica* I would think it preferable, for the present at least, simply to consider them as *S. indica*.

The specimen from station 5450 is notable through the unusual length of the primaries, up to 82 mm. long in a size of 32 mm. horizontal diameter. The color of this specimen also is unusually dark, but this may be due to preservation. One of the specimens from station 5119 is infested with a group of parasitic snails (*Stylifer*, species?) and has thereby become somewhat deformed. The specimen from station 5348 is a young one and the identification uncertain; this also applies to one of the specimens from station 5592.

**STEREOCIDARIS SCEPTRIFEROIDES, var. LAMELLATA, new variety**

Plates 71, 72; plate 74, figs. 8, 9; plate 78, figs. 13, 14

*Locality*.—Station 5630; south of Patiente Strait; Doworra Island (N.) bearing N. 3° W., 4.5 miles distant (lat. 0° 56' 30" S., long. 128° 05' 00" E.); 1,040 meters; coral sand and mud; December 2, 1909 (1 specimen, the type, Cat. No. E. 1286, U.S.N.M.).

*Measurements*

h. d.	v. d.	Apical system	Peristome	Width of—		Number of—		Longest spines
				I. a.	A.	I. a.	A. pro I. a.	
26 mm.	16.5 mm.	12.5 mm. (48 per cent h. d.)	9.5 mm. (36.5 per cent h. d.)	12.5 mm.	3 mm.	5-6	13-14	55 mm.

*Description*.—The test is rather low, distinctly flattened above, slightly less so below, and not sunken toward the peristome. The sides are regularly arched. The circumference is circular. The ambulacra are distinctly sinuate. The interporiferous zone is not much broader than a pore zone. The marginal series of tubercles is very regular, the tubercles not contiguous, usually separated by a pair of small miliary tubercles. Inside the marginal tubercle each plate carries a secondary tubercle about half the size of the marginal one, or even larger, situated at the lower corner of the plate. These secondary tubercles form a pair of very regular longitudinal series within the marginal series, and the whole interporiferous zone is so narrow that it is quite filled up by those four series, no naked median space being left. Rarely there are two smaller inner tubercles instead of the normal one at the lower edge; in such a case a slight irregularity is caused in the vertical series. The pores are about equal in size, and are separated by a fairly broad scarcely elevated wall, whereas the ridge separating the pore pairs is rather high, the pores thus being fairly deep lying (pl. 74, figs. 8-9).

In the interambulacra the areoles are fairly deep and well separated, at most the two proximal ones being confluent; those on the oral side are slightly transverse-oval. The uppermost areole is rudimentary and without a primary spine, as is usual in stereocidarids; but the areole and its tubercle are not so very small. The scrobicular ring is very regular, rather conspicuous, but not raised, the tubercles being more than twice as large as the marginal ambulacral ones, and almost contiguous; outside the scrobicular ring the plates are covered with small miliary tubercles of uniform size, which leave just an indication of a naked, but not sunken, vertical median line. There is an indication of fine horizontal transverse furrows, especially on the oral side. The median interambulacral area is scarcely half as broad as an areole.



FIG. 22.—PART OF APICAL SYSTEM OF STEREOCIDARIS SCYPHIFEROIDES, DÖDERLEIN, VAR. LAMELLATA, NEW VARIETY.  $\times 6$

The apical system is nearly half the horizontal diameter. The

oculars are all widely exsert, small, with the inner edge forming almost a half circle. Both genitals and oculars are rather elevated, and are covered, not very closely, with tubercles of uniform size, leaving a rather broad edge bare. The genital pores are near the outer edge (fig. 22). The madreporite is not enlarged. The periproct is small, with rather few periproctal plates. The peristome is flat, distinctly smaller than the apical system; there are 8 ambulacral plates in a series, the ambulacra joining each other at the mouth edge. The interradiial plates are small, arranged in a fairly regular double series of 4 or 5 plates in each series.

The primary spines are conspicuously swollen at the base, thence tapering gradually toward the tip, which is rather conspicuously widened, with a central depression. The upper primaries are about twice as long as the horizontal diameter; they diminish in length very rapidly toward the oral side. In the basal part the larger upper primaries are provided with about 12 prominent closely serrate narrow ridges, which give the spine a lamellate appearance. In the outer half these ridges become quite low, rising again at the expanded tip. The surface of the spine between and on the sides of the ridges is covered with a close coating of fine anastomosing hairs. The ridges begin about 2 mm. above the collar, which is very low, scarcely 1 mm. high, and very inconspicuous, as is the milled ring. The portion

of the spine between the collar and the ridges is very conspicuous being smooth and shining and of a pinkish color. The oral primaries are slightly curved, flattened, slightly broadened, with the edges fairly distinctly serrate. They have a couple of conspicuous ridges on both the oral and aboral side; only the innermost may be quite smooth on both sides. The third is transitional to the ambital spines.

The scrobicular spines are about 3 mm. long, rather thick, with the outer side slightly convex and the inner side concave with a median ridge. The sides are straight, not narrowing toward the end, which is slightly rounded. The marginal ambulacral spines are about 2 mm. long, narrow, straight, and slightly flattened; near the peristome they are somewhat broadened and concave toward the end. The miliary spines are simply spine-shaped, very conspicuously smaller than the scrobicular and marginal ambulacral spines; transitional sizes are scarcely to be found around the scrobicular ring. The miliary spines are rather erect, the others appressed.

Large globiferous pedicellariae are very scarce; their valves (pl. 78, fig. 14) are long and very narrow, with a small subterminal opening, the outermost teeth of which join so as to form an apparently unpaired end tooth. The stalk is very short and simple. The small globiferous pedicellariae (pl. 78, fig. 13) likewise have narrow and rather elongate valves of very simple structure. No tridentate pedicellariae were observed.

The spicules are of the usual stereocidarid shape.

The primary spines are of a slightly pinkish tint, the portion between the collar and the ridges being more conspicuously pink. The secondaries are brownish. The naked test is pure white.

*Remarks.*—This form evidently is so closely related to *Stereocidaris sceptriferoides* Döderlein that it might well be questioned whether it should not simply be designated as *sceptriferoides*. The shape of the primaries, however, seems to be rather conspicuously different, judging from Döderlein's description and figures. The scrobicular spines also would seem to be different, judging from the description of *sceptriferoides*, and likewise the shape of the large globiferous pedicellariae is not in accordance with the figure given by Döderlein. It is very possible that these and the other minor differences which according to the descriptions exist are no more than what may well be found within the limits of the species; but so long as no material has been brought to light to show this species to be so variable, it does not seem justifiable simply to unite the form from the Philippine Sea with the Japanese species, which is not yet known from beyond the Japanese seas. In view of the insufficient knowledge of *S. sceptriferoides* I have thought it well to give a full description of the specimen at hand, be it simply identical with the Japanese species, or a separate variety, or perhaps a distinct species.



EXPLANATION OF PLATES

PLATE 48

*Histocidaris magnifica*, new species. Side view. Natural size

PLATE 49

*Histocidaris magnifica*, new species. Seen from the oral side. Natural size

PLATE 50

*Histocidaris acutispina*. Natural size

- FIG. 1. Seen from the oral side.  
2. Seen from the aboral side.

PLATE 51

*Histocidaris*, species. Natural size

- FIG. 1. Side view.  
2. Seen from oral side.

PLATE 52

All figures natural size

- FIG. 1. *Histocidaris elegans*, naked test, side view.  
2. *Histocidaris acutispina*; primary spines.  
3. *Prionocidaris bispinosa*; primary spines.

PLATE 53

*Prionocidaris baculosa*, var. *annulifera*; oral side. Natural size

PLATE 54

*Prionocidaris baculosa*, var. *annulifera*; aboral side. Natural size

PLATE 55

*Goniocidaris (Discocidaris) peltata*, new species; aboral side. Natural size

PLATE 56

*Goniocidaris (Discocidaris) peltata*, new species; oral side. Natural size

PLATE 57

All figures natural size

- FIG. 1. *Goniocidaris (Cyrtocidaris) tenuispina*, new species; aboral side.  
2. Same specimen; oral side.  
3. *Goniocidaris (Cyrtocidaris) tenuispina*, new species, var. *tuberculata*, new variety; aboral side.

## PLATE 58

Both figures natural size

- FIG. 1. *Goniocidaris (Cyrtocidaris) tenuispina*, new species. Side view.  
 2. *Goniocidaris (Cyrtocidaris) tenuispina*, new species, var. *major*, new variety; aboral side.

## PLATE 59

All figures natural size

- FIG. 1. *Goniocidaris (Cyrtocidaris) tenuispina*, new species, var. *tuberculata*, new variety. Side view.  
 2. *Goniocidaris (Cyrtocidaris) tenuispina*, new species; aboral side.  
 3. *Stylocidaris effluens*, new species, side view; abnormal specimen, showing double ambulacrum.

## PLATE 60

Both figures natural size

- FIG. 1. *Psilocidaris echinulata*, new species; aboral side.  
 2. *Psilocidaris echinulata*, new species; oral side.

## PLATE 61

All figures natural size

- FIG. 1. *Schizocidaris serrata* Mortensen; oral side.  
 2. *Rhopalocidaris hirsutispina* (de Meijere), var. *viridis*, new variety. Half side view, aboral side.  
 3. *Schizocidaris fasciata*, new species. Side view.  
 4. *Psilocidaris echinulata*, new species; aboral side.  
 5. *Psilocidaris echinulata*, new species; oral side.  
 6. *Goniocidaris (Cyrtocidaris) tenuispina*, new species, male; aboral side.  
 7. *Goniocidaris (Cyrtocidaris) tenuispina*, new species; oral side.  
 8. *Goniocidaris (Cyrtocidaris) tenuispina*, new species, female; aboral side.  
 9. *Goniocidaris (Cyrtocidaris) tenuispina*, var. *tuberculata*, new variety; side view.  
 10. *Goniocidaris (Cyrtocidaris) tenuispina*, var. *tuberculata*, new variety; oral side.  
 11. *Goniocidaris (Cyrtocidaris) tenuispina*, var. *tuberculata*, male; aboral side.

## PLATE 62

Both figures natural size

- FIG. 1. *Stylocidaris effluens*, new species; aboral side.  
*Stylocidaris effluens*, new species; oral side.

## PLATE 63

All figures natural size

- FIG. 1. *Stylocidaris annulosa*, new species; aboral side.  
 2. *Stylocidaris reini* (Döderlein), var. *rubida*, new variety; oral side.  
 3. *Stylocidaris reini* (Döderlein), var. *rubida*, new variety; aboral side.  
 4. *Psilocidaris echinulata*, new species. Spines (station 5429).  
 5. *Goniocidaris (Cyrtocidaris) tenuispina*, new species. Spines.

## PLATE 64

All figures natural size

- FIG. 1. *Stylocidaris annulosa*, new species; oral side.  
 2. *Stylocidaris annulosa*, new species, naked test; aboral side.  
 3. *Stylocidaris annulosa*, new species, naked test; oral side.

## PLATE 65

All figures natural size

- FIG. 1. *Stylocidaris effluens*, new species, naked test; aboral side.  
 2. *Stylocidaris effluens*, new species, naked test; oral side.  
 3. *Stylocidaris effluens*, new species. Half side view.  
 4. *Stylocidaris effluens*, new species. Side view.  
 5. *Stylocidaris reini* (Döderlein), var. *cladothrix*, new variety, naked test; aboral side.  
 6. *Stylocidaris reini* (Döderlein), var. *cladothrix*, new variety, naked test; oral side.  
 7. *Stylocidaris reini* (Döderlein), var. *cladothrix*, new variety, naked test. Side view.  
 8. *Stylocidaris annulosa*, new species, naked test. Side view.

## PLATE 66

The figures are natural size

- FIG. 1. *Stylocidaris reini* (Döderlein), var. *cladothrix*, new variety; aboral side.  
 2. *Stylocidaris reini* (Döderlein); aboral side.

## PLATE 67

The figures are natural size

- FIG. 1. *Stylocidaris reini* (Döderlein), var. *cladothrix*, new variety; oral side.  
 2. *Stylocidaris reini* (Döderlein); oral side.

## PLATE 68

The figures are natural size

- FIG. 1. *Stereocidaris grandis* Döderlein, var. *rubra*, new variety; aboral side.  
 2. *Stereocidaris grandis* Döderlein, var. *rubra*, new variety; oral side.

## PLATE 69

- FIG. 1. *Stereocidaris microtuberculata* Yoshiwara; aboral side. Natural size.

## PLATE 70

- FIG. 1. *Stereocidaris microtuberculata* Yoshiwara; oral side. Natural size.

## PLATE 71

- FIG. 1. *Stereocidaris sceptriferoides* Döderlein, var. *lamellata*, new variety; aboral side. Natural size.

## PLATE 72

- FIG. 1. *Stereocidaris sceptriferoides* Döderlein, var. *lamellata*, new variety; oral side. Natural size.

## PLATE 73

## Details of ambulacral structure

- FIG. 1. *Rhopalocidaris hirsutispina* (de Meijere), var. *viridis*, new variety.  $\times 12$ .  
 2. *Rhopalocidaris hirsutispina* (de Meijere), var. *viridis*, new variety.  $\times 30$ .  
 3. *Psilocidaris echinulata*, new species.  $\times 12$ .  
 4. *Psilocidaris echinulata*, new species.  $\times 30$ .  
 5. *Goniocidaris* (*Cyrtocidaris*) *tenuispina*, new species.  $\times 12$ .  
 6. *Goniocidaris* (*Cyrtocidaris*) *tenuispina*, new species.  $\times 30$ .  
 7. *Goniocidaris* (*Cyrtocidaris*) *tenuispina*, var. *tuberculata*, new variety.  $\times 12$ .  
 8. *Goniocidaris* (*Cyrtocidaris*) *tenuispina*, var. *tuberculata*, new variety.  $\times 30$ .

## PLATE 74

## Details of ambulacral structure

- FIG. 1. *Schizocidaris serrata* Mortensen.  $\times 12$ .  
 2. *Schizocidaris serrata* Mortensen.  $\times 30$ .  
 3. *Schizocidaris fasciata*, new species.  $\times 30$ .  
 4. *Goniocidaris* (*Discocidaris*) *peltata*, new species.  $\times 12$ .  
 5. *Goniocidaris* (*Discocidaris*) *peltata*, new species.  $\times 30$ .  
 6. *Stylocidaris reini* (Döderlein), var. *rubida*, new variety.  $\times 12$ .  
 7. *Stylocidaris reini* (Döderlein), var. *rubida*, new variety.  $\times 30$ .  
 8. *Stereocidaris sceptiferoides* Döderlein, var. *lamellata*, new variety.  $\times 12$ .  
 9. *Stereocidaris sceptiferoides* Döderlein, var. *lamellata*, new variety.  $\times 30$ .

## PLATE 75

## Details of ambulacral structure

- FIGS. 1-2. *Stylocidaris effluens*, new species.  $\times 12$ .  
 3. *Stylocidaris annulosa*, new species.  $\times 12$ .  
 4. *Stylocidaris reini* (Döderlein), var. *cladothrix*, new variety.  $\times 12$ .

## PLATE 76

- FIGS. 1-2. Scrobicular spines of *Histocidaris magnifica*, new species.  $\times 12$ .  
 3. Valve of tridentate pedicellaria of *Histocidaris magnifica*, new species.  $\times 38$ .

## PLATE 77

## Pedicellariae, and a scrobicular spine

- FIG. 1. Valve of tridentate pedicellaria, large form, of *Histocidaris elegans* (A. Agassiz).  $\times 38$ .  
 2. Valve of tridentate pedicellaria, small form, of *Histocidaris elegans* (A. Agassiz) (specimen from station 5450).  $\times 65$ .  
 3. Valve of tridentate pedicellaria, large form, of *Histocidaris elegans* (A. Agassiz) (specimen from station 5450).  $\times 38$ .  
 4. Valve of tridentate pedicellaria, large form, of *Histocidaris acutispina*, new species.  $\times 38$ .  
 5. Valve of tridentate pedicellaria, large form, of *Histocidaris*, species.  $\times 38$ .  
 6-7. Valve of tridentate pedicellaria, small form, of *Histocidaris*, species.  $\times 65$ .  
 8. Scrobicular spine of *Histocidaris*, species.  $\times 12$ .

