THE ASTEROIDS OF THE COASTAL WATERS OF SURINAM

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With 28 text-figures and 18 plates

CONTENTS

INTRODUCTION

The present paper deals with the Asteroidea (Echinodermata), collected during two surveys of the continental shelf of Surinam (O. C. P. S. I & II) carried out in the spring of 1966 and 1969 by H. NL. M. S. Snellius and H. NL. M. S. Luymes, respectively.

During my studies I have identified and classified the sea-stars of the bottom-samples. I have also tried to solve nomenclatural problems and to correct some nomenclatural conceptions, with which I did not agree. For each species I have composed the distributional pattern from records in the literature.

During the surveys "it proved to be possible to correlate the zoological work with the geomorphological and sedimentological survey of the shelf bottom" (Vervoort, 1967, 1971, these papers can be considered as an introduction to this report).

In most of the stations where asteroids have been collected, the bottom material was a mixture of sand and mud in variable proportions. In the species caught in the greatest numbers (*Astropecten riensis* and *Echinaster brasiliensis*) a preference for this mixture is obvious, although they were also found on bottoms of sand or clay. Only the species *Astropecten marginatus* and the deeper water species *Astropecten americanus* were caught on a bottom of pure mud; one specimen of *Anthenoides peircei* was collected from soft mud with inclusions of sand and clay. Except for the clay bottoms, shell fragments usually were part of the bottom material. In the seven sta-

tions, where the greatest diversity of species occurred, the bottom material was a mixture of mud and sand, with or without shell fragments, Bryozoa, worm-tubes, or fragments of clay.

All specimens are preserved in alcohol 70%; *Astropecten brasiliensis, Oreaster reticulatus, Nymphaster subspinosus* and a few specimens of *Tethyaster vestitus, Luidia clathrata* and *Luidia senegalensis,* were dry.

Acknowledgements: I am indebted to many people for their kind cooperation: - to Prof. Dr. J. Th. Wiebes and Prof. Dr. W. Vervoort for their valuable help in supporting my first steps in the systematic zoology. - to Dr. S. van der Spoel for giving me access to the collection of Asteroidea in the Institute for Taxonomic Zoology (I.T.Z.), (Zoologisch Museum), Amsterdam. - to Dr. Ailsa M. Clark for her help to use the collections of Asteroidea in the British Museum (Natural History), London.

List of the stations, where Asteroidea were collected

Sta. **A 9**, 06° 52.2′ N, 55° 12.4′ W, 21.iv.1966
51 m depth. Coarse sand with mud and many dead Mollusca.
Astropecten riensis Döderlein
Tethyaster vestitus (Say)
Echinaster brasiliensis Müller & Troschel

Sta. **A 10**, 06° 59.5′ N, 55° 11.2′ W, 21.iv.1966
56 m depth. Coarse sand with mud and many dead Mollusca.
Astropecten riensis Döderlein
Luidia ludwigi Fisher
Echinaster brasiliensis Müller & Troschel

Sta. **A 14**, 06° 14.2′ N, 55° 19.2′ W, 23.iv.1966
20 m depth. Heavy clay.
Astropecten marginatus Gray

Sta. **A 15**, 06° 21.2′ N, 55° 17.7 W, 23 & 25.iv.1966
34 m depth. Sandy clay with shell fragments.
Astropecten riensis Döderlein

Sta. **A 25**, 06° 44.3′ N, 55° 13.5′ W, 28.iv.1966
44-48 m depth. Sandy mud with clay and many shell fragments.
Astropecten riensis Döderlein
Luidia ludwigi Fisher

Sta. **A 27**, 06° 35.1′ N, 55° 15.4′ W, 28.iv.1966
41 m depth. Sandy mud with clay and shell fragments.
Astropecten riensis Döderlein
Tethyaster vestitus (Say)
Luidia clathrata (Say)
Echinaster brasiliensis Müller & Troschel

Sta. **A 68**, 06° 32.5′ N, 55° 15.6′ W, 24.iii.1969
36 m depth. Coarse sand with many shell fragments and some living Lamellibranchia and Bryozoa.
Astropecten riensis Döderlein
Luidia senegalensis (Lamarck)
Echinaster brasiliensis Müller & Troschel

Sta. **B 2**, 06° 54.1′ N, 55° 29.0′ W, 3.iv.1966
51 m depth. Hard sand with some mud.
Tethyaster vestitus (Say)
Luidia barimae John & Clark
Luidia clathrata (Say)
Luidia ludwigi Fisher
Echinaster brasiliensis Müller & Troschel

Sta. **B 17**, 06° 17.5′ N, 55° 33.8′ W, 25.iv.1966
31 m depth. Sandy clay with many shell fragments.
Echinaster brasiliensis Müller & Troschel

Sta. **B 22**, 07° 21.6′ N, 55° 22.2′ W, 27.iv.1966
400-420 m depth. Heavy clay.
Astropecten riensis Döderlein
Nymphaster subspinosus (Perrier)

Sta. **B 23**, 07° 17.8′ N, 55° 23.3′ W, 27.iv.1966
99-101 m depth. Rock fragments.
Luidia barbadensis Perrier

Sta. **B 24**, 07° 04.4′ N, 55° 25.0′ W, 27.iv.1966
66 m depth. Sandy mud with clay and many shell fragments.
Astropecten riensis Döderlein

Sta. **C 18**, 06° 13.3′ N, 55° 50.0′ W, 25 & 26.iv.1966
30 m depth. Sand with some mud and clay fragments, many fragments of Lamellibranchia.
Astropecten riensis Döderlein

Sta. **C 21**, 07° 03.8′ N, 55° 40.4′ W, 26.iv.1966
71-79 m depth. Sandy mud with hard clay pellets.
Luidia ludwigi Fisher
Astropecten riensis Döderlein

Sta. **D 30**, 06° 26.2′ N, 56° 02.5′ W, 3.v.1966
34-41 m depth. Heavy clay with some mud and fine sand.
Luidia senegalensis (Lamarck)
Echinaster brasiliensis Müller & Troschel

Sta. **D 31**, 06° 32.2′ N, 56° 02.1′ W, 3.v.1966
38-39 m depth. Sandy clay with superficial worm tubes and shell fragments.
Astropecten riensis Döderlein
Echinaster brasiliensis Müller & Troschel

Sta. **D 32**, 06° 44.5′ N, 55° 59.6′ W, 3.v.1966
48.5-49.5 m depth. Sandy mud with many shell fragments.
Echinaster brasiliensis Müller & Troschel

Sta. **D 33**, 06° 56.6′ N, 55° 56.9′ W, 4.v.1966
60-62 m depth. Muddy sand with shells of Lamellibranchia and fragments of Gastropoda.
Echinaster brasiliensis Müller & Troschel

Sta. **E 60**, 06° 05.8′ N, 56° 21.2′ W, 12.v.1966
18-21 m depth. Soft grey mud with brown superficial layer.
Astropecten marginatus Gray

Sta. **E 62**, 06° 30.6′ N, 56° 15.3′ W, 12.v.1966
36-38 m depth. Sand with coarse shell fragments and iron-hydroxyde pebbles.
Astropecten riensis Döderlein
Echinaster brasiliensis Müller & Troschel

Sta. **E 64**, 06° 53.3′ N, 56° 12.1′ W, 13.v.1966
56-59 m depth. Sand with some mud and shell fragments.
Goniaster tessellatus (Lamarck)

Sta. **5x**, 06° 24.5′ N, 56° 25.0′ W, 7.iv.1966
31 m depth. No bottom sample.
Luidia clathrata (Say)

Sta. **F 6**, 06° 26.6′ N, 56° 33.0′ W, 12.iv.1966
33 m depth. Mud and fine sand, some clay fragments.
Astropecten riensis Döderlein
Astropecten marginatus Gray
Tethyaster vestitus (Say)
Luidia clathrata (Say)
Luidia senegalensis (Lamarck)
Echinaster brasiliensis Müller & Troschel

Sta. **F 38**, 07° 13.8′ N, 56° 24.4′ W, 5.v.1966
81 m depth. Sand with shell fragments.
Narcissia trigonaria Sladen
Echinaster brasiliensis Müller & Troschel

Sta. **F 39**, 07° 05.4′ N, 56° 25.8′ W, 5.v.1966
65 m depth. Sand with some mud and coarse shell fragments.
Narcissia trigonaria Sladen

Sta. **F 40**, 07° 00.2′ N, 56° 26.5′ W, 6.v.1966
58-59 m depth. Sand with some fine mud and fine shell fragments.
Goniaster tessellatus (Lamarck)
Echinaster brasiliensis Müller & Troschel

Sta. **F 41**, 06° 54.8′ N, 56° 28.6′ W, 6.v.1966
55-60 m depth. Coarse sand with some mud and many shell fragments.
Tethyaster vestitus (Say)
Luidia clathrata (Say)
Echinaster brasiliensis Müller & Troschel

Sta. **F 42**, 06° 46.5′ N, 56° 30.6′ W, 6.v.1966
39-40 m depth. Sandy mud with shell fragments.
Tethyaster vestitus (Say)
Luidia senegalensis (Lamarck)
Echinaster brasiliensis Müller & Troschel

Sta. **F 43**, 06° 37.2′ N, 56° 31.3′ W, 6.v.1966
37-38 m depth. Sand with mud at surface, covering blue-black clay.
Astropecten riensis Döderlein
Luidia clathrata (Say)
Luidia senegalensis (Lamarck)
Luidia ludwigi Fisher
Goniaster tessellatus (Lamarck)
Echinaster brasiliensis Müller & Troschel