## Plate 78

## Pedicellariae, spines and hairs

- Fig. 1. Valve of small globiferous pedicellaria of *Schizocidaris serrata* (Mortensen).  $\times 120$ .
2. Valve of small globiferous pedicellaria of *Schizocidaris fasciata*, new species.  $\times 120$ .
- 3-5. Valves of small globiferous pedicellaria of *Psilocidaris echinulata*, new species.  $\times 100$ . (Fig. 4 from a very elongate form, resembling a tridentate pedicellaria.)
6. Secondary spine of *Rhopalocidaris hirsutispina* (de Meijere), var. *viridis*, new variety.  $\times 50$ .
7. Valve of small globiferous pedicellaria of *Rhopalocidaris hirsutispina* (de Meijere), var. *viridis*, new variety.  $\times 120$ .
- 8a-b. Hairs from primary spine of *Rhopalocidaris hirsutispina* (de Meijere) var. *viridis*, new variety.  $\times 50$ .
9. Valve of large globiferous pedicellaria of *Goniocidaris (Discocidaris) peltata*, new species.  $\times 70$ .
- 10-11. Valves of small globiferous pedicellariae of *Goniocidaris (Discocidaris) peltata*, new species.  $\times 70$ .
12. Scrobicular spine of *Goniocidaris (Discocidaris) peltata*, new species.  $\times 30$
13. Valve of small globiferous pedicellaria of *Stereocidaris sceptriferoides* Döderlein, var. *lamellata*, new variety.  $\times 100$ .
14. Valve of large globiferous pedicellaria of *Stereocidaris sceptriferoides* Döderlein, var. *lamellata*, new variety.  $\times 100$ . The end tooth is only apparently single; in reality it is composed of two lateral teeth so closely appressed as to appear like an unpaired terminal tooth.

## PLATE 79

## Pedicellariae

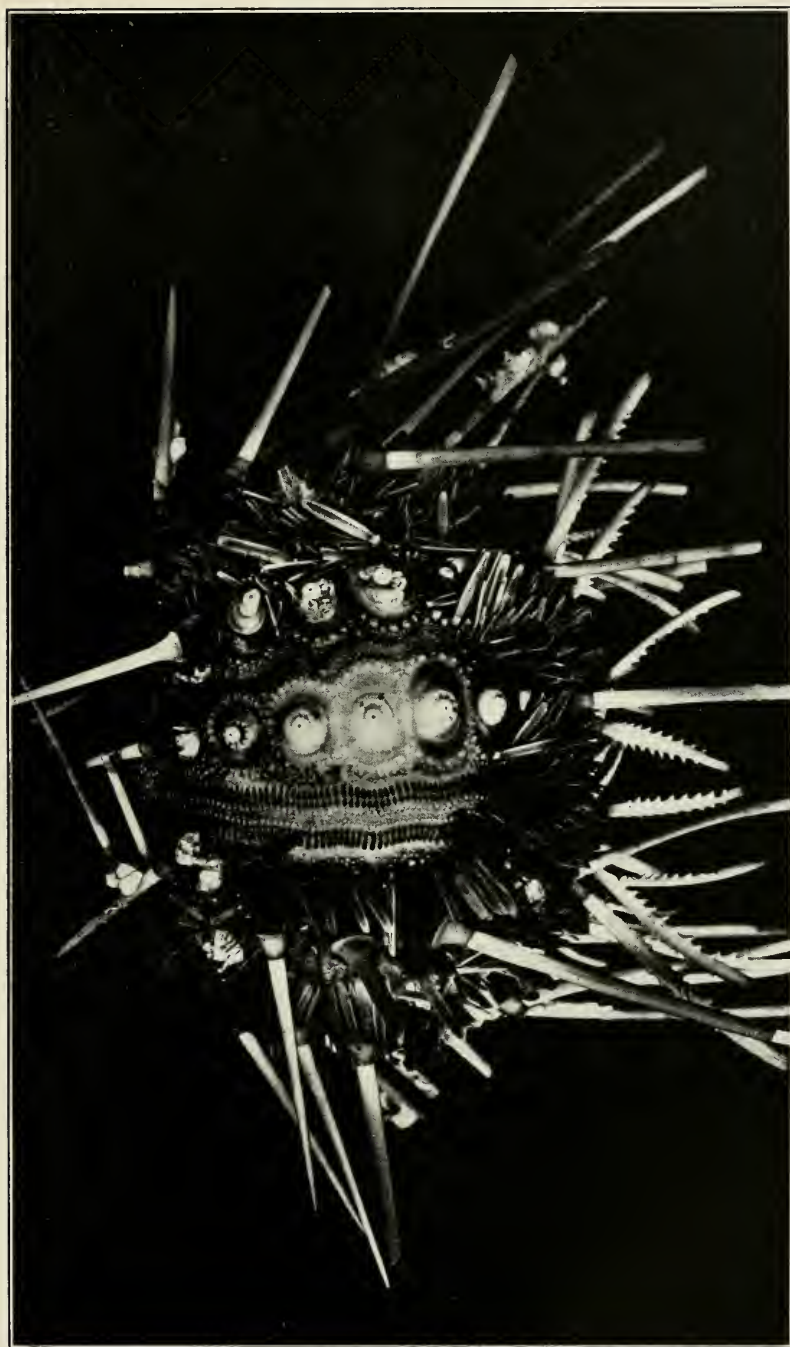
- FIG. 1. Valve of tridentate pedicellaria of *Goniocidaris (Cyrtocidaris) tenuispina*, new species.  $\times 95$ .
- 2-3. Valves of small globiferous pedicellariae of *Goniocidaris (Cyrtocidaris) tenuispina*, new species.  $\times 95$ .
- 4-6. Valves of various forms of small globiferous pedicellariae of *Goniocidaris (Cyrtocidaris) tenuispina*, new species, var. *tuberculata*, new variety.  $\times 95$ .
7. Large tridentate pedicellaria of *Goniocidaris (Cyrtocidaris) tenuispina*, new species, var. *tuberculata*, new variety.  $\times 50$ .
8. Valve of same.  $\times 50$ .
9. Valve of large globiferous pedicellaria of *Goniocidaris (Cyrtocidaris) tenuispina*, new species, var. *major*, new variety.  $\times 70$ .

## PLATE 80

## Pedicellariae, spines, and spicules

- FIG. 1. Short-stalked form of small globiferous pedicellaria of *Stylocidaris effluens*, new species.  $\times 70$ .
- 2-3. Valves of same form.  $\times 100$ .
4. Valve of large globiferous pedicellaria of *Stylocidaris effluens*, new species.  $\times 100$ .
5. Tridentate pedicellaria of *Stylocidaris effluens*, new species.  $\times 50$ .
6. Valve of usual form of small globiferous pedicellaria of *Stylocidaris effluens*, new species.  $\times 70$ .
7. Scrobicular spine of *Stylocidaris annulosa*, new species.  $\times 12$ .
8. Valve of small globiferous pedicellaria of *Stylocidaris annulosa*, new species.  $\times 70$ .
9. Valve of large globiferous pedicellaria of *Stylocidaris annulosa*, new species.  $\times 70$ .
10. Valve of tridentate pedicellaria of *Stylocidaris annulosa*, new species.  $\times 50$ .
- 11a-b. Spicules from intestinal wall of *Stylocidaris annulosa*, new species.  $\times 70$ .





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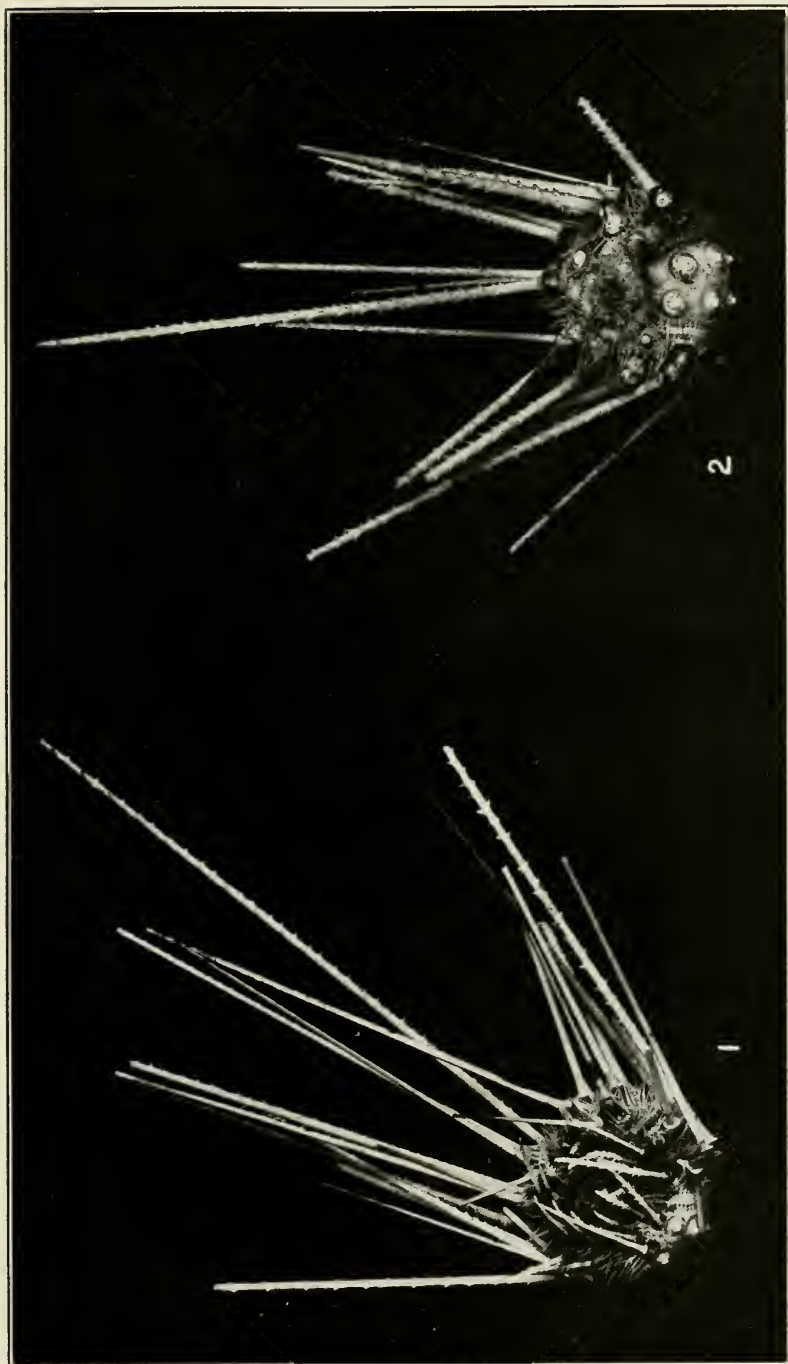
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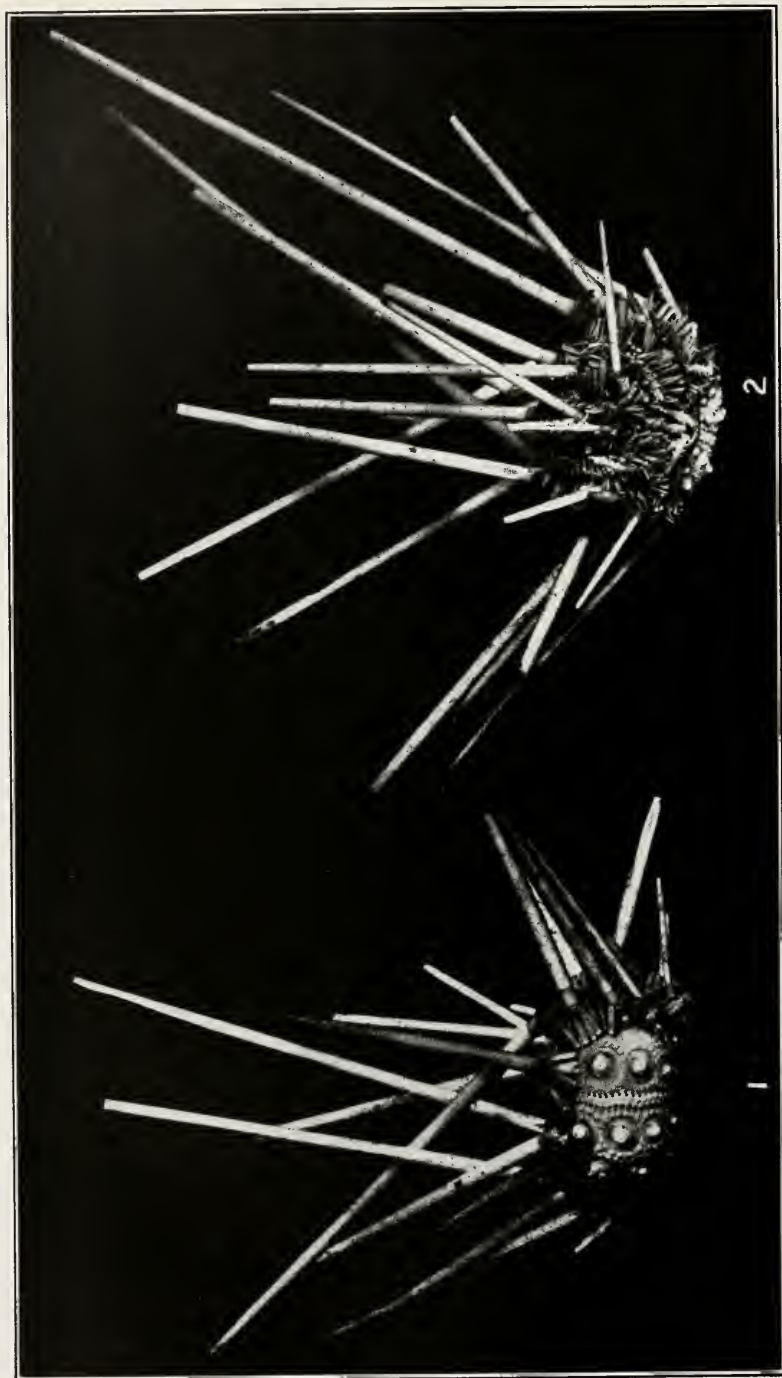
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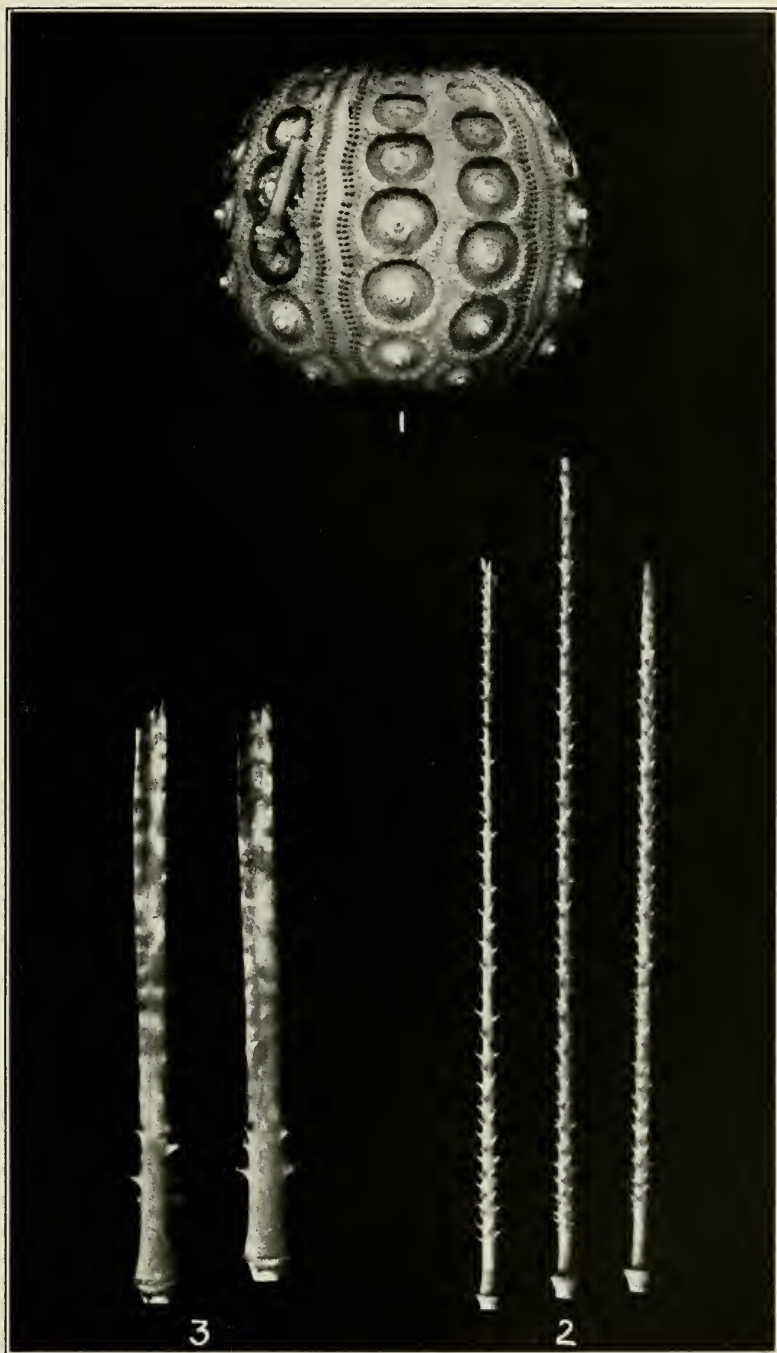
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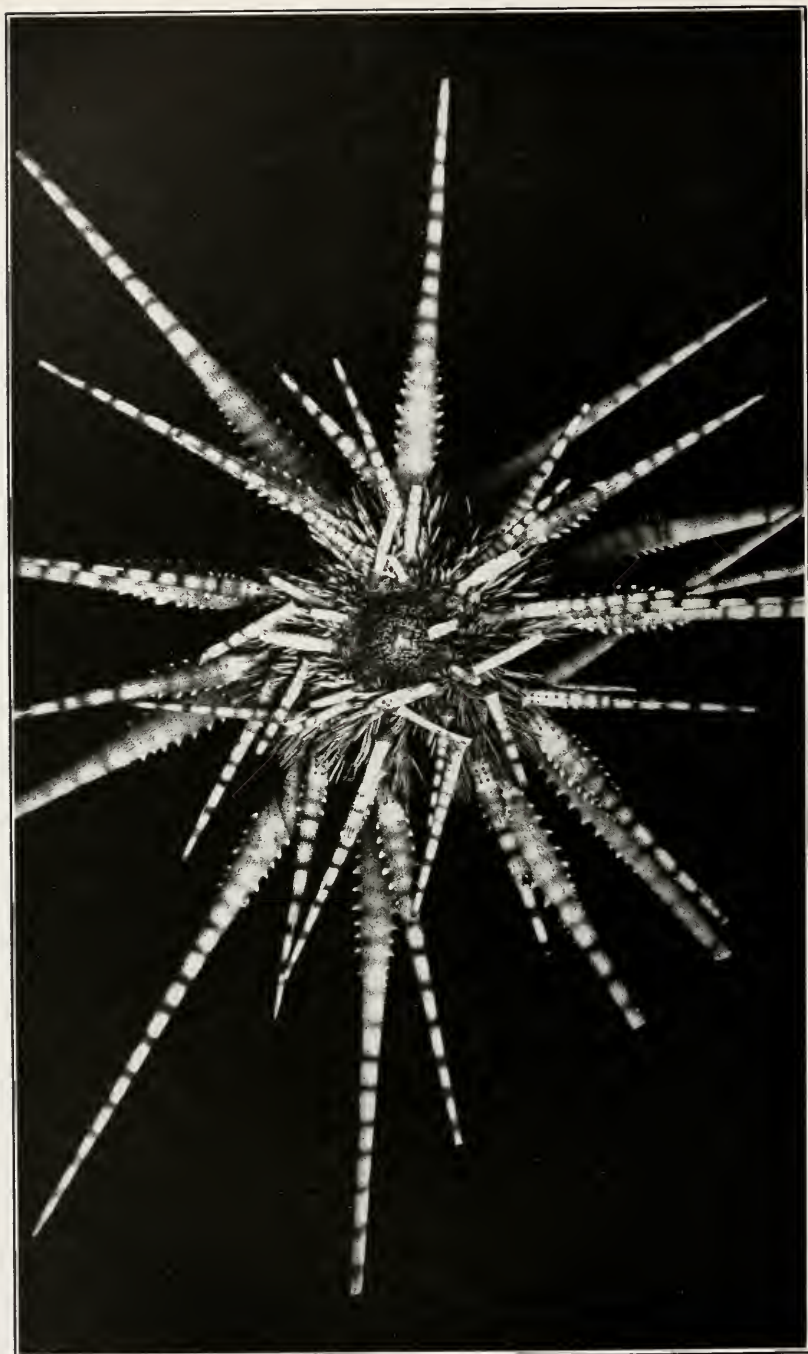
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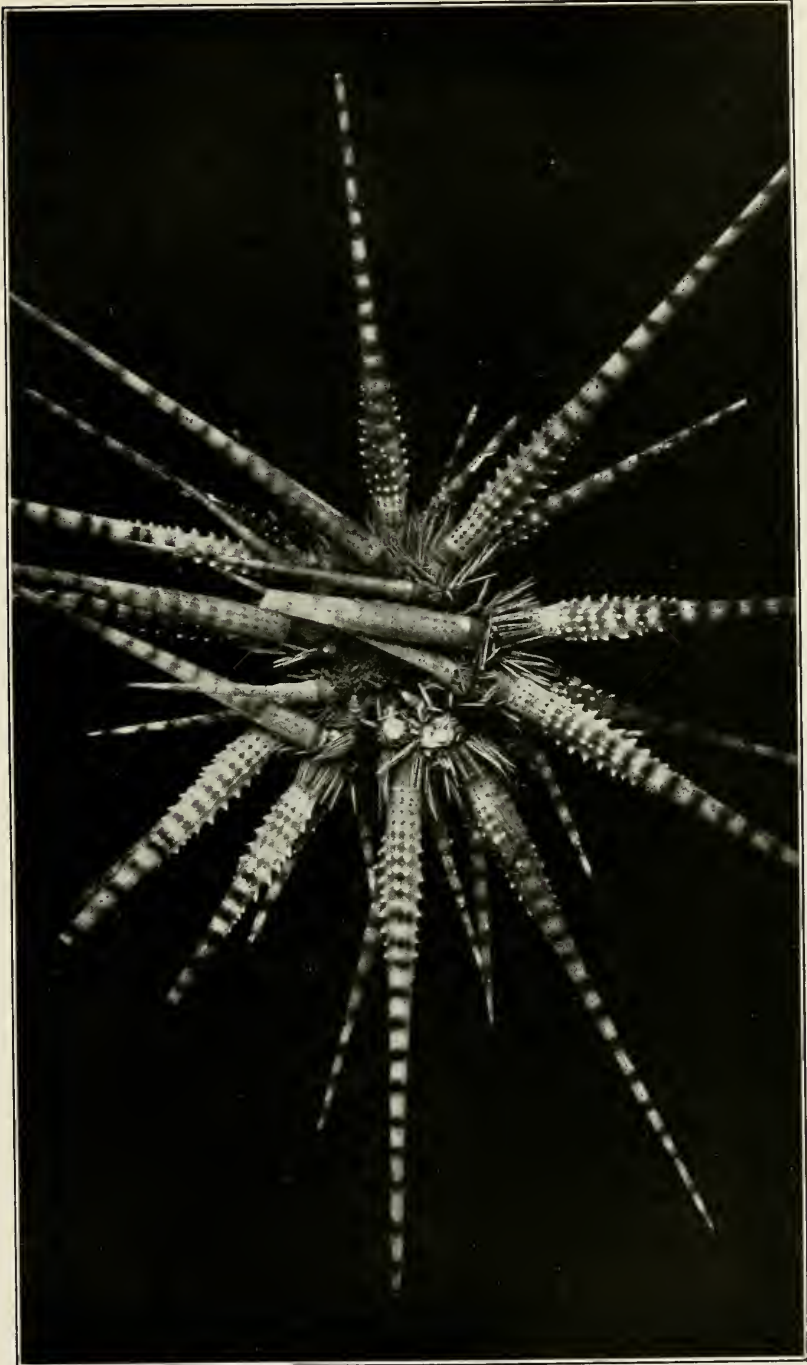