Sta. **F 44**, 06° 33.6′ N, 56° 31.6′ W, 6.v.1966
38 m depth. Sandy mud with shell fragments and shells.
Astropecten riensis Döderlein
Luidia senegalensis (Lamarck)

Sta. **F 46**, 06° 18.7′ N, 56° 34.2′ W, 7.v.1966
25-29 m depth. Calcareous rock with corals, Bryozoa, Gorgonaria.
Coarse sand with pebbles and empty shells.
Linckia guildingii Gray

Sta. **F 47**, 06° 13.2′ N, 56° 35.3′ W, 7.v.1966
27-28 m depth. Sandy mud with shell fragments.
Astropecten riensis Döderlein
Astropecten marginatus Gray
Luidia clathrata (Say)
Luidia senegalensis (Lamarck)
Luidia alternata (Say)

Sta. **G 7**, 07° 16.8′ N, 56° 47.6′ W, 13.iv.1966
64 m depth. No bottom sample.
Narcissia trigonaria Sladen
Echinaster brasiliensis Müller & Troschel

Sta. **G 54**, 06° 38.8′ N, 56° 43.8′ W, 10.v.1966
38 m depth. Sand with some mud and shell fragments.
Tethyaster vestitus (Say)

Sta. **G 55**, 06° 55.7′ N, 56° 42.2′ W, 10.v.1966
45 m depth. Sandy mud with Bryozoa and Ascidia.
Echinaster brasiliensis Müller & Troschel

Sta. **G 56**, 07° 15.6′ N, 56° 40.0′ W, 10.v.1966
67-68 m depth. Coarse sand with some mud, shell fragments.
Tethyaster vestitus (Say)
Narcissia trigonaria Sladen
Echinaster modestus Perrier

Sta. **H 51**, 06° 36.1′ N, 57° 02.0′ W, 9.v.1966
29-30 m depth. Coarse sand with some mud, shell fragments and empty shells.
Astropecten riensis Döderlein
Echinaster brasiliensis Müller & Troschel

Sta. **H 52**, 06° 50.3′ N, 56° 59.2′ W, 9.v.1966
39 m depth. Coarse sand with mud and shell fragments.
Tethyaster vestitus (Say)
Oreaster reticulatus (L.)
Echinaster brasiliensis Müller & Troschel

Sta. **H 53**, 07° 00.5′ N, 56° 58.2′ W, 10.v.1966
38-40 m depth. Coarse sand with some shell fragments and some mud.
Tethyaster vestitus (Say)
Echinaster brasiliensis Müller & Troschel

Sta. **H 57**, 07° 35.7′ N, 56° 52.6′ W, 11.v.1966
94-97 m depth. Coarse sand with some mud and coarse shell fragments; fragment of calcareous coral rock.
Astropecten marginatus Gray
Echinaster modestus Perrier

Sta, **H 58**, 07° 25.4′ N, 56° 54.4′ W, 11.v.1966
66-69 m depth. Coarse sand with some mud and coarse shell fragments.
Goniaster tessellatus (Lamarck)
Narcissia trigonaria Sladen

Sta. **H 59**, 07° 08.5′ N, 56° 57.0′ W, 11.v.1966
49 m depth. Coarse sand with mud and shell fragments.
Goniaster tessellatus (Lamarck)

Sta. **I 70**, 06° 39′ N, 54° 57′ W, 26.iii.1969
40 m depth. Fine sand with some mud and many shell fragments.
Astropecten riensis Döderlein
Luidia clathrata (Say)
Luidia senegalensis (Lamarck)

Sta. **I 76**, 06° 08.8′ N, 55° 03.5′ W, 8.iv.1969
6 m depth. Soft blue mud with brown surface, some fragments of hard clay in lower strata.
Astropecten marginatus Gray

Sta. **I 122**, Van Veen grab, 32 m, 06° 25.4′ N, 55° 00.9′ W, 25.iv.1969;
Agassiz trawl, 33 m depth, 06°25.8′ N, 55° 01.5′ W, 26.iv.1969
Grey sandy mud with reef fragments and some shells.
Luidia clathrata (Say)
Luidia senegalensis (Lamarck)

Sta. **J 110**, 06° 45.2′ N, 54° 42.7′ W, 22.iv.1969
46.5 m depth. Grey, soft, muddy sand with shell fragments and Bryozoa.
Surface layer softer, greyish-brown.
Astropecten riensis Döderlein
Luidia clathrata (Say)

Sta. **J 111**, 06° 52.8′ N, 54° 41.1′ W, 22.iv.1969
52 m depth. Very sandy mud with hard clay inclusions and many fragments of shells and Bryozoa.
Astropecten riensis Döderlein
Echinaster brasiliensis Müller & Troschel

Sta. **J 112**, 07° 18.3′ N, 54° 36.3′ W, 22.iv.1969
89 m depth. Sandy, greyish-green mud with shell fragments. Surface layer soft.
Luidia ludwigi Fisher
Anthenoides peircei Perrier

Sta. **J 113a**, 07° 22.7′ N, 54° 36.4′ W, 23.iv.1969
Heavy rectangular dredge, haul between two coral reefs.
Luidia ludwigi Fisher
Anthenoides peircei Perrier

Sta. **K 100**, 07° 36.9′ N, 54° 18.0′ W, 17.iv.1969
300 m depth. Soft grey mud adhearing to Van Veen grab.
Astropecten americanus (Verrill)

Sta. **K 101**, 07° 25.4′ N, 54° 20.5′ W, 17.iv.1969
120 m depth. Coarse sand with some mud and shell fragments.
Luidia barbadensis Perrier
Luidia ludwigi Fisher

Sta. **I 115**, 07° 12.6′ N, 54° 51.7′ W, 24.iv.1969
81-83 m depth. Coarse sand with some mud; shell and reef fragments.
Astropecten riensis Döderlein

Sta. **I 116**, 06° 59.8′ N, 53.7′ W, 24.iv.1969
60 m depth. Greyish-green, sandy mud with yellowish-brown surface layer. Many shell fragments are present.
Astropecten riensis Döderlein
Tethyaster vestitus (Say)
Echinaster brasiliensis Müller & Troschel

Sta. **I 117**, 06° 54.7′ N, 54° 54.3′ W, 24.iv.1969
54 m depth. Greyish-green, sandy mud with yellowish-brown surface layer and many shell fragments.
Astropecten riensis Döderlein
Luidia clathrata (Say)
Luidia ludwigi Fisher
Echinaster brasiliensis Müller & Troschel

Sta. **I 119**, 06° 36′ N, 55° 58.3′ W, 25.iv.1969
42 m depth. Grey-greenish sandy mud with many shell fragments.
Luidia clathrata (Say)
Luidia ludwigi Fisher

Sta. **I 120**, 06° 30.3′ N, 54° 59.7′ W, 25.iv.1969
36-37.5 m depth. Soft, sandy mud with inclusions of hard clay, small pebbles and Bryozoa.
Luidia clathrata (Say)
Luidia senegalensis (Lamarck)

Sta. **I 121**, 06° 28.3′ N, 55° 00.2′ W, 25.iv.1969
33 m depth. Coarse sand with Mollusca, Coelenterata and coral rock fragments.
Astropecten riensis Döderlein
Luidia senegalensis (Lamarck)
Echinaster brasiliensis Müller & Troschel

Sta. **K 102**, 07° 11.3′ N, 54° 23.0′ W, 18.iv.1969
79.5-81 m depth. Grey-greenish mud, with fine, greenish sand.
Surface layer soft. Including holes of Crustacea filled with sand and shell fragments.
Astropecten riensis Döderlein
Luidia barimae John & Clark

Sta. **K 103**, 06° 58.6′ N, 54° 25.2′ W, 18.iv.1969
63 m depth. Sandy mud with inclusions of firmer, hard clay. Many shell fragments.
Astropecten riensis Döderlein

Sta. **K 104**, 06° 54.8′ N, 54° 26.0′ W, 21.iv.1969
55 m depth. Soft, greenish mud with much fine, greenish sand.
Inclusions of hard clay fragments and shells.
Astropecten riensis Döderlein

Sta. **K 105**, 06° 28.6′ N, 54° 31.3′ W, 21.iv.1969
33 m depth. Sandy clay with inclusions of hard clay. Includes also holes of Echinodermata, filled with sand and shell fragments. Surface layer soft, brownish.
Astropecten marginatus Gray

Sta. **L 87**, 06° 28.1′ N, 54° 15.3′ W, 11.iv.1969
33 m depth. Greenish, fine sand with some mud, worm tubes, Mollusca and Bryozoa.
Astropecten marginatus Gray

Sta. **L 90**, 06° 48.0′ N, 54° 11.4′ W, 12.iv.1969
45 m depth. Sandy mud with inclusions of heavy clay; many shell fragments and Bryozoa.
Astropecten riensis Döderlein
Luidia clathrata (Say)

Sta. **L 95**, 07° 18.7′ N, 54° 04.0′ W, 15.iv.1969
Van Veen grab south of reef, 90.5 m depth. Sand with much mud and many dead shells.
Van Veen grab north of reef, 95.5 m depth. Sand with some mud and a few dead shells.
Agassiz trawl, 90-100 m depth.
Luidia barimae John & Clark
Anthenoides peircei Perrier

Sta. **L 96**, 07° 28.0′ N, 54° 03.1′ W, 15.iv.1969
200-207 m depth. Soft mud with inclusions of sand and clay.
Anthenoides peircei Perrier