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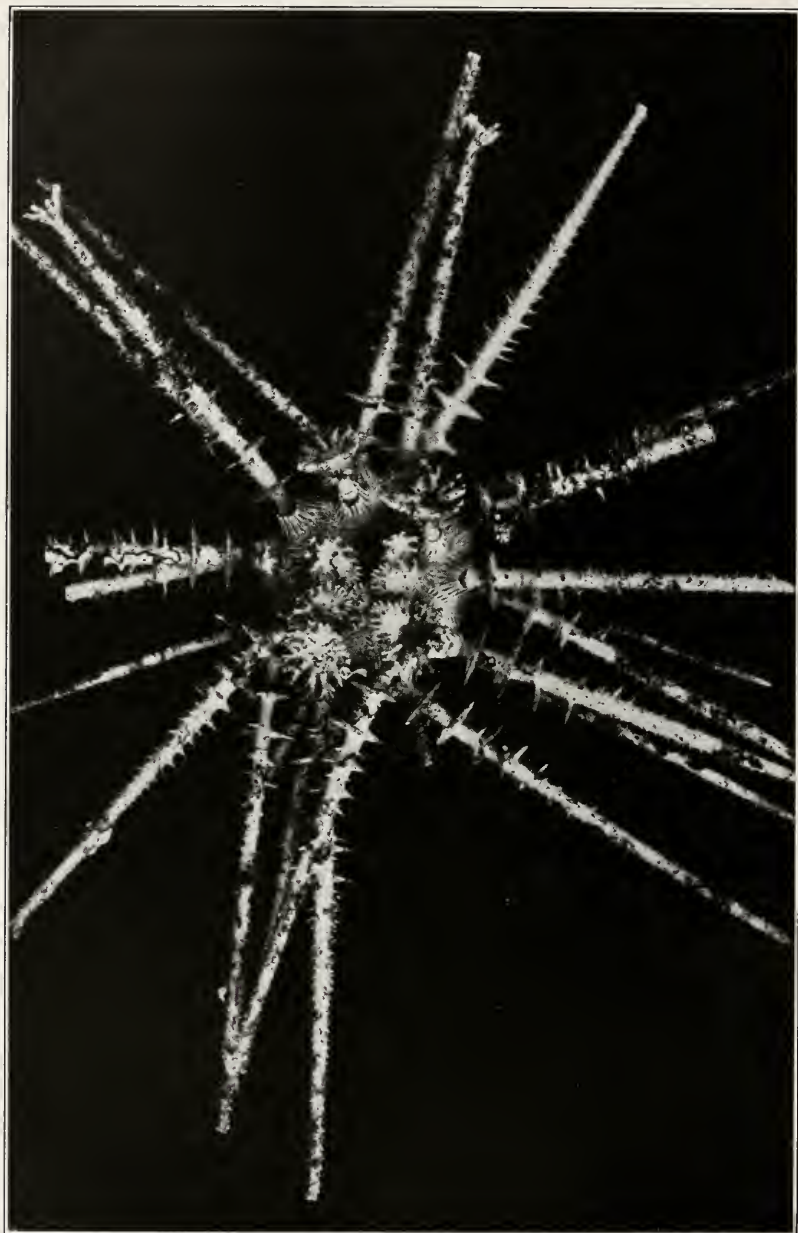
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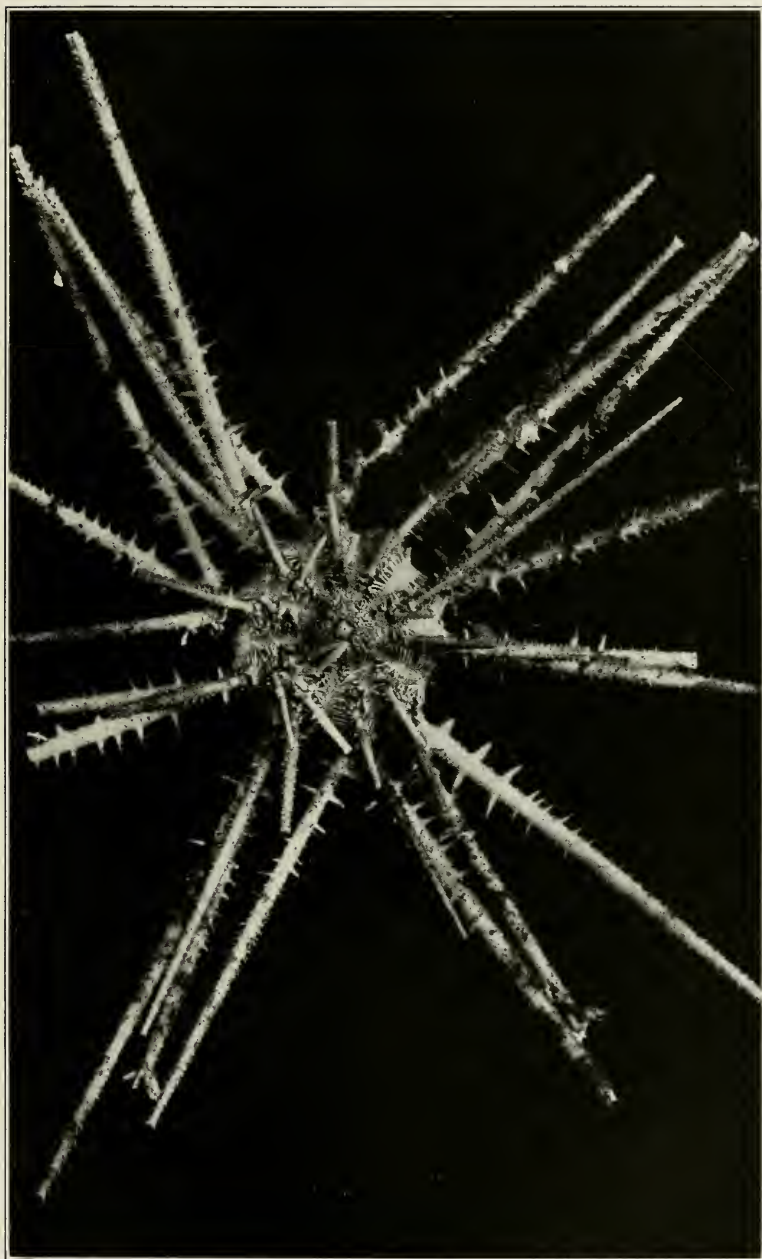
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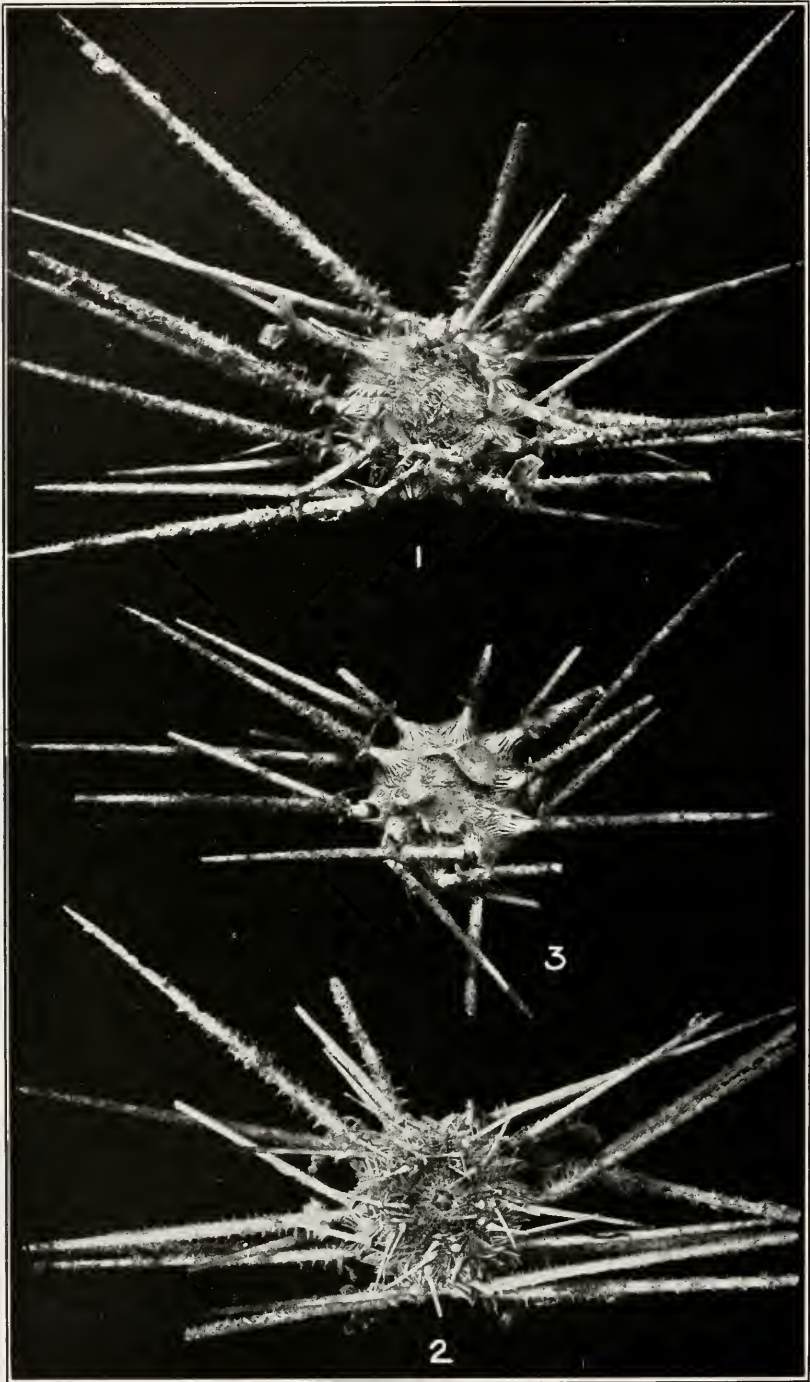
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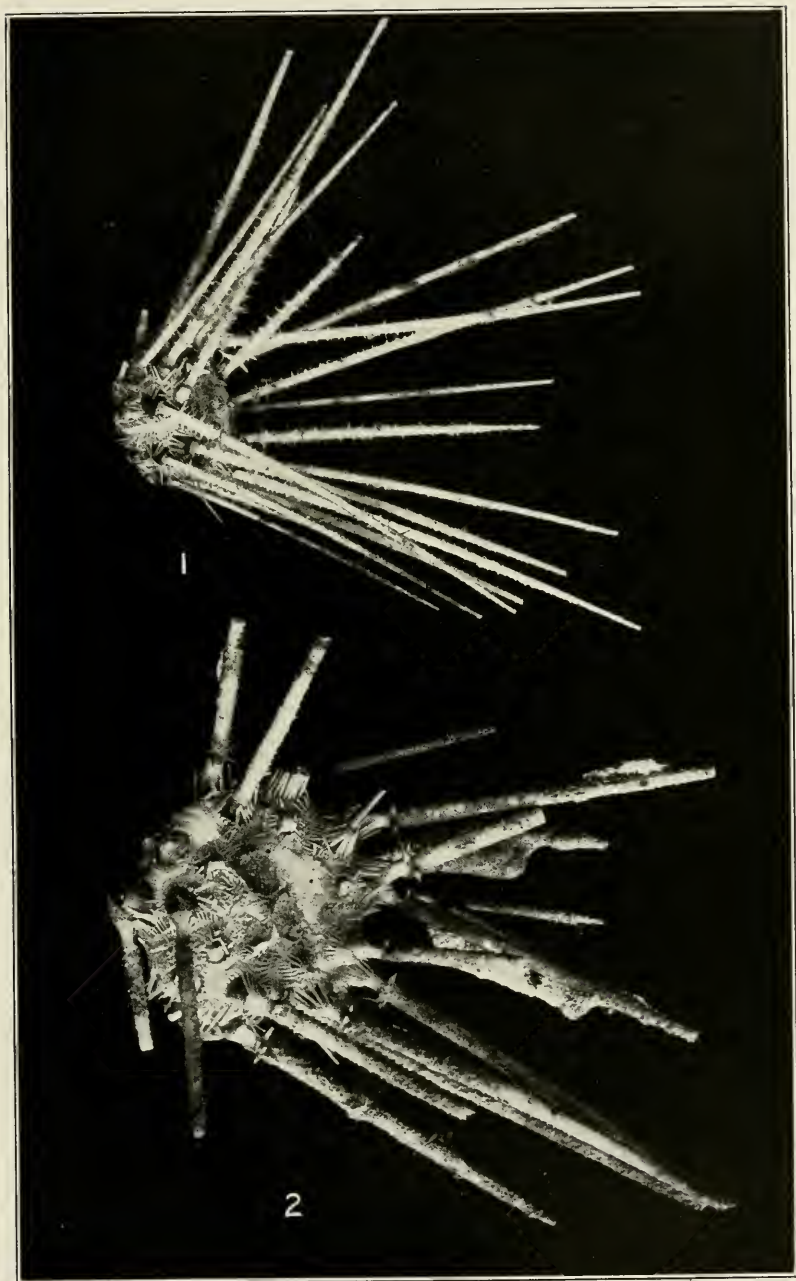
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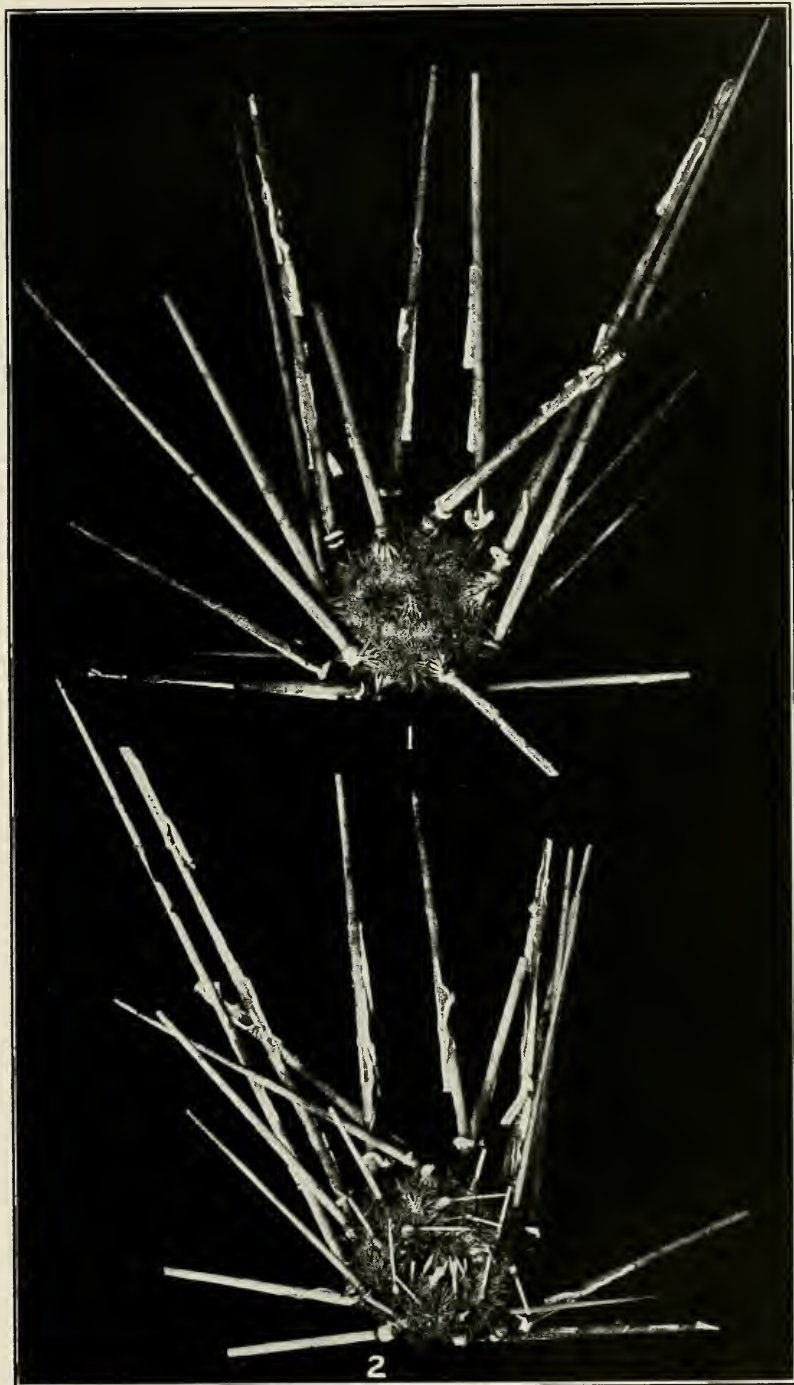
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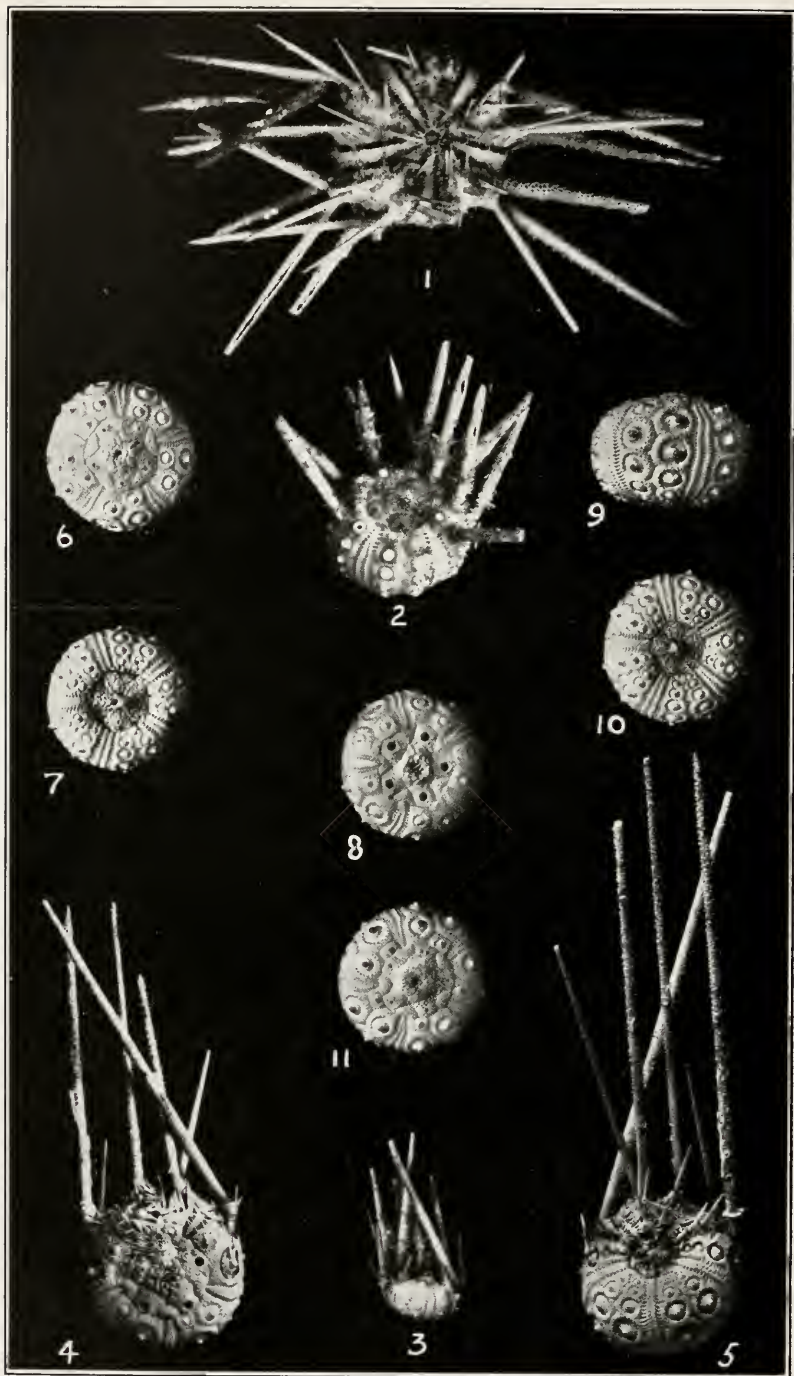
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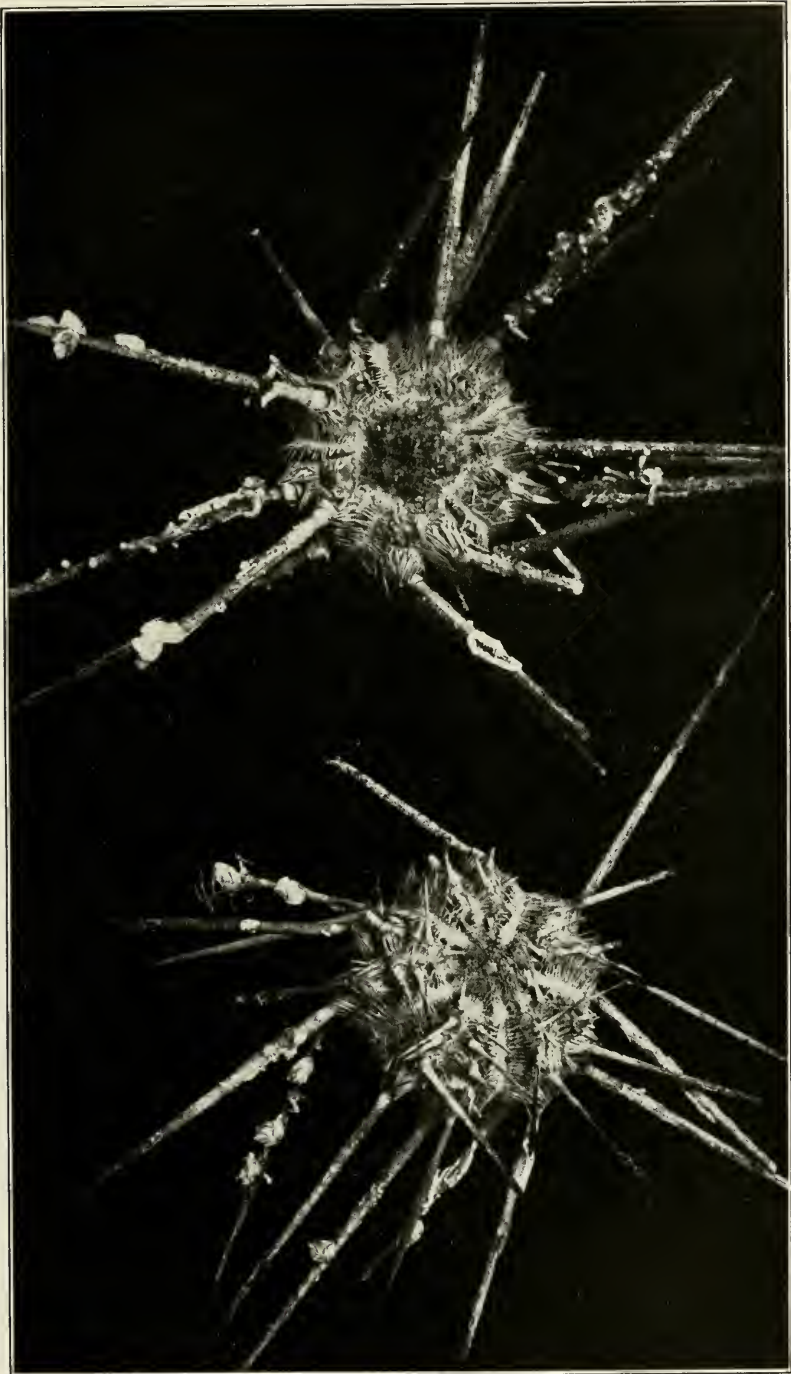
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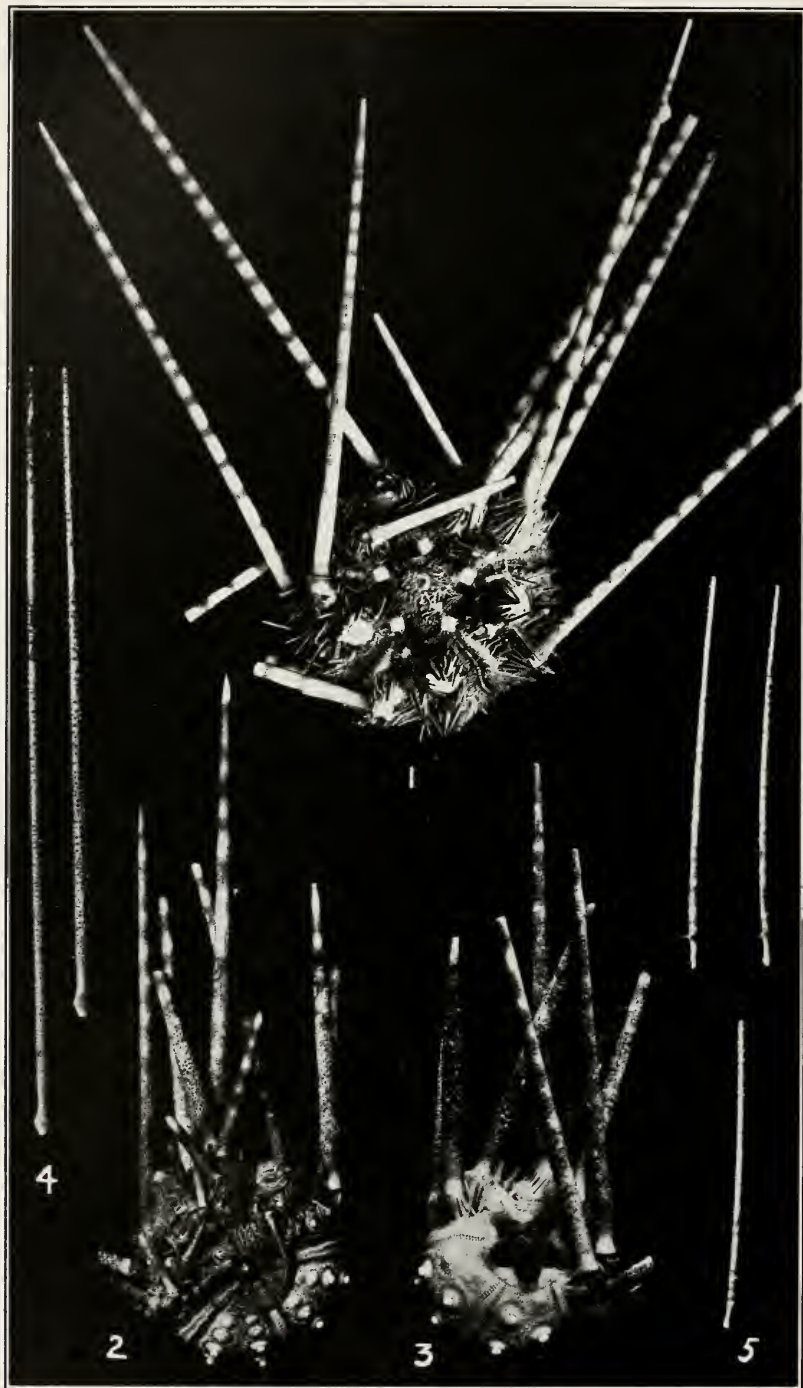
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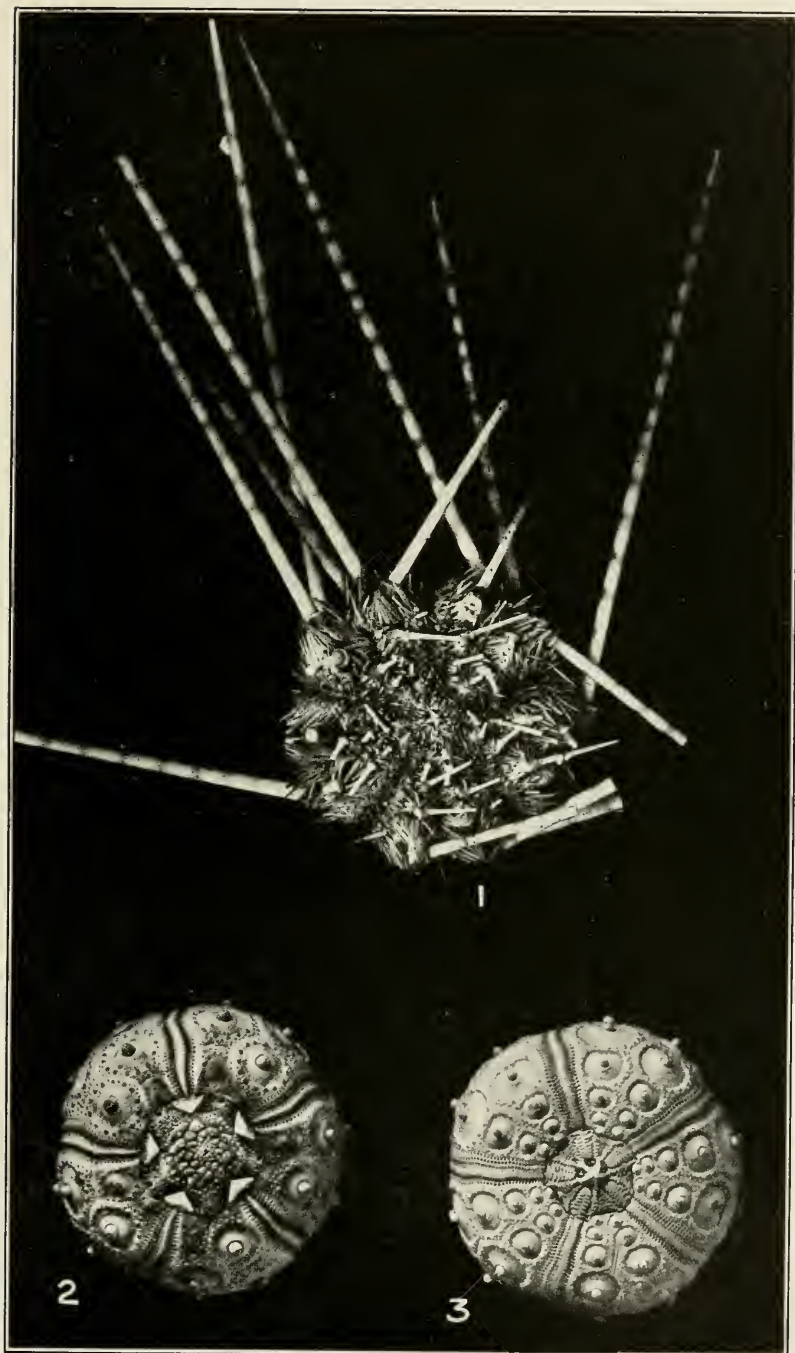
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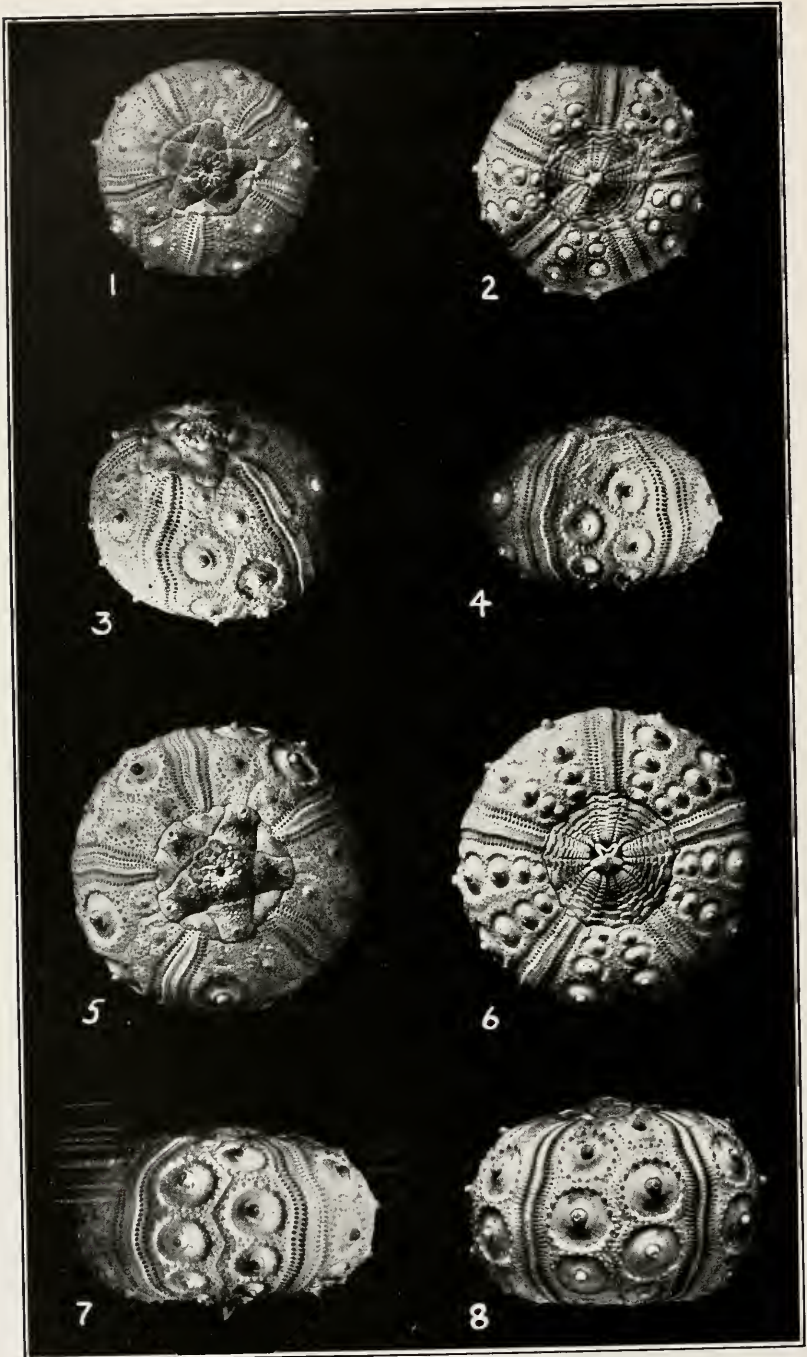