Sta. **M 72**, 06° 15.32′ N, 54° 03.65′ W, 29.iii.1969
25 m depth. Sandy mud mith many shell fragments, soft, blue clay in deeper strata.
Astropecten marginatus Gray

Sta. **M 73**, 06° 55.44′ N, 53° 54.68′ W, 31.iii.1969
55 m depth. Fine, blackish sand with some mud and many shells; shell fragments and Bryozoa.
Astropecten riensis Döderlein

Sta. **M 81**, 05° 59.4′ N, 54.04′ W, 10.iv.1969
8 m depth. Soft, blue mud, surface brownish. Many shell fragments on surface.
Astropecten marginatus Gray

Sta. **M 85**, 06° 28.7′ N, 54° 02.2′ W, 11.iv.1969
36 m depth. Sandy mud with many shell fragments and Bryozoa.
Astropecten marginatus Gray
Luidia senegalensis (Lamarck)

Sta. **M 86**, 06° 36.2′ N, 54° 00.1′ W, 11.iv.1969
42 m depth. Sandy mud with worm tubes.
Astropecten riensis Döderlein
Tethyaster vestitus (Say)
Luidia clathrata (Say)
Luidia senegalensis (Lamarck)
Luidia ludwigi Fisher

Sta. **M 88**, 06° 42.8′ N, 53° 58.5′ W, 12.iv.1969
46 m depth. Muddy sand with worm tubes, many Mollusca and Bryozoa.
Astropecten riensis Döderlein
Tethyaster vestitus (Say)
Luidia clathrata (Say)
Luidia senegalensis (Lamarck)
Luidia ludwigi Fisher
Echinaster brasiliensis Müller & Troschel

Sta. **M 89**, 06° 50.7′ N, 53° 55.2′ W, 12.iv.1969
51 m depth. Muddy sand with worm tubes, many Mollusca and Bryozoa.
Tethyaster vestitus (Say)
Luidia ludwigi Fisher

Sta. **M 97**, 07° 18.5′ N, 53° 48.7′ W, 16.iv.1969
130 m depth. Coarse sand with some mud and many shell fragments.
Astropecten marginatus Gray
Tethyaster vestitus (Say)
Luidia ludwigi Fisher
Tosia clugreta spec. nov.
Anthenoides peircei Perrier
Rosaster alexandri (Perrier)

Sta. **M 98**, 07° 10.6′ N, 53° 50.7′ W, 16.iv.1969
85 m depth. Coarse sand with reef fragments and many shell fragments.
Luidia ludwigi Fisher
Echinaster brasiliensis Müller & Troschel

Sta. **N 80**, 06° 28.0′ N, 53° 46.9′ W, 9.iv.1969
35 m depth. Coarse sand with small pebbles, some mud and many shell fragments.
Luidia clathrata (Say)

Taxonomic report

Asteroidea represented in the Surinam waters

Subclassis Asteroidea de Blainville, 1830.
Ordo Platyasterida Spencer, 1951.
Familia Luidiidae Verrill, 1899.
Genus *Luidia* Forbes, 1839.
Species *L. barimae* John & A. M. Clark, 1954.
L. barbadensis Perrier, 1881.
L. clathrata (Say, 1825).
L. senegalensis (Lamarck, 1816).

L. alternata (Say, 1825).
L. ludwigi Fisher, 1906.
Ordo Paxillosida Perrier, 1884.
Subordo Diplozonina Spencer & Wright, 1966.
Familia Astropectinidae Gray, 1840.
Subfamilia Astropectininae Gray, 1840.
Genus *Astropecten* Gray, 1840.
Species *A. riensis* Döderlein, 1917.
A. brasiliensis Müller & Troschel, 1842.
A. marginatus Gray, 1840.
A. americanus Verrill, 1880.
Genus *Tethyaster* Sladen, 1889.
Species *T. vestitus* (Say, 1825).
Ordo Valvatida Perrier, 1884.
Subordo Granulosina Perrier, 1894.
Familia Goniasteridae Forbes, 1841.
Genus *Goniaster* Agassiz, 1835.
Species *G. tessellatus* (Lamarck, 1816).
Genus *Tosia* Gray, 1840.
Species *T. clugreta* spec. nov.
Genus *Anthenoides* Perrier, 1881.
Species *A. peircei* Perrier, 1881.
Genus *Rosaster* Perrier, 1894.
Species *R. alexandri* Perrier, 1881.
Genus *Nymphaster* Sladen, 1889.
Species *N. subspinosus* (Perrier, 1881).
Familia Oreasteridae Fisher, 1911.
Genus *Oreaster* Müller & Troschel, 1842.
Species *O. reticulatus* (Linnaeus, 1758).
Familia Ophidiasteridae Verrill, 1867.
Genus *Linckia* Nardo, 1834.
Species *L. guildingii* Gray, 1840.
Genus *Narcissia* Gray, 1840.
Species *N. trigonaria* Sladen, 1889.
Ordo Spinulosida Perrier, 1884.
Subordo Leptognathina Spencer & Wright, 1966.
Familia Echinasteridae Verrill, 1867.
Genus *Echinaster* Müller & Troschel, 1840.
Species *E. brasiliensis* Müller & Troschel, 1842.
E. modestus Perrier, 1881.

The Asteroidea are considered to be a subclass of the Stelleroidea Lamarck, 1816, the latter being considered a class of the subphylum Asterozoa Zittel, 1895 (Spencer and Wright, 1966).

Key to the orders of the Asteroidea represented in the Surinam waters

1. Tube feet without a sucking disk 2
   Tube feet with a sucking disk 3
2. Supero-marginal plates absent . . . . . Platyasterida
   Supero-marginal plates present . . . . . Paxillosida
3. Marginal plates conspicuous . . . . . Valvatida
   Marginal plates inconspicuous or absent . . . . . Spinulosida

The order Forcipulatida Perrier, 1884 is not represented in the material from Surinam.

The order Platyasterida consists of one recent family, Luidiidae, with one genus, *Luidia.*

The order Paxillosida is represented in Surinam by the family Astropectinidae of the suborder Diplozonina.

The order Valvatida is represented in Surinam by the families Goniasteridae, Oreasteridae and Ophidiasteridae of the suborder Granulosina.

The order Spinulosida is represented in Surinam by the family Echinasteridae of the suborder Leptognathina, in one genus, *Echinaster.*

Luidia Forbes, 1839

Supero-marginal plates replaced by paxillae. Arms rather long and narrow. Disk small and flat. Infero-marginal plates very broad, with some large, projecting spines. Dorsal surface covered with paxillae, usually in regular, longitudinal series. Ventro-lateral areas small. Simple pedicellariae may occur. Papulae bush-shaped. Ampullae double. No intestine, intestinal caeca or anus.

Key to the Surinam species of *Luidia*

1. Rays ten. Dorsal paxillae irregularly arranged. Infero-marginal plates extending on dorsal side, with four (sometimes three) large spines, which alternate in position on adjacent plates . . . . . *Luidia barimae* John & Clark
— Rays less than ten. At least the lateral paxillae usually arranged in regular series. Infero-marginal plates not extending on dorsal side and spines not alternating in position on adjacent plates 2
2. Rays six. Paxillae gradually decreasing in size towards mid-radial part of arm . . . . . *Luidia barbadensis* Perrier
— Rays not six. Distinct difference between lateral and dorsal paxillae 3

3. Pedicellariae absent. Spinelets on dorsal paxillae of equal length. Dorsal side of body blueish-gray 4
— Pedicellariae present. Spinelets on dorsal paxillae not all of equal length. Dorsal side of body white and brown 5
4. Five broad arms. Three regular rows of rectangular lateral paxillae. In the interradial angles only a few ventro-lateral plates, which have not fused . . . . . *Luidia clathrata* (Say)
— Nine long and slender arms. Two regular rows of rectangular lateral paxillae. In the interradial angles numerous ventro-lateral plates, which haye fused and connect the first infero-marginal and adambulacral plates . . . . . *Luidia senegalensis* (Lamarck)
5. Lateral paxillae irregularly alternating in size; larger lateral and dorsal paxillae with enlarged spines. No pedicellariae on infero-marginal plates or marginal paxillae . . . . . *Luidia alternata* (Say)
— Dorsal nor lateral paxillae alternating in size and all without enlarged spines. Usually some of the central paxillar-spinelets larger than the marginal ones. Pedicellariae on most of the infero-marginal plates and marginal paxillae . . . . . *Luidia ludwigi* Fisher

Family Astropectinidae

Supero- and infero-marginal plates well developed, thick, more or less covered with spines or granules. Aboral side covered with paxillae. Ventro-lateral area covered with spines. Often distinct marginal fascioles, which are never webbed. Intestine, generally also intestinal caeca, present. Ambulacral feet pointed; ampullae double; papulae simple.

Key to the Surinam genera of Astropectinidae

. Ventro-lateral area very small, actinal intermediate plates not continuing beyond base of arm; adambulacral plates therefore joining infero-marginal plates in almost the whole length of the arm. Spines on infero-marginal plates forming a prominent fringe all around body and arms. Madreporite usually smaller than three supero-marginal plates . . . . . *Astropecten*
— Ventro-lateral area very large, with 6-7 series of plates. Spines on infero-marginal plates not forming a prominent fringe. Madreporite large, naked. Large forms . . . . . *Tethyaster*

Astropecten Gray, 1840

Disk fairly large; arms long, broad, of medium length. Supero-marginal plates with fine granules and, sometimes, with one or more larger, erect,

conical spines; infero-marginal plates with flat spines, which form a distinct fringe all around the edge of disk and arms. Ventro-lateral areas very small, with only 1-3 series of ventro-lateral plates, which do not continue beyond the basal part of the arms, thus the adambulacral and infero-marginal plates join each other in almost the whole length of the arm. Madreporite bare. No pedicellariae.

Key to the Surinam species of *Astropecten*

1. Spines on infero-marginal plates forming an oblique row, in such a way that the most interior spine is also the most aboral one . . . 2
— Spines on infero-marginal plates forming a straight, transverse row on the aboral side, and often also on the adoral side of the plate . 3
2. A smaller spine on each side of the large furrow spine. Only the first supero-marginal plate bears one interior spine . . . . . *Astropecten riensis* Döderlein
— A smaller spine only present on the aboral side of the large furrow spine. Several supero-marginal plates bear an interior spine . . . . . *Astropecten brasiliensis* Müller & Troschel
3. Infero-marginal plates protruding beyond supero-marginal plates, exclusively forming the edge of the arms. Body flattened; arms broad and petaloid . . . . . *Astropecten marginatus* Gray
— Infero-marginal plates not protruding beyond supero-marginal plates and not exclusively forming the edge of the arms. Body not flattened; arms long and tapering . . . *Astropecten americanus* Verrill

Tethyaster Sladen, 1889

Both series of marginal plates large and conspicuous, equally developed; supero-marginal plates granulated or with numerous short spinelets, the infero-marginal plates with a median row of usually about five enlarged and flattened, oppressed spines. Ventro-lateral areas large, with numerous ventro-lateral plates, arranged in definite series with an incomplete unpaired median row; ventro-lateral plates extending to almost the end of the arm. Madreporite large and bare. Aboral plates with paxillae having high colums. Gonads extending far along the arm.

The genus *Tethyaster* is represented in Surinam by one species: *Tethyaster vestitus* (Say).

Key to the Surinam families of the Granulosina

1. Dorsal side flattened, with short, flat spines, arranged like paxillae, or with spines surrounded by grains. Papulae as a rule only in the radial areas . . . . . Goniasteridae

— Dorsal side not flattened; dorsal skeleton reticulate. Papulae not restricted to radial areas 2
2. Disk large and high; arms short; ventro-lateral area very large . . . . . Oreasteridae
— Disk small and low; arms long; ventro-lateral area small . . . . . Ophidiasteridae

Family Goniasteridae

Marginal plates large and distinct; edge of disk vertical, not sharp. Dorsal side flattened, with short, flat spines, arranged like paxillae, or with spines surrounded by grains. Pedicellariae alveolar or sessile. Papulae as a rule only in the radial areas. Genital organs in the interradii, not passing into the rays.

Key to the Surinam species of the Goniasteridae

1. Dorsal plates paxilla-like. Supero-marginal plates contiguous throughout nearly whole length of arms 4
— Dorsal plates not paxilla-like. Supero-marginal plates not contiguous throughout nearly whole length of arms 2
2. Arms rather long, slender and tapering to acute end. Ventro-lateral areas with large, bivalved pedicellariae. Adults with thick skin . . . . . *Anthenoides peircei* Perrier
— Arms short, bluntly pointed. Pedicellariae small or absent. No thick skin present 3
3. Several dorsal plates with thick, conical spines. Dorsal plates granular all over. A large number of very small, secondary plates between dorsal plates. Supero-marginal plates strongly elevated . . . . . *Goniaster tessellatus* (Lamarck)
— Dorsal plates naked, except for fringe of granules around edge. No secondary plates between dorsal plates. Supero-marginal plates hardly or not elevated . . . . . *Tosia clugreta* spec. nov.
4. Large specimens, with very long and slender, acutely pointed arms. R/r ratio 4.2. Interradial supero-marginal plates smaller than those at bases of arms. Furrow spines usually eleven . . . . . *Nymphaster subspinosus* (Perrier)
— Small specimens; arms shorter and not as slender and pointed as in *N. subspinosus*. R/r ratio 2.6. Supero-marginal plates gradually decreasing in size to the tip of the arm. Furrow spines usually five . . . . . *Rosaster alexandri* (Perrier)

Family Oreasteridae

Disk large, generally high and swollen, even cushion-like in adults, with robust arms or none; younger stages generally resembling Goniasteridae; body normally covered with thick granulose membrane; marginals large; intermarginals may be present; dorsal skeleton reticulate, composed of stellate plates, in many forms bearing stout spines. Papulae numerous, in special areas; calcareous interbrachial septa.

The family Oreasteridae is represented in Surinam by one species: *Oreaster reticulatus* (L.).

Family Ophidiasteridae

Disk small, arms long and more or less cylindrical. Ventro-lateral and marginal plates small. Ambulacral feet in two series with well developed disks. Generally covered with a thick skin.

Key to the Surinam species of the Ophidiasteridae

Arms long, cylindrical and bluntly pointed; more or less flattened on oral side; laterally bearing three regular, longitudinal series of plates. Papular areas between dorsal plates equal in size or larger than the plates, each with 15-40 pores. No pedicellariae present . . . . . *Linckia guildingii* Gray

— Arms shorter and triangular in cross section; gradually tapering to an acute end. Marginal plates forming two regular, distinct series. Dorsal plates surrounded by small, single, isolated papular pores. Small spatulate pedicellariae present . . . . . *Narcissia trigonaria* Sladen

Family Echinasteridae

Disk very small; arms five, long, slender, cylindrical, with no distinct delimitation between dorsal and oral side. Dorsal skeleton reticulate; spines single or in small groups not in the shape of paxillae. No pedicellariae. Ambulacral feet in two series.

Echinaster Müller & Troschel

One or few coarse spines at nodes. As a rule no papulae on oral surface.

Key to the Surinam species of *Echinaster*

Spines rather strong; supero-marginal spines form border of arms. Arms strong and only slightly tapering. Distinct spine pentagon on disk, around apical spine. Madreporite without fringe of spines . . . . . *Echinaster brasiliensis* Müller & Troschel

— Spines very small; supero-marginal spines do not form distinct border. Arms elegantly tapering. No distinct pentagon of spines on disk. Madreporite with fringe of small, acute spines . . . . . *Echinaster modestus* Perrier

SURVEY OF THE SPECIES

Luidia barimae John & A. M. Clark, 1954 (pl. 1 figs. 1-3)

Luidia barimae John & A. M. Clark, 1954: 145.

Material examined: Nine specimens from three different stations. Sta. B2: 2 disks, r: 16 and 17 mm; nine arms or the distal parts of arms; six arm fragments. The larger disk has one, although regenerated, arm; the smaller two, also regenerated, arms. Sta. K102: 1 juvenile specimen, R: 21 and r: 5 mm. Eight of the ten arms are present. Sta. L95: 6 disks, r: 9, 13, 14, 14, 16 and 18 mm; in one specimens (r: 14 mm) two whole arms (R: 132 and 137 mm) and one regenerated arm (R: 103 mm) are present; in two specimens (r: 13 and 16 mm) one regenerated arm is present; 22 arms or the outer parts of arms, with a length varying from 39 to 109 mm; 20 arm fragments. All disks once had ten arms.

Diagnosis (after John & A. M. Clark). — A ten-rayed species of *Luidia* belonging to the Quinaria group of Döderlein, with all dorsal paxillae irregularly arranged, some with one or more pedicellariae; no spino-paxillae; three adambulacral spines in a row at right angles to furrow; one to four ventrolateral pedicellariae; no furrow pedicellariae except on the mouth plates; infero-marginal plates extending to dorsal side, with four (sometimes three) large spines which alternate in position on adjacent plates. Cf. pl. 1 figs. 1-3.

Description. — John & A. M. Clark (1954) give a very thorough description of this species, to which I refer here.

Variability. — The number of the central paxillae, bearing a pedicellaria, may vary considerably. Quite a number of infero-marginal plates only bears three, large, pointed spines.

Discussion. — The nearest relative of this species is *Luidia heterozona* Fisher, 1940, from the coasts of West-Africa. Shortly after 1940 this last species was redescribed by Cadenat (1941) as *Luidia mortenseni*. Both names are synonymous. Madsen (1950) listed the variation in a number of features of *Luidia heterozona*. Although the variability may be quite considerable, it is not sufficiently so to make it probable that *Luidia barimae* is conspecific with *Luidia heterozona*.

The supero-marginal paxillae in *Luidia heterozona* are much larger than the lateral ones, which is not so in *Luidia barimae*. The paxillae in *Luidia barimae* are not regularly arranged, unlike *Luidia heterozona*; the number of the infero-marginal spines is smaller (2-3) in *Luidia heterozona*, being 4, sometimes 8, in *L. barimae*.

Distribution. — This species was only known from the type locality, 9°25′ N, 59°52′ W, off Rio Orinoco. Its range can now be extended to the coastal waters off Surinam.

Luidia barbadensis Perrier, 1881 (fig. 1; pl. 2 fig. 3)

Luidia barbadensis Perrier, 1881: 29; 1883: 267. — Verrill, 1915: 205. — Döderlein, 1920: 241. — H. L. Clark, 1941: 25. — A. H. Clark, 1954: 375. — Cherbonnier, 1959: 170. — Downey, 1973: 24.

Material examined: Two specimens from different stations. Sta. B23: 1 specimen, R: 16 mm; Sta. K 101: 1 specimen, R: 15 mm.