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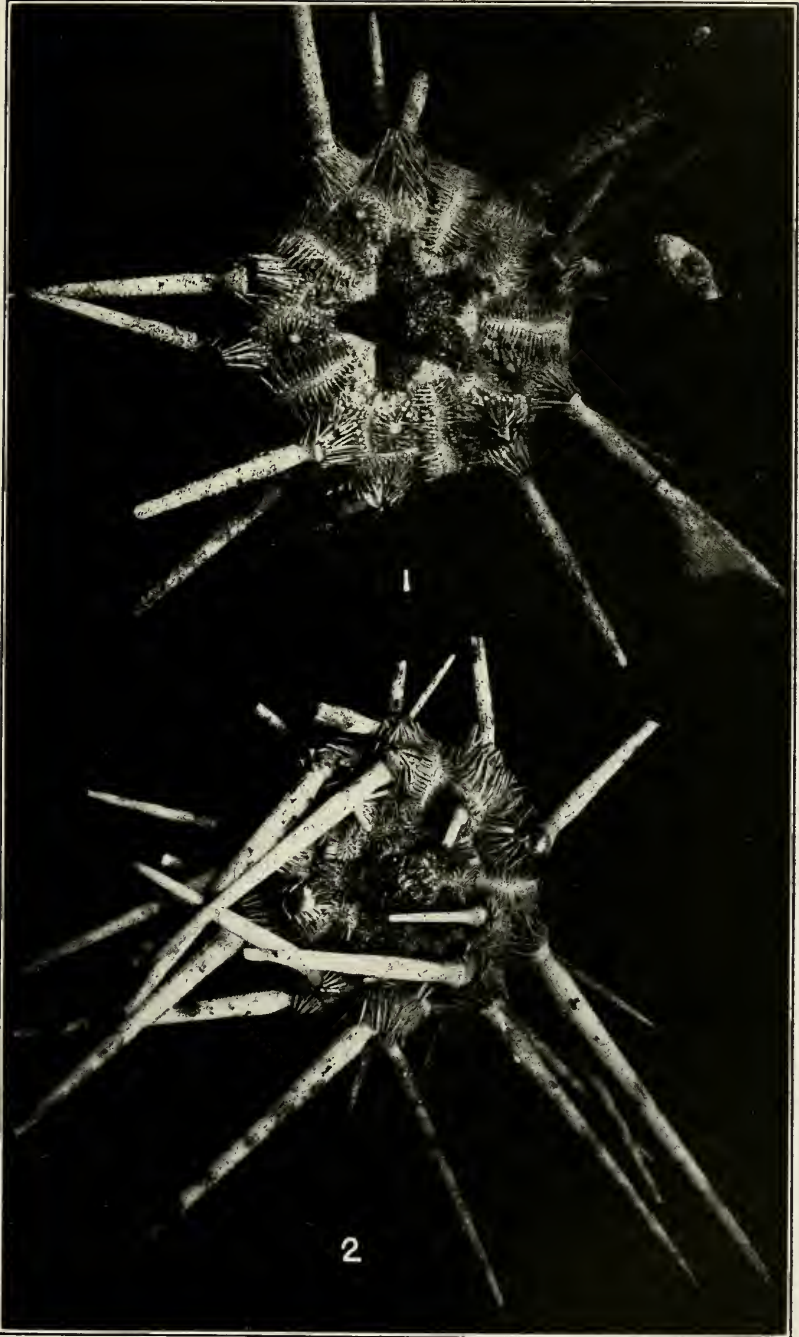
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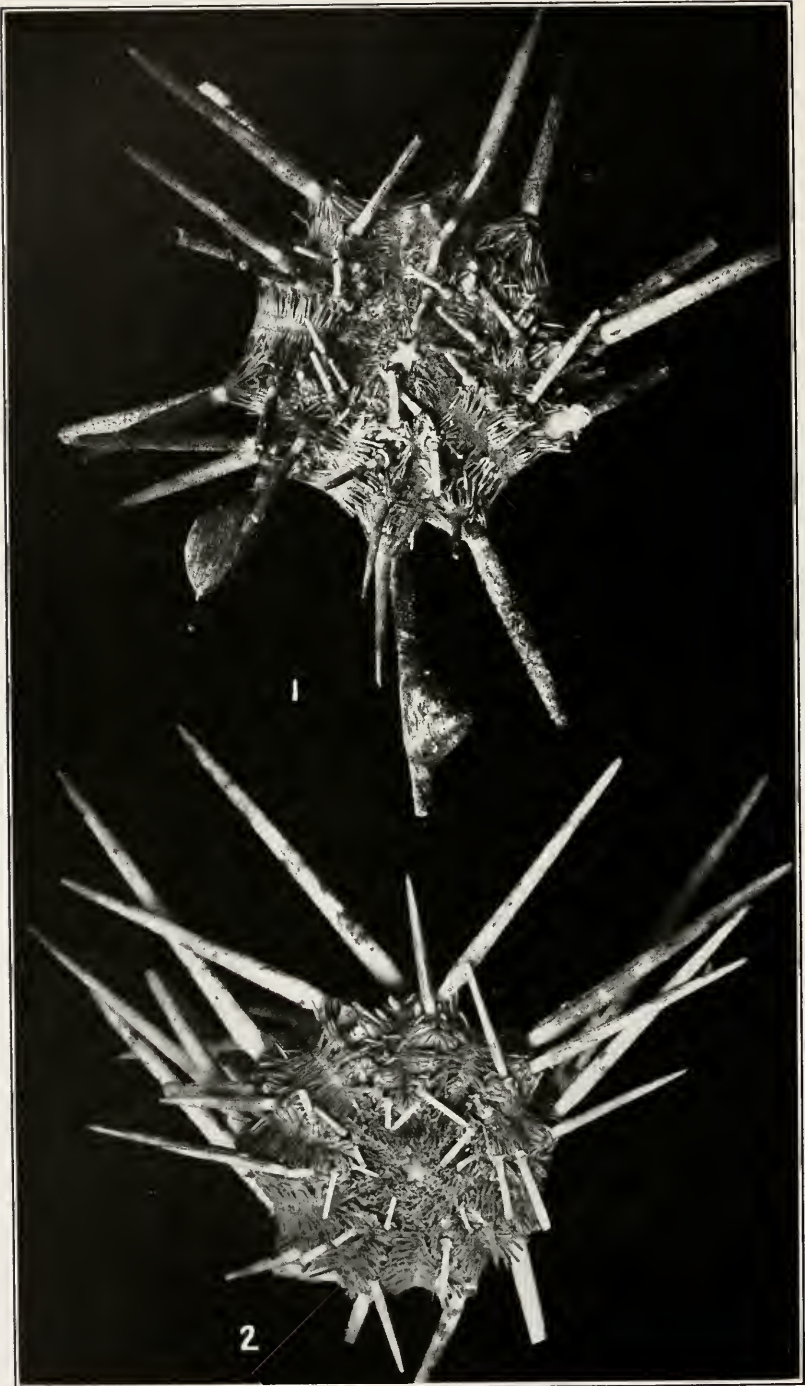
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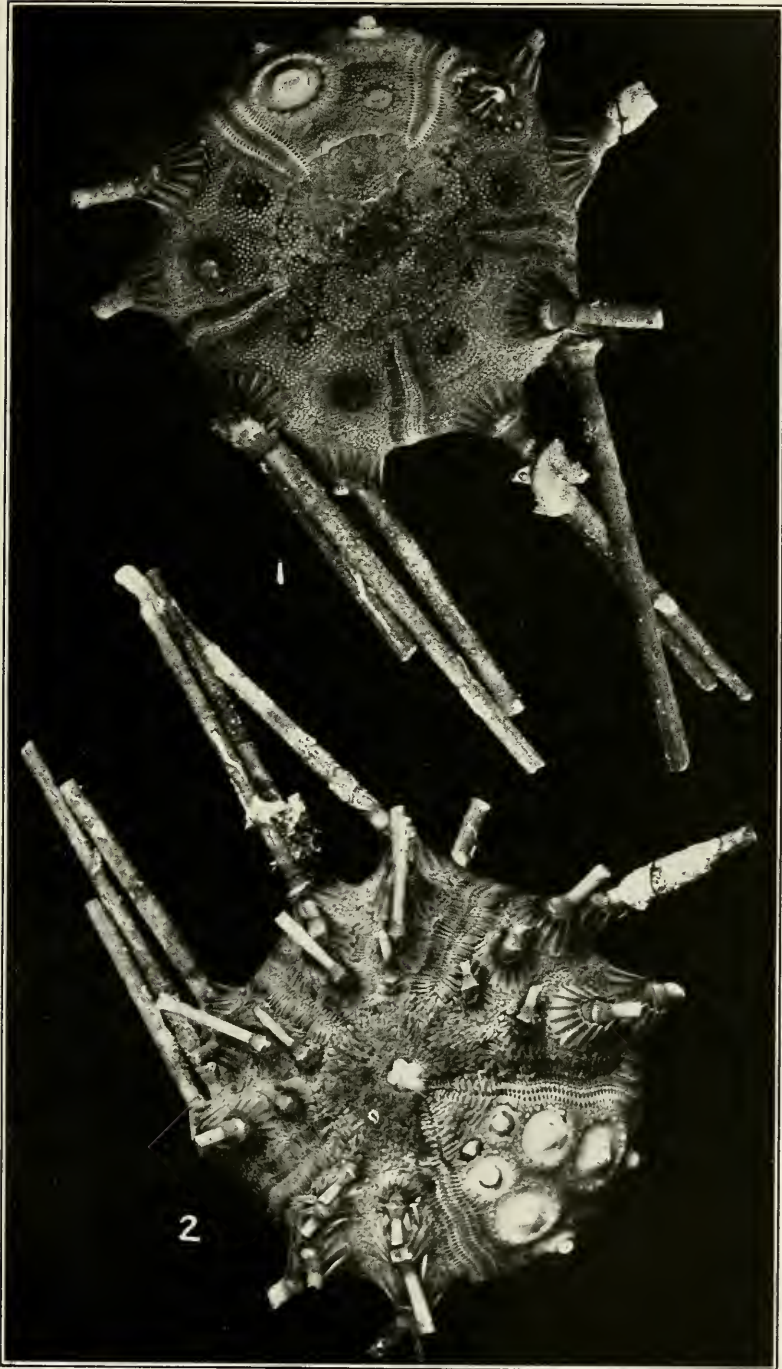
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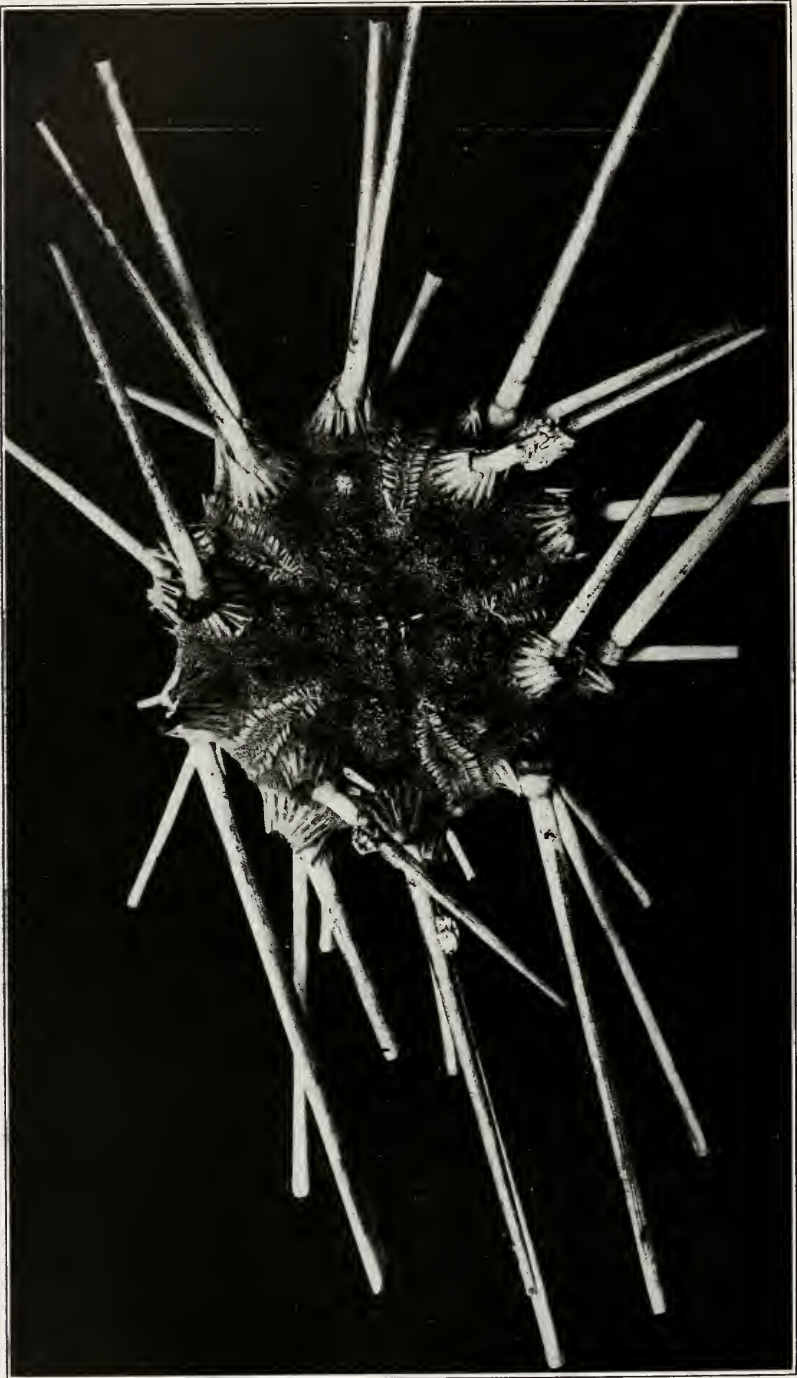
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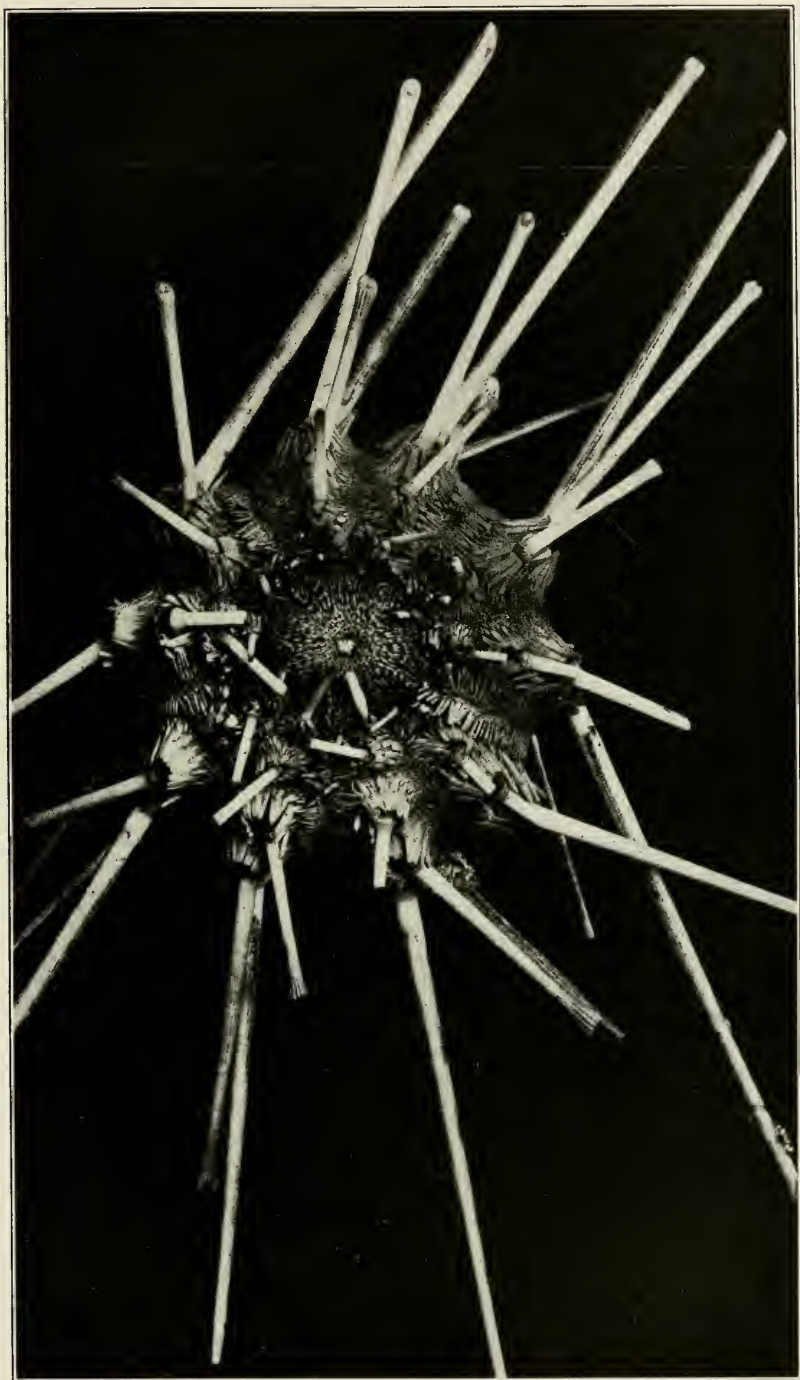