Diagnosis. — Six, sometimes five, rays. Arms long and slender. Dorsal paxillae gradually decreasing in size towards mid-radial part of arm. Adambulacral plates with transverse interior, and longitudinal exterior series of two large spines; the interior furrow-spine is strongly curved. Cf. pl. 2 fig. 3.

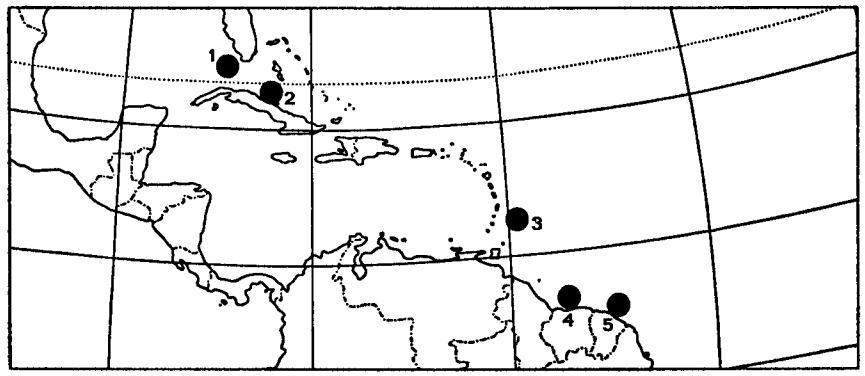


Fig. 1, *Luidia barbadensis* Perrier, distribution in tropical western Atlantic. Explanation of numbers used: 1, West Florida; 2, Old Bahama Channel; 3, Barbados; 4, Surinam; 5, French Guyana. This species also occurs off British Guyana.

Discussion. — In the two Surinam specimens, both being very young, actually none of the specific features is adequately developed. I decided to identify them as *Luidia barbadensis* because they have six rays and the spine-pattern on the adambulacral plates agrees with that species. The specimens investigated by H. L. Clark (1941) were also juveniles (R: 12-25 mm) and all but one of a cream-white colour as are also my specimens.

Distribution (fig. 1). — Barbados (type locality); Gulf of Mexico; off West Florida; old Bahama Channel; Cuba; Guyana; French Guyana; Surinam.

Luidia clathrata (Say, 1825) (figs. 19a, 2, 3, 4; pl. 3 fig. 2)

Asterias clathrata Say, 1825: 142.
Luidia clathrata — Lütken, 1859: 37. — Gray, 1866: 4. — Verrill, 1867: 343; 1872: 483;

1895: 134; 1901: 36; 1914: 7; 1915: 200. — Perrier 1876a: 252; 1878: 34; 1883: 269. — Agassiz 1877: 117. — Rathbun, 1879: 150. — Sladen, 1889: 253. — H. L. Clark, 1899: 130; 1919: 54, 71; 1933: 19. — Döderlein & Hartmeyer, 1910: 150. — Döderlein, 1920: 238. — Koeheler, 1911: 19. — A. H. Clark, 1940: 442; 1954: 375. — Bernasconi, 1943: 6. — John & A. M. Clark, 1954: 139. — Tommasi, 1958: 9. — Cherbonnier, 1959: 105, 170. — Engel, Croes & Schroevers, 1960: 5. — Brito, 1960: 12; 1962: 4; 1968: 11. — Caso, 1961: 39. — Ummels, 1963: 95. — Gray, Downey & Cerame-Vivas, 1968: 139. — Downey, 1973: 23.

Material examined: 68 specimens from 17 different stations. Sta. A 27: 2 specimens, R: 47 and 55 mm; Sta. B2: 3 specimens, R: 65, 138 and 146 mm; Sta. F 6: 17 specimens, R: 29, 31, 31, 44, 56, 62, 66, 69, 70, 74, 76, 76, 78, 85, 89, 95 and 96 mm; Sta. F 44: 1 specimen, R: 8 mm; Sta. F 43: 5 specimens, R: 58, 62, 62, 71 and 86 mm; Sta. F 47: 1 specimen, R: 75 mm; Sta. I 70: 4 specimens, R: 61, 67, 73 and 82 mm; Sta. I 117: 1 specimen, R: 75 mm; Sta. I 119: 2 specimens, R: 69 and 71 mm; Sta. I 120: 2 specimens, R: 79 and 82 mm; Sta. I 122: 3 specimens, R: 49, 56 and 71 mm; Sta. J 110: 2 specimens, R: 58 and 81 mm; Sta. L 90: 3 specimens, R: 81, 88 and 98 mm; Sta. M86: 2 specimens, R: 61 and 69 mm; Sta. M88: 18 specimens, R: 42, 44, 49, 49, 49, 49, 49, 53, 53, 53, 54, 55, 60, 60, 61, 63, 64 and 116 mm; Sta. N 80: 1 specimen, R: 52 mm; Sta. 5^{x}: 1 specimen, R: 63 mm.

Diagnosis. — Five broad arms. Dorsal paxillae small and numerous. Three regular rows of rectangular, lateral paxillae. Interradial areas with few ventro-lateral plates, which are not fused. Cf. pl. 3 fig. 2.

Description. — Five, fairly broad and long arms are present, R/r ratio, in fully grown individuals, is about 7-8. The dorsal surface of the body is of a blueish-grey colour with the median area of each ray darker than the margins, so that a dark, longitudinal band along the middle of each ray appears to be present; this feature, however, is not always distinct. In dried specimens this band is not visible at all and the colour generally is lighter, paler and more greenish-grey. The ventral surface is white. Along the middle of each arm there is dorsally also a very shallow, longitudinal fasciole, which is slightly deeper in dried specimens.

The rectangular, marginal paxillae are the largest of all. Dorsal to these, three regular rows of lateral paxillae run along the whole length of the arm. The paxillae in the mid-radial row, however, are smaller than the others and interrupt the transverse rows formed by the marginal and the lower lateral paxillae. Dorsal to the lateral paxillae, the paxillae gradually become smaller, more irregularly arranged and more circular. On the mid-radial part of the arm they are quite circular; their size is about 1/7 of that of the marginal paxillae. There are about ten irregular rows of paxillae, dorsal to the lateral ones. The marginal and lateral paxillae bear about 25 identical granules, which are surrounded by a single or double, irregular row of thin marginal spinelets, about as long as the granules. The small, circular paxillae on the mid-radial part of the arm bear about 7 thick granules, usually arranged around one

central granule, which is often slightly thicker. Around these granules there is again an irregular row of very thin marginal spinelets. The paxillae on the disk resemble these dorsal arm paxillae very much; they are a little larger and bear a few more granules.

The madreporite is small, about the size of four of the paxillae that surround it and almost completely overlap it and which give it its irregular shape, because it is squeezed between them.

The broad infero-marginal plates each bear three large lateral spines, about two thirds as long as the width of the plates. Dorsally to these spines there usually is another, smaller spine, about half their size. The dorsal-most lateral spines are surrounded by small, pointed, slightly flattened spines. In some specimens (cf. fig. 2a) on the ventral part of the plates, there is a fourth, similarly shaped, large spine. Its size varies between 1/4 and 5/6 of that of the largest lateral spine. Between the exterior parts of the plates the fasciole is very deep and its ad- and aboral sides are set with numerous, very thin, needle-like spinelets. The ventral part of the plates is set with an irregular row of about nine, slender, flattened spines, about four times as long as wide. Some of these are often longer, up to 1/3 the size of the largest lateral spine. Ad- and aborally to this median row there is usually another irregular row of similarly shaped, but smaller spines. On the ad- and aboral edges of the plates there is a fairly regular row of short, thin marginal spinelets. The ventro-lateral plates (cf. fig. 3) are much less numerous than in *Luidia senegalensis* and have not fused. Aborally to the second infero-marginal plate there is only one ventro-lateral plate between each adambulacral and infero-marginal plate. The spine-pattern is similar to the one on the infero-marginal plates (cf. fig. 2b).

The adambulacral plates (cf. fig. 2c) on their interior part show the same spine-pattern as in *Luidia senegalensis*: two interior, ad- and aborally flattened, keel-shaped spines in a transverse row and exterior to these a longitudinal row of, in- and exteriorly flattened, slightly shorter spines, which are, however, truncated at their tips. On the exterior part, however, the plates bear another two or three smaller, similarly shaped spines, and about three slender, pointed spines on the aboral side. Along the aboral edge of the plates there is an irregular row of thin, marginal spinelets. Marginal spinelets along the adoral edge are only present in the exterior part of the plate, if any are present at all.

Variability. — The lateral paxillae in smaller specimens are oval rather than rectangular and bear fewer granules and marginal spinelets. The number of large lateral spines in some smaller specimens is two, or even only one. In those specimens and in some others the large, pointed spine on the ventral

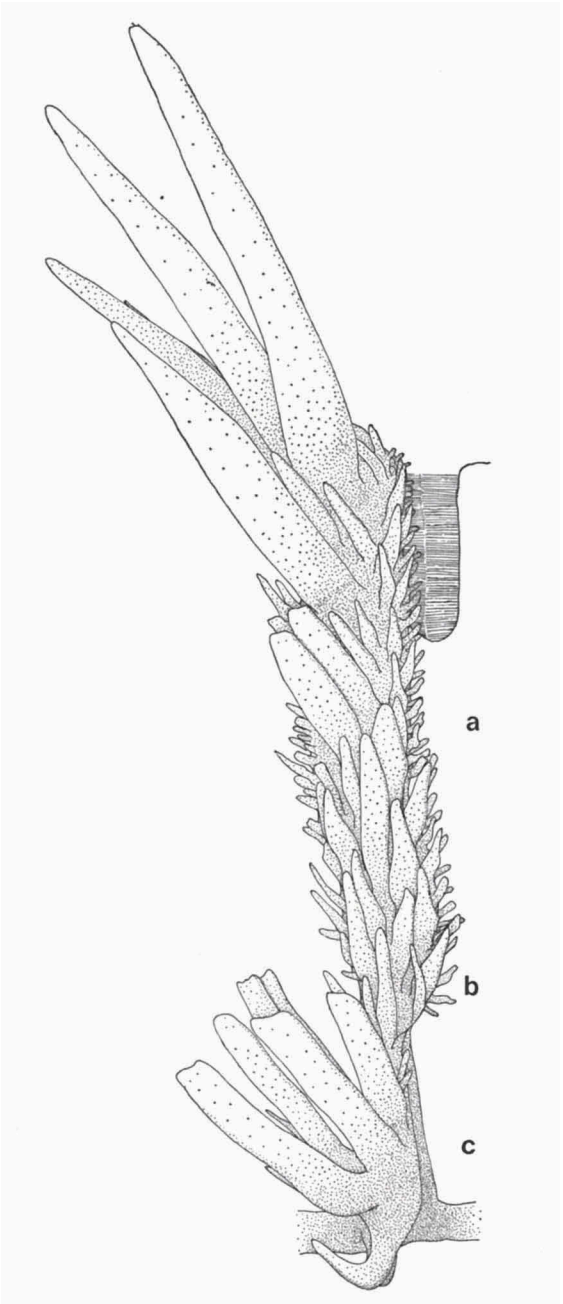


Fig. 2, *Luidia clathrata* (Say), R = 100 mm, a, infero-marginal; b, ventro-lateral and c, adambulacral plates. × 12.

part of the infero-marginal plate is absent. The spines on the ventro-lateral plates are sometimes more slender than those of the infero-marginal plates. There is a little variation in the number of ventro-lateral plates. The size variation is illustrated in fig. 19a.

Distribution (fig. 4). — Atlantic coast of America from Accomac County, Virginia, to Santa Catarina, Brazil; the type locality is the coast of Georgia. Further records are from New Jersey (?); Virginia: Accomac County, Chesapeake Bay; North Carolina: Beaufort, Cape Hatteras; South Carolina:

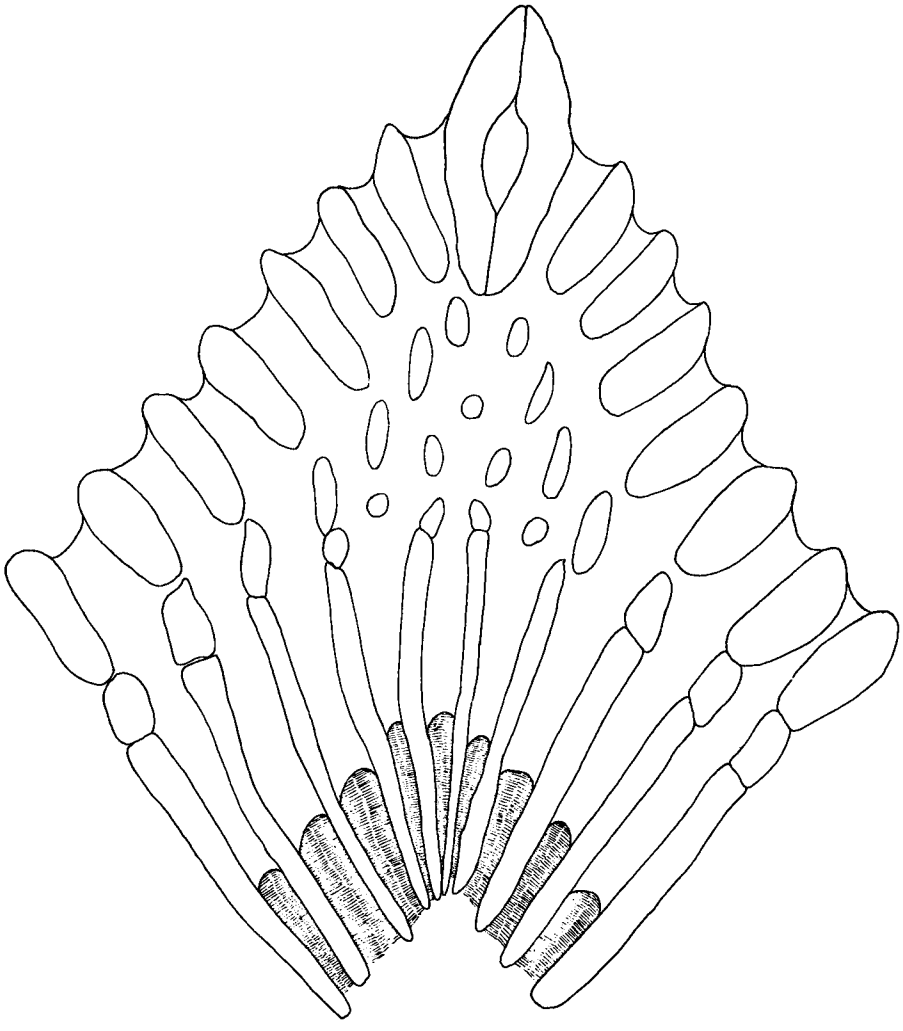


Fig. 3, *Luidia clathrata* (Say), R = 138 mm, ventro-lateral area. × 7.

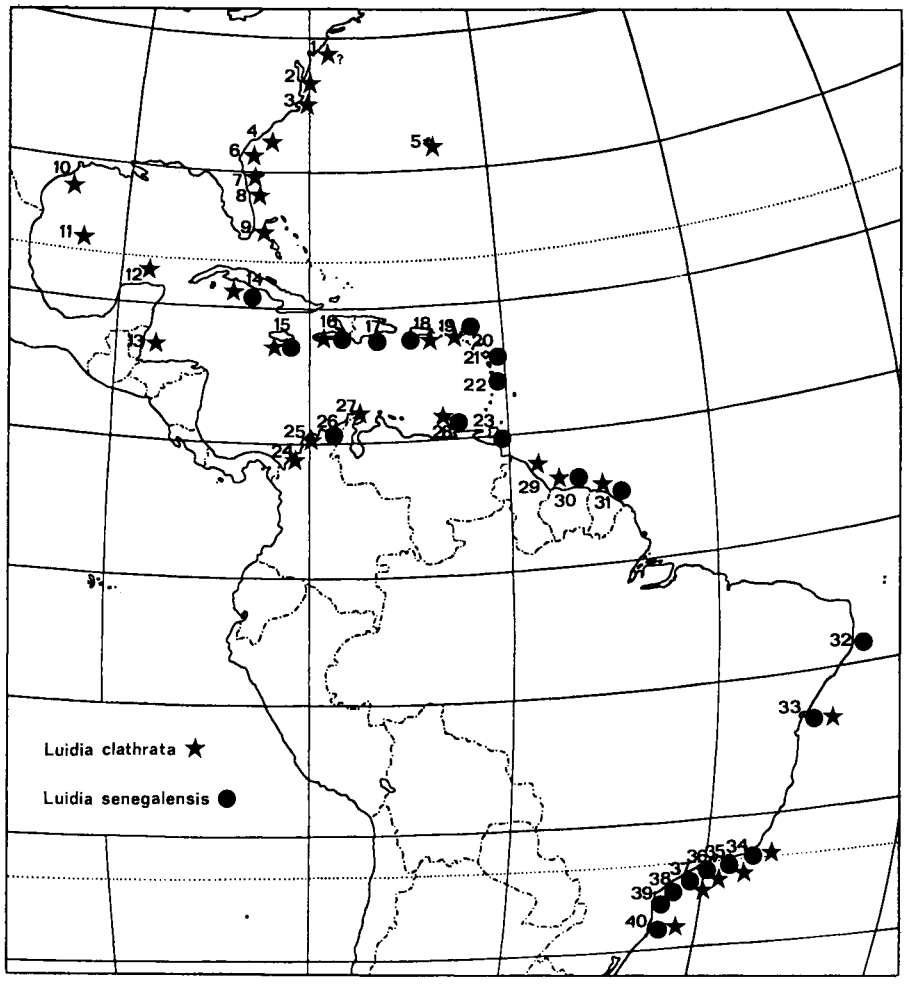


Fig. 4, Distribution of *Luidia clathrata* (Say) and *Luidia senegalensis* (Lamarck). Explanation of the numbers used: 1, New Jersey; 2, Accomac County, Chesapeake Bay, Virginia; 3, Cape Hatteras, Beaufort, North Carolina; 4, Charleston, South Carolina; 5, Bermudas; 6, Georgia; 7, Jacksonville, Florida; 8, Cape Kennedy (Canaveral), Florida; 9, Miami, Florida; 10, Texas; 11, Gulf of Mexico; 12, Jolbos Islands, Yucatan; 13, British Honduras; 14, Cuba; 15, Jamaica; 16, Haiti; 17, Santo Domingo; 18, Puerto Rico; 19, St. Thomas; 20, St. Johns Harbour, Antigua; 21, Guadeloupe; 22, Lesser Antilles; 23, Trinidad; 24, I. Tortuguilla, Colombia; 25, Santa Catalina, Colombia; 26, Riohacha, Colombia; 27, Cabo de la Vela, Colombia; 28, I. Margarita, I. Coche, Venezuela; 29, British Guyana; 30, Surinam; 31, French Guyana; 32, Rio Formoso, Pernambuco, Brazil; 33, Baia de Todos os Santos, Bahia, Brazil; 34, Cabo Frio, Brazil; 35, Rio de Janeiro, Baia de Guanabara, Enseada de Botafogo, Brazil; 36, Mangaratiba, Brazil; 37, Ubatuba, I. de São Sebastião, São Paulo, Santos, Brazil; 38, Cananeia, Parana, Brazil; 39, Morretes, Brazil; 40, Florianopolis, Santa Catarina, Brazil.