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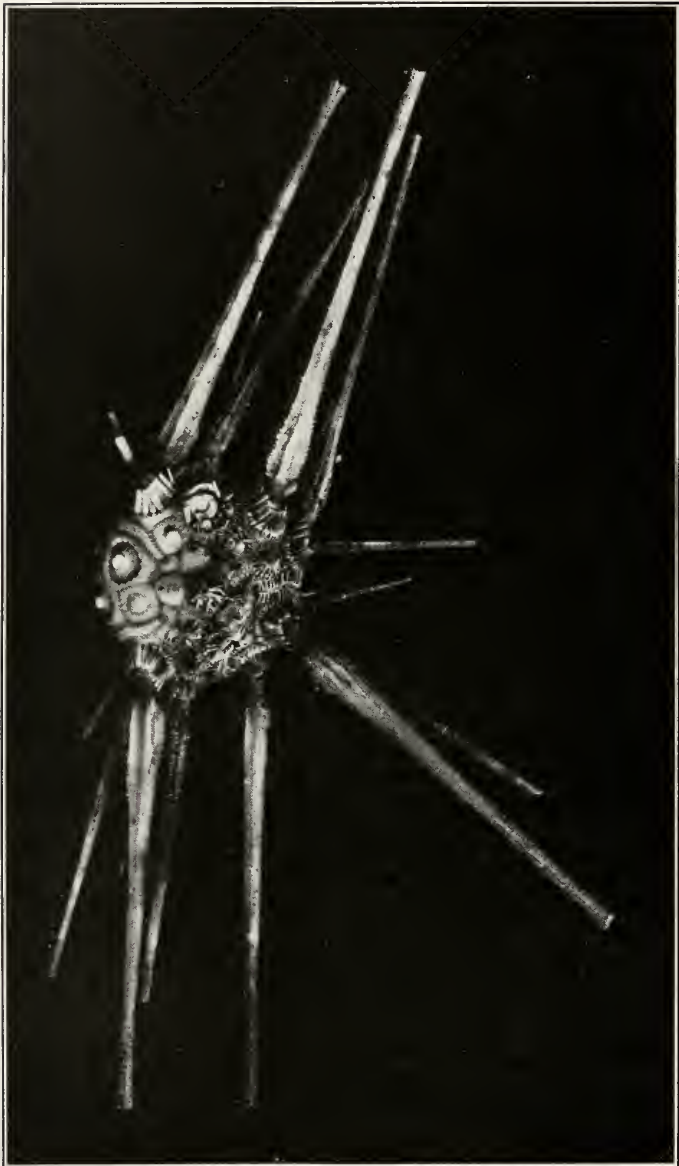
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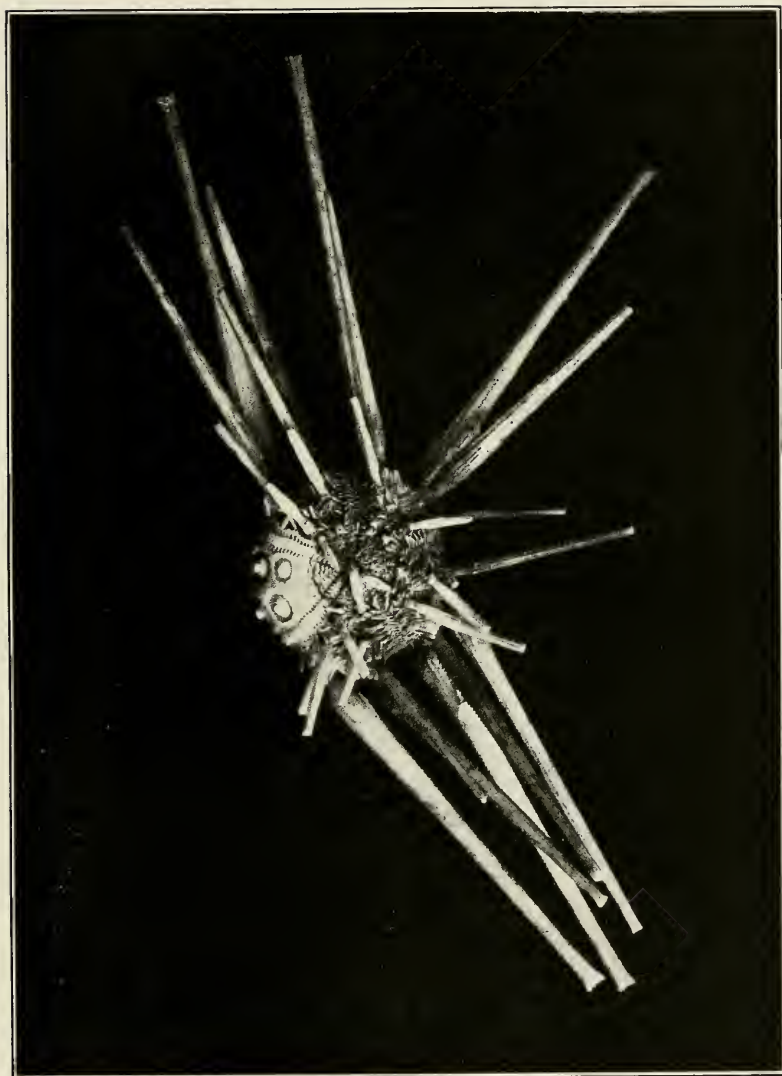
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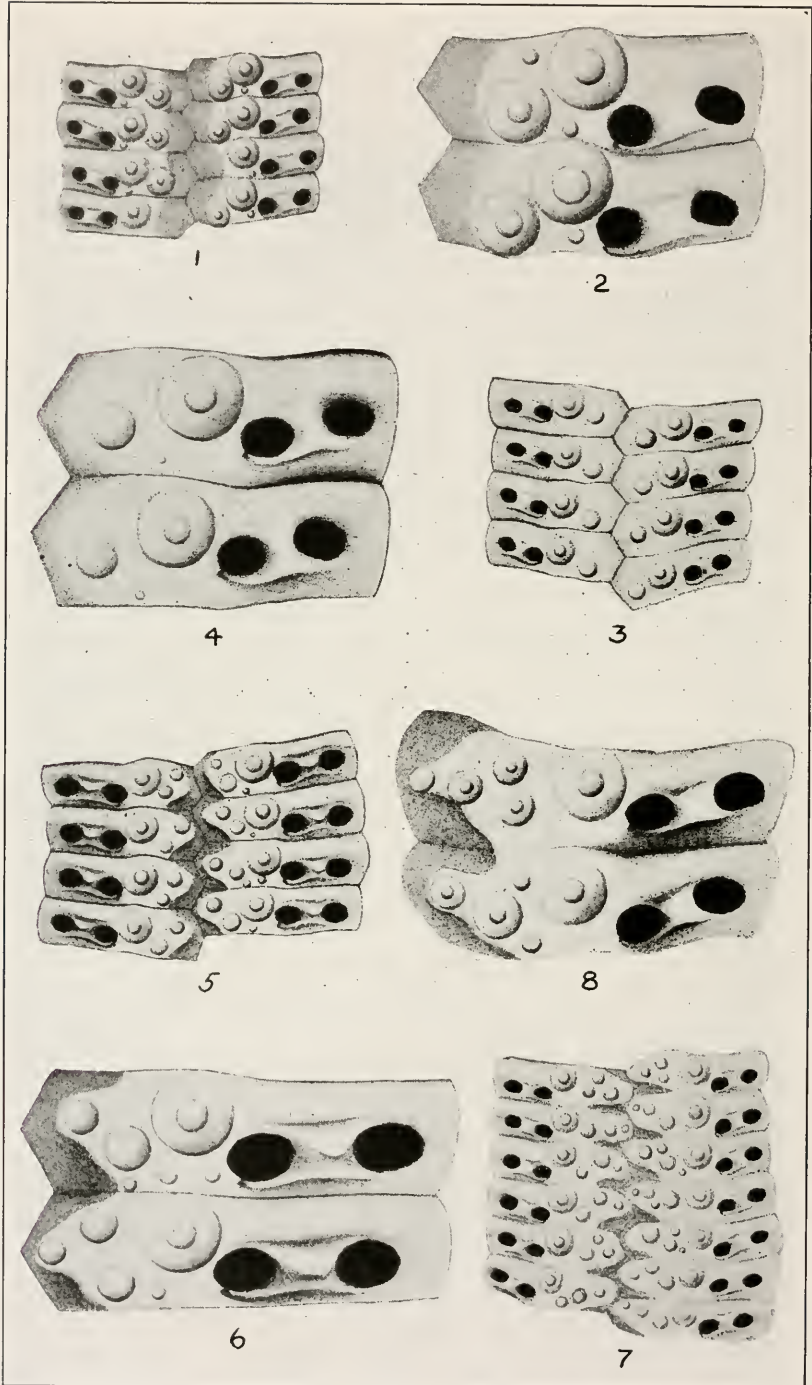
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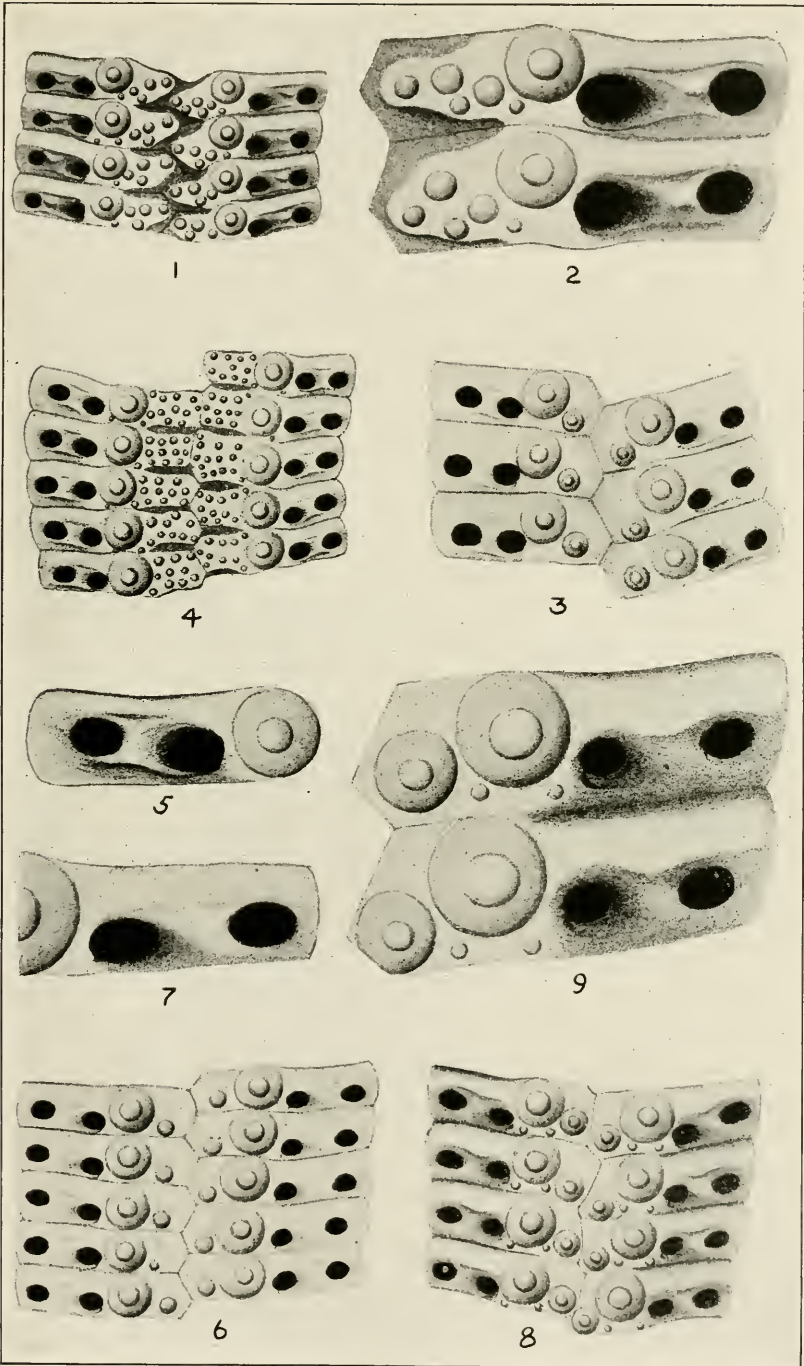
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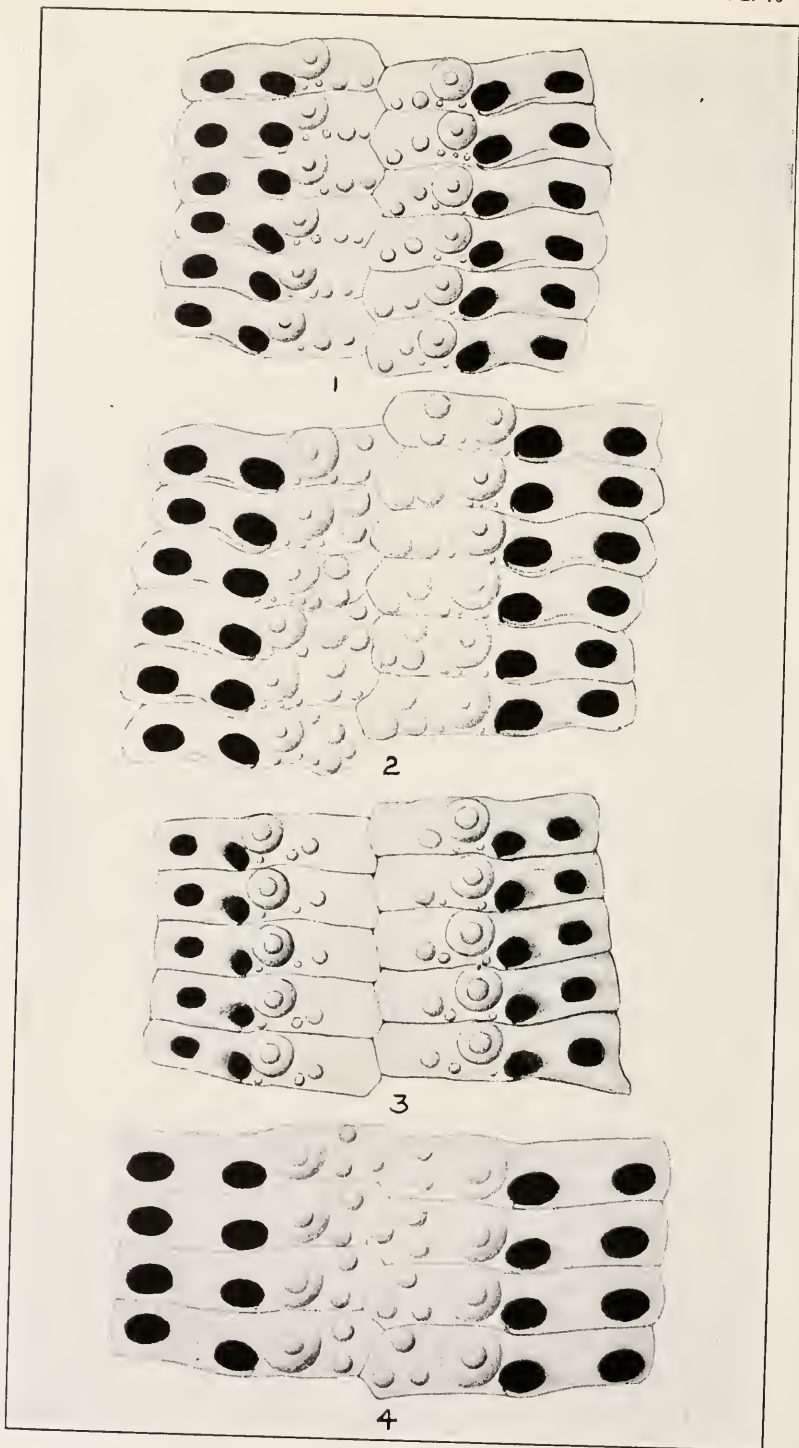