Charleston; Bermudas; Georgia; Florida: Jacksonville, Cape Canaveral, Miami; Texas; Gulf of Mexico; Yucatan: Jolbos Islands; British Honduras; Cuba; Jamaica; Haiti; Puerto Rico; St. Thomas; Colombia: I. Tortuguilla, Santa Catalina, Cabo de la Vela; Venezuela: I. de Margarita; British Guyana; Surinam; French Guyana; Brazil: Bahia, Cabo Frio, Rio de Janeiro, Botafogo Bay, Mangaratiba, I. de São Sebastião, São Paulo, Ubatuba and Santa Catarina.

Luidia senegalensis (Lamarck, 1816) (figs. 19b, 4, 5; pl. 1 fig. 4)

Asterias senegalensis Lamarck, 1816: 567.
Luida senegalensis — Müller & Troschel, 1842: 78. — Perrier, 1876a: 262. — Rathbun, 1879: 149. — Sladen, 1889: 246. — Döderlein, 1920: 238. — H. L. Clark, 1933: 20. — Engel, 1939: 3. — Bernasconi, 1943: 5. —Tommasi, 1958: 9; 1970: 8. — Cherbonnier, 1959: 170. — Brito, 1960: 10; 1968: 10. — Engel, Croes & Schroevers, 1960: 5. — Ummels, 1963: 94. — Downey, 1973: 22.
Luidia marcgravii Lütken (Steenstrup in mnscr.), 1859: 43. — Verrill, 1867: 343; 1915: 208. — Boone, 1933: 76. — Bernasconi, 1956: 125. — Brito, 1960a: 66.

Material examined: Thirty specimens from 14 different stations. Sta. A68: 2 specimens, R: 124 and 137 mm; Sta. D30: 3 specimens, R: 40, 86 and 99 mm; Sta. F6: 8 specimens, R: 5, 8, 10, 11, 49, 66, 134 and 152 mm; Sta. F42: 1 specimen, R: 126 mm; Sta. F43: 1 specimen, R: 133 mm; Sta. F44: 2 specimens, R: 9 and 119 mm; Sta. F47: 3 specimens, R: 67, 69 and 71 mm; Sta. I 70: 1 specimen, R: 144 mm; Sta. I 120: 1 specimen, R: 117 mm. Sta. I 121: 1 specimen, R: 103 mm; Sta. I 122: 2 specimens, R: 64 and 80 mm; Sta. M 85: 1 specimen, R: 128 mm; Sta. M 86: 4 specimens, R: 119, 127, 142 and 163 mm; Sta. M88: 1 specimen, R: 163 mm.

Diagnosis. — Nine long and slender arms. Dorsal paxillae small and numerous. Two regular rows of rectangular lateral paxillae. Numerous ventro-lateral plates, which have fused together and connect the first infero-marginal plates with the adambulacral plates. Cf. fig. 5.

Description. — Nine, sometimes eight or seven, long and slender arms are present. The R/r ratio, in fully grown specimens is 7-8.5. The dorsal surface of the body is blueish- or greenish grey; darker and blueish-grey in specimens preserved in alcohol, and lighter, paler and more greenish-grey in dried specimens. The ventral surface is white. On the dorsal surface a dark, longitudinal band runs along the middle of each arm from the centre of the disk to the tip of the arms.

Along the middle of each arm there also is a very shallow, longitudinal fasciole, slightly deeper in dried specimens.

Inwards from the regular row of rectangular supero-marginal paxillae there are two similar, regular rows of rectangular paxillae. These lateral paxillae form, together with the supero-marginal paxillae, regular, transverse rows, which are interrupted by the adjacent adradial paxillae, the 7-9 ir-

regular, longitudinal rows of which become gradually more irregular and the paxillae smaller and more circular. The rectangular supero-marginal and lateral paxillae are set with about 30 short, thick granules. Along the edges of the paxillae there is a very irregular row of thin, marginal spinelets, which, together with the spinelets on the adjacent paxillae, easily overlap the furrows between the paxillae. On the proximal part of the arm the ad- and aboral sides of the rectangular marginal paxillae are longer than the ventral and dorsal sides; in other words the paxillae there are wider than long. In the lateral-most or abradial row the lateral paxillae gradually become narrower near the tip of the arm until they are twice as long as wide. Adradially the paxillae gradually become smaller and more circular until they are about 1/7 the diameter of the lateral paxillae. In that case the paxillae are set with about 8 granules, which often are situated around one central granule. Around these granules there is, along the edge of the paxillae, an irregular row of about 20 thin, marginal spinelets. In each interradial area between the marginal and lateral paxillae, there are about 14 similarly shaped paxillae, perfectly fitting in the transverse rows. The paxillae on the disk are circular and slightly larger than those on the mid-radial part of the arm. They are set with about 10 granules, arranged around one central granule. Surrounding these granules and along the edge of the paxillae, there is an irregular row of about 25, thin, marginal spinelets.

The madreporite is small, about as large as four of the surrounding paxillae. It is very difficult to find, because paxillae almost overlap it. The madreporite, being squeezed between overlapping paxillae, is irregular. On its surface there are many radiating furrows.

The infero-marginal plates bear one irregular row of flattened, often wide, squamiform spines. They are twice as long as wide, sharply pointed or truncate. Adorally, and often also aborally to these spines there is an irregular row of squamiform spines, which are about half as long as the central ones. Along the ab- and adoral edges of the plates there is a single or double, irregular row of thin marginal spinelets, which, together with the rows of spinelets from adjacent plates, overlap the furrows between the plates. Laterally to the exterior-most squamiform spine the plate bears one large lateral spine, which is slender, pointed and almost as long as the infero-marginal plates are wide, or about four times as long as the large squamiform spines. Dorsally to this spine there is a smaller lateral spine, which is also pointed and slender, but its size is only two thirds of that of the large lateral spines. Adorally to this smaller lateral spine, and often dorsally to it, there often is a small, slender, pointed and flattened, squamiform spine. In the lateral part of the furrows, under the marginal spinelets, there are numerous very fine and slender,

needle-like spinelets. The adambulacral plates bear four large spines. The interior two form a transverse row and are flattened on their ad- and aboral sides. They are curved and keel-shaped. The two exterior spines form a longitudinal row and are flattened in the opposite plane. They are not curved, but are also fairly sharply pointed. The ad- and aboral edges of the plates are set with a single or double irregular row of very thin, marginal spinelets.

In each interradial area there are numerous ventro-lateral plates. They have fused together to connect the infero-marginal plates with the adambulacral plates. Inspection of the separate plates is only possible after removal of the ventral half of them. Having done so, it was possible to count the plates and to make a drawing of their configuration (cf. fig. 5). Between the infero-marginal and adambulacral plates, aborally to the seventh infero-marginal plate and towards the tip of the arm, only one ventro-lateral plate is situated. The spine-pattern on the ventro-lateral plates is about the same as that on the infero-marginal plates. The plates lack, of course, the large lateral spines, and the squamiform spines are longer than those on the infero-marginal plates.

Variability. — Two of the specimens investigated have eight arms. There was some variation in size (fig. 19b).

Discussion. — Lamarck (1816) described *Asterias senegalensis* from Senegal (Africa). Müller & Troschel (1842) gave a description of *Luidia senegalensis*, which sea-star they thought to be identical with *Asterias senegalensis* Lamarck from Senegal and with *Stella marina* Marcgrav (1648) from Brazil. Lütken (1859) described a *Luidia* with nine arms from Cotinguiba, Brazil, as *Luidia marcgravii*. Although Lamarck's description of *Asterias senegalensis* fitted his American *Luidia marcgravii* very well, Lütken considered this *Luidia* all the same as a distinct, though related, species for zoogeographical reasons. According to Lütken the description of *Luidia senegalensis* by Müller & Troschel also fitted his specimens from America very well. He was, however, inclined to believe that the drawings were made from a specimen of *Luidia senegalensis* from Senegal, because he noticed certain differences between those drawings and his specimens from Brasil. I noticed the same differences (in the size of the dorsal paxillae and the number of the squamiform spines on the infra-marginal plates) between those drawings and the specimens from Surinam. I think, however, these differences can be attributed to inaccuracies in the drawing. Lütken did not see any specimens from Senegal.