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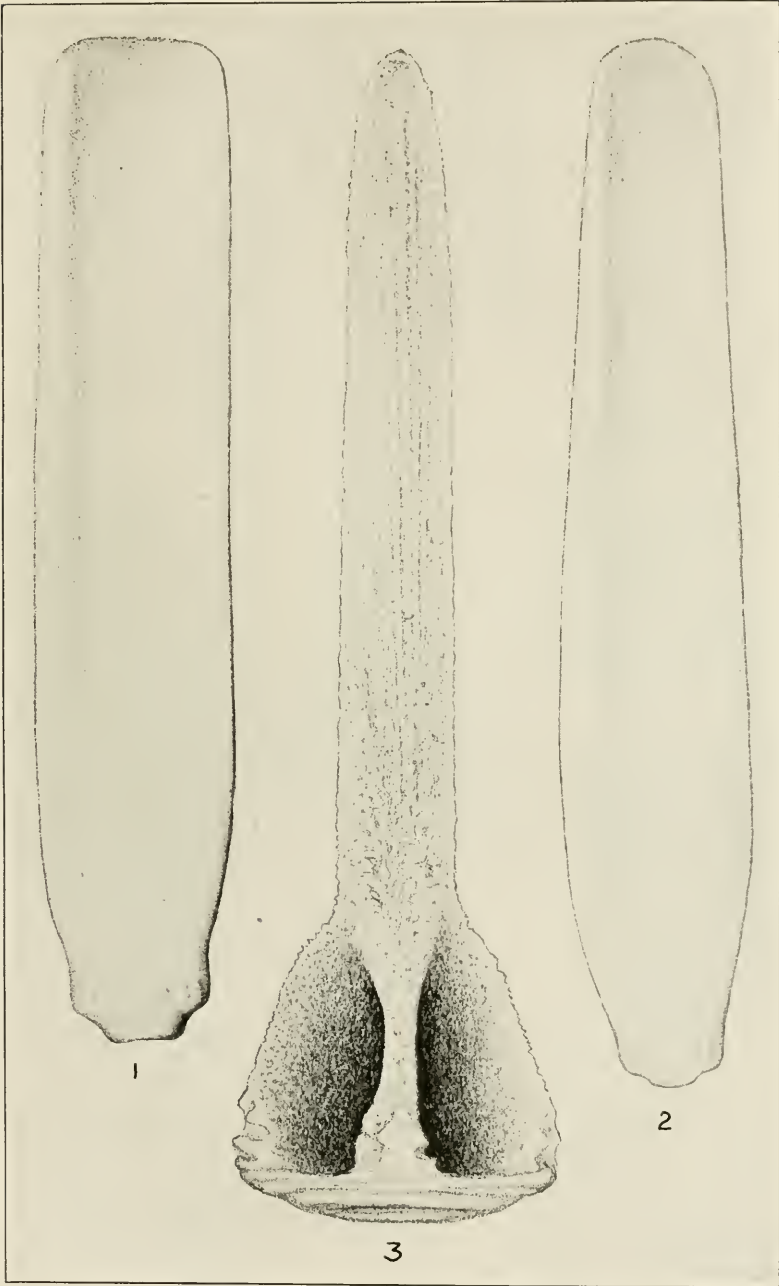
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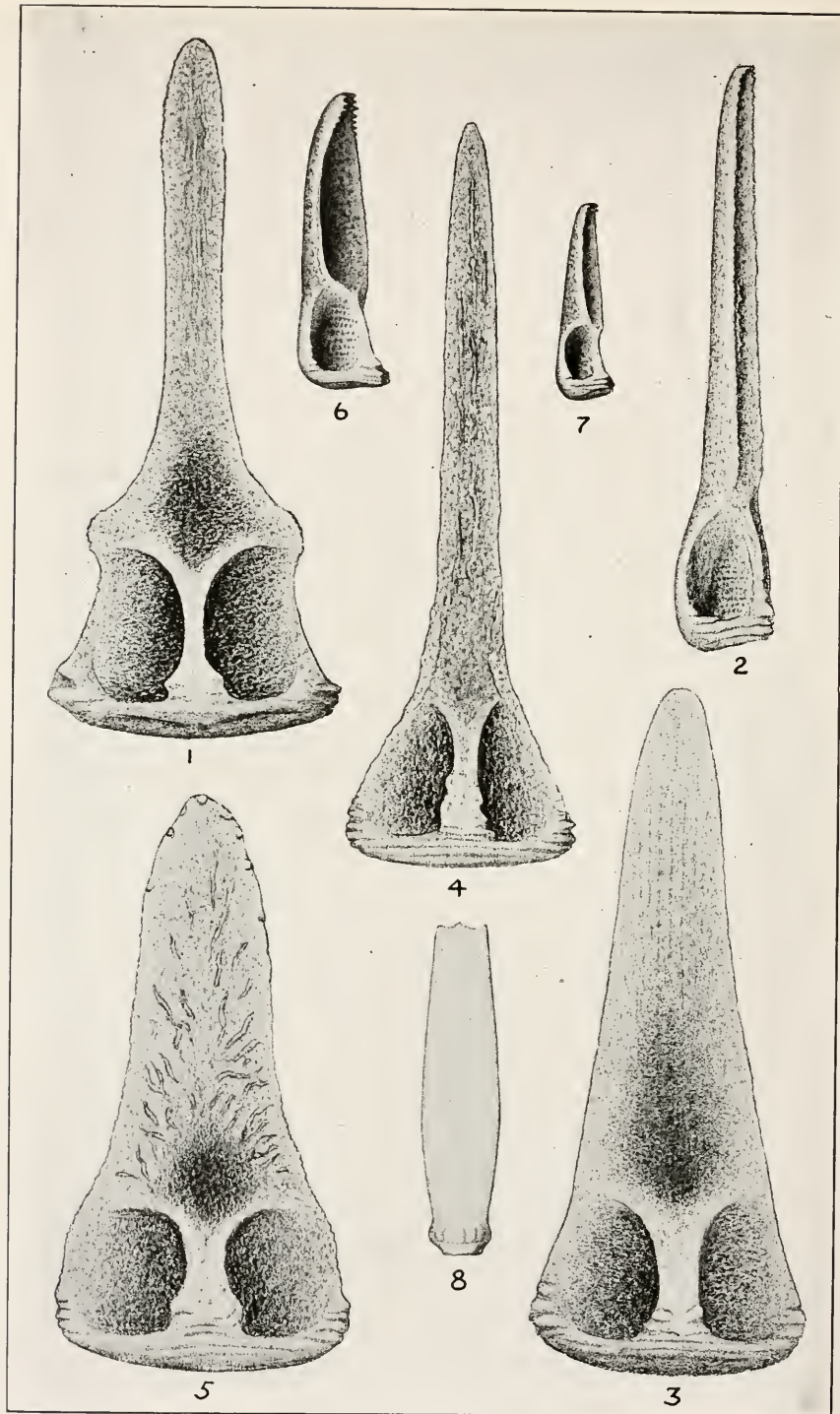
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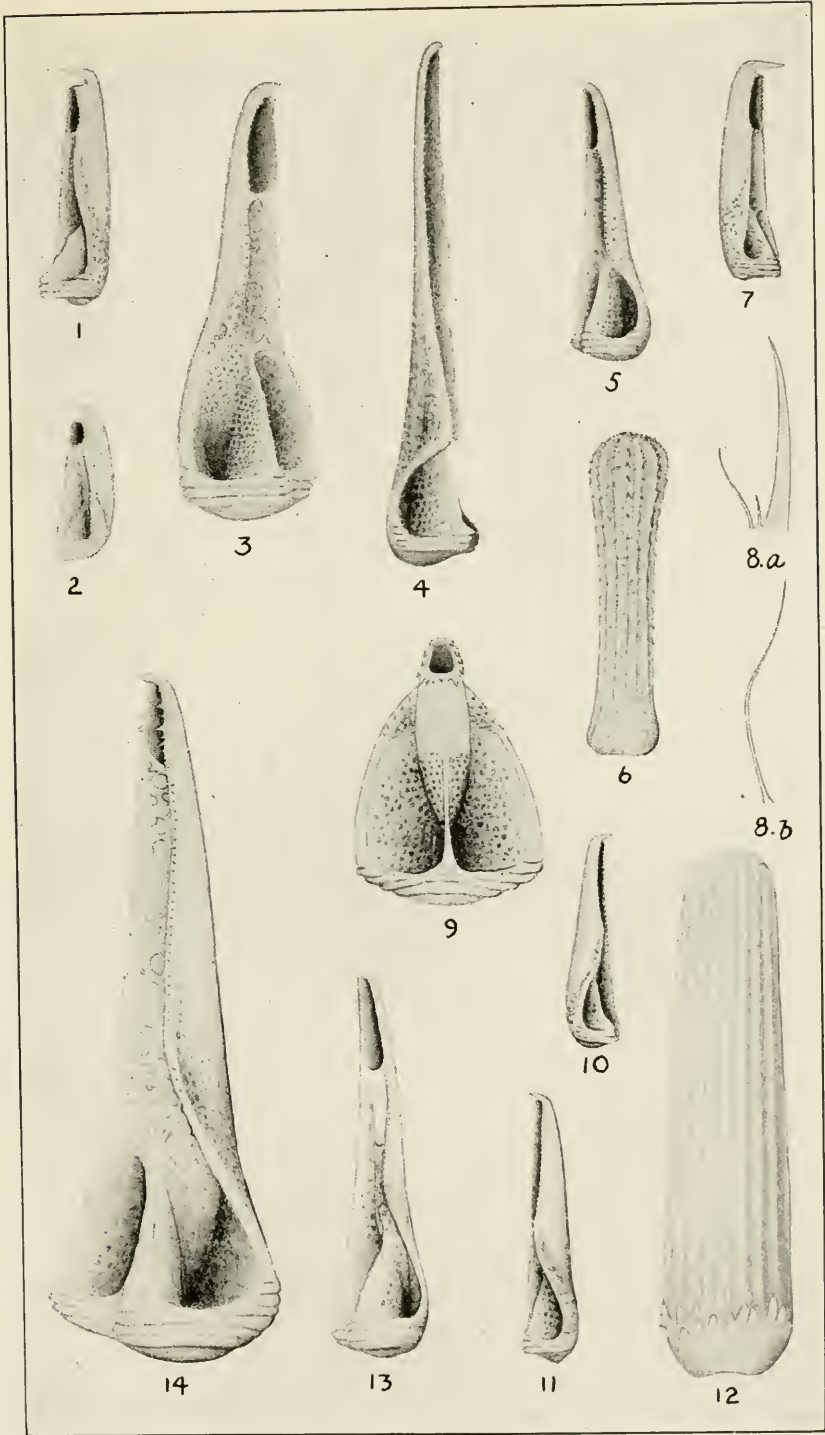
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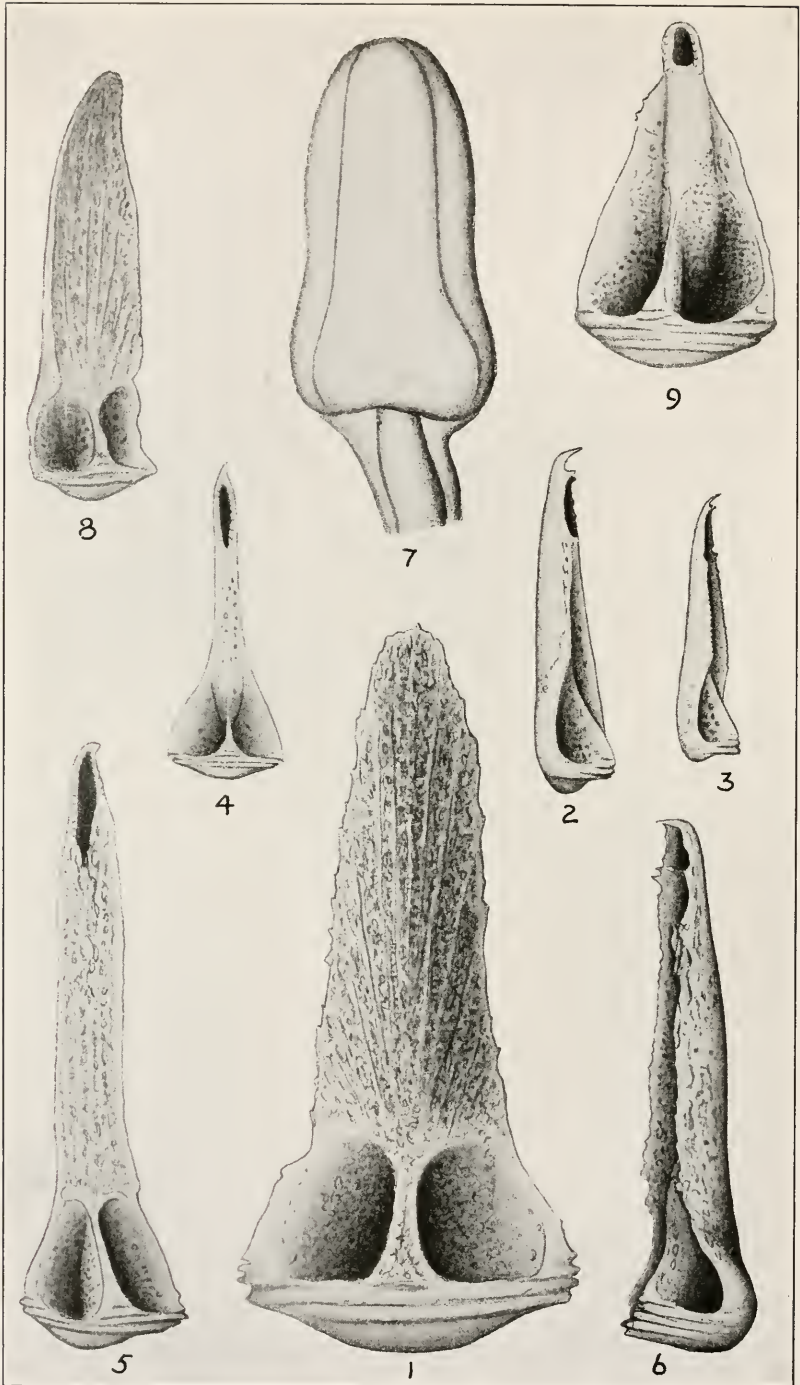
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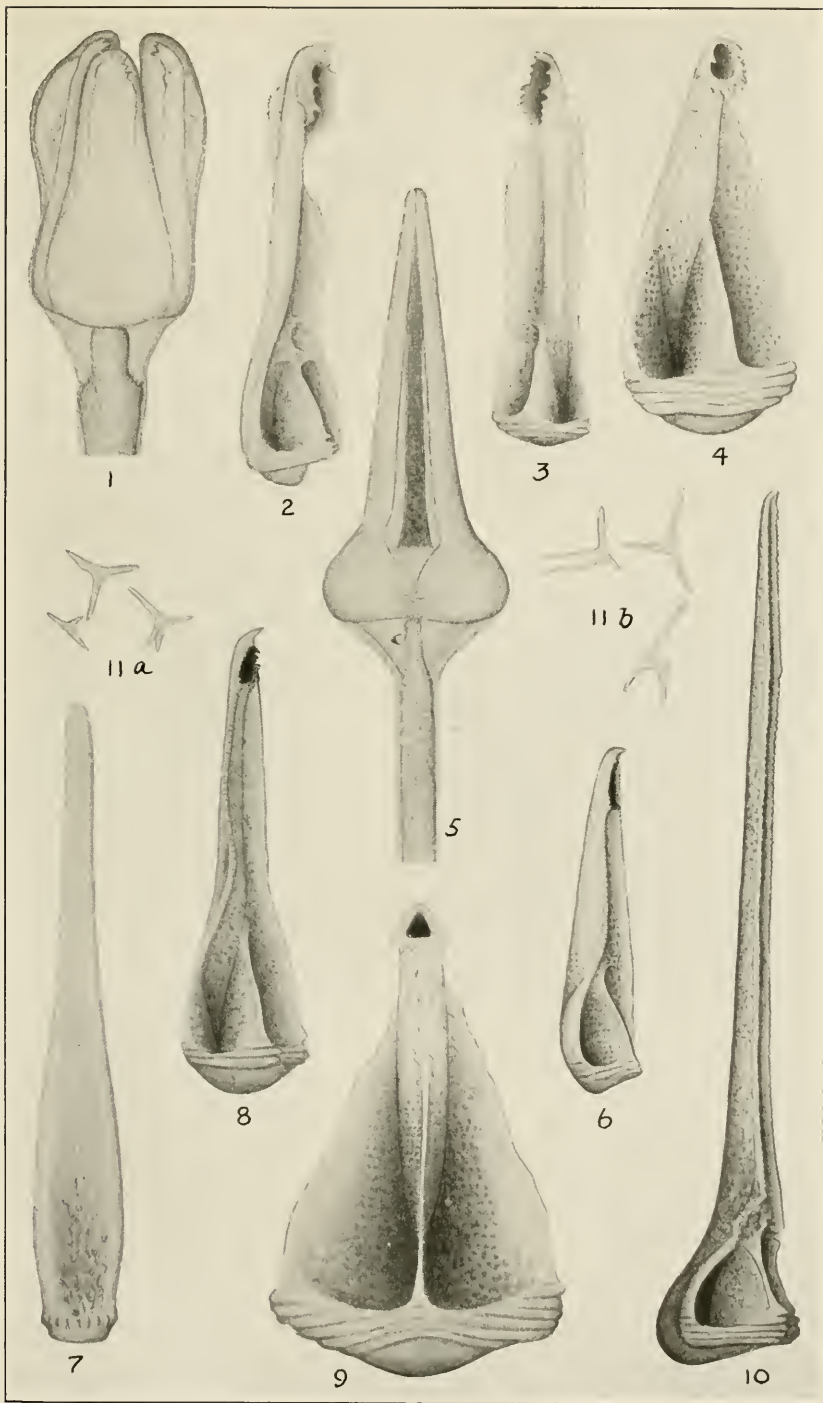
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