Perrier (1876a) was able to examine Lamarck's specimens, supposedly from Senegal, in the Musée d'Histoire Naturelle and identified these with

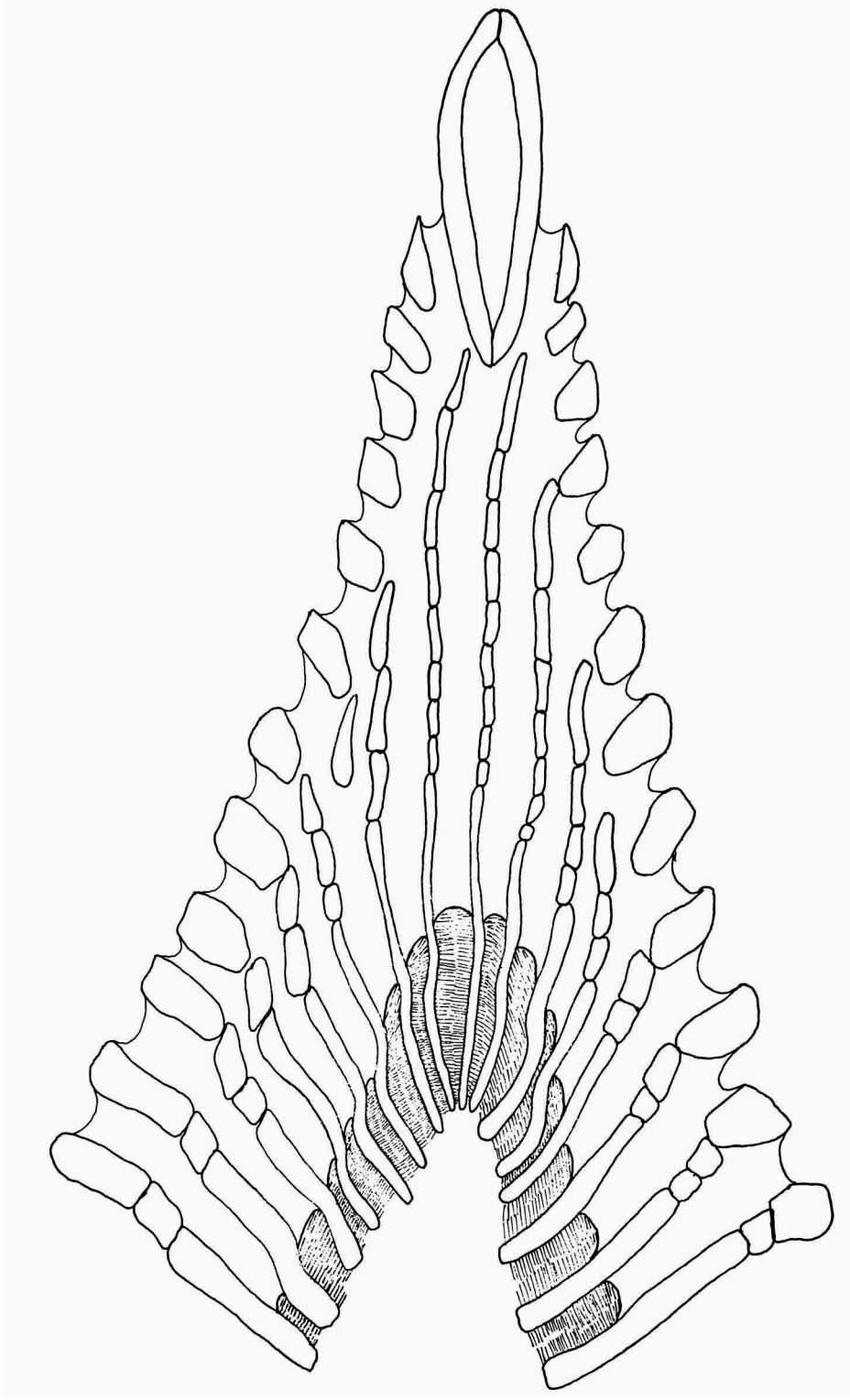


Fig. 5, *Luidia senegalensis* (Lamarck), R = 117 mm, ventro-lateral area. × 12.

the American specimens. Rathbun (1879) and Döderlein (1920) also considered *Luidia marcgravii* to be synonymous with *Luidia senegalensis*.

Bernasconi (1956b) is of the opinion that the description of Lamarck need not be taken into consideration, because it was based on specimens from the Antilles, which were brought to Europe, via Senegal, by Adanson and, by mistake, were ascribed to that locality. She also quotes a map of Prof. J. Cadenat of Institut Français d'Afrique Noire, dated 7-4-1955, in which he claims that this species does not occur off the coasts of Senegal at all. Cherbonnier (1959) compared his specimens from Guadeloupe with those of Lamarck, and did not find any difference at all. Thus, whether or not this *Luidia* occurs off the coasts of Senegal, which seems very unlikely, it is obvious that *Luidia senegalensis* and *Luidia marcgravii* are synonymous and, because *L. senegalensis* is the oldest name, I have identified and described the specimens from Surinam as *Luidia senegalensis* (Lamarck).

Distribution (fig. 4). — Jamaica; Cuba; Santo Domingo; Haiti; Puerto Rico; St. Johns Harbour, Antigua; Guadeloupe; Antilles; Trinidad; Riohacha, Colombia; I. Coche, south of I. Margarita, Venezuela; Surinam; French Guyana; Brazil: Pernambuco, Rio Formoso, Baia de Todos os Santos, Cabo Frio, Rio de Janeiro, Baia de Guanabara, Mangaratiba, Angra dos Reis, I. de São Sebastião, São Paulo, Santos, Ubatuba, Parana, Cananeia, Morretes, Santa Catarina and Florianopolis.

There is strong doubt about its presence off Senegal (Africa).

Luidia alternata (Say, 1825) (figs. 6, 7; pl. 3 fig. 3; pl. 4 fig. 4)

Asterias alternata Say, 1825: 141.
Luidia alternata — Lütken, 1859: 42; 1871: 301. — Verrill, 1867: 343; 1915: 201. — Perrier, 1876a: 254; 1883: 269. — Ludwig, 1882: 9. — Sladen, 1889: 250. — Ives, 1890: 326. — H. L. Clark, 1898: 5; 1919: 71; 1933: 20. — Döderlein & Hartmeyer, 1910: 151. — Koehler, 1912: 5. — Döderlein, 1920: 241, 267. — Bernasconi, 1943: 14. — A. H. Clark, 1954: 375. — Engel, Croes & Schroevers, 1960: 6. — Brito, 1962: 4; 1968: 13. — Ummels, 1963: 97. — Roa, 1967: 278. — Gray, Downey & Cerame-Vivas, 1968: 138. — Tommasi, 1970: 24. — Downey, 1973: 23.
Luidia granulosa — Perrier, 1869: 301.

Material examined: One specimen from station F 47, R: 72 mm; r: 9 mm.

Diagnosis. — Marginal paxillae very small, smaller than lateral paxillae. Lateral paxillae without pedicellariae, with enlarged spines. Ventro-lateral plates with trivalvate pedicellariae. Cf. pl. 3 fig. 3; pl. 4 fig. 4.

Description. — Five, rather long and slender, arms are present. The R/r ratio is 8. The dorsal surface of the body is white; a dark brown pentagon marks the margins of the disk; the corners of the pentagon lie at the bases of the arms; the centre of the disk also is of a dark brown colour. About

five transverse bands of the same colour alternate with the white parts on each arm. These bands are very irregular and often connected by a dorsal, longitudinal band. The dorsal spines, as well as the ventral surface are white.

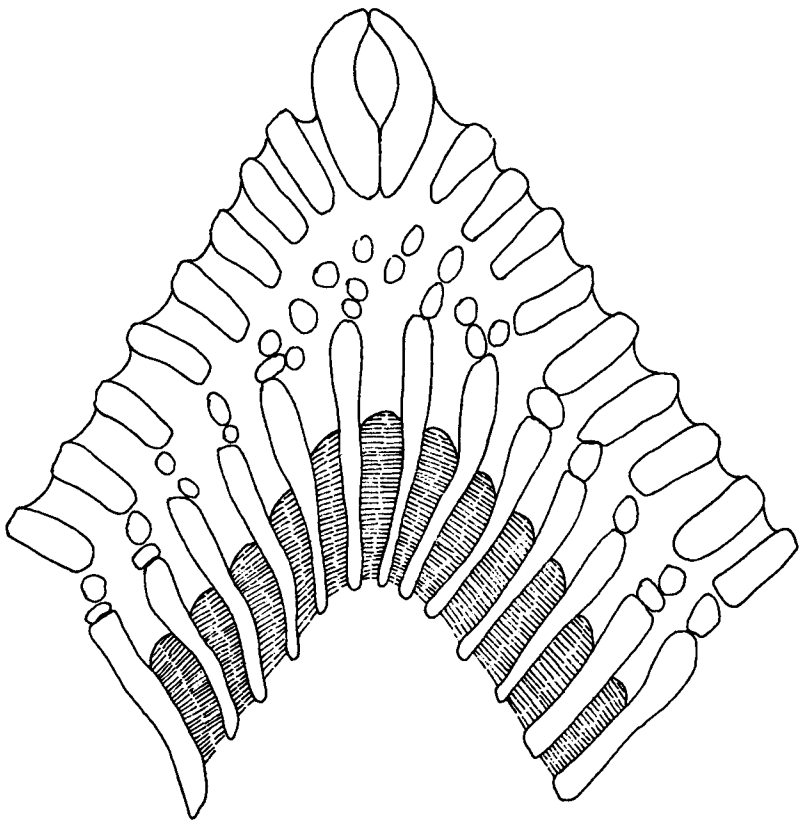


Fig. 6, *Luidia alternata* (Say), Sta. F 47, R = 72 mm, ventro-lateral area. × 12.

The supero-marginal paxillae are small, about half the size of the outer lateral ones and they do not bear any enlarged spines or pedicellariae. Although the lateral paxillae can differ very much in size, they form about four, regular, longitudinal rows. Together with the marginal paxillae they form regular, transverse rows. The outermost lateral paxillae often are enlarged and, in that case, bear a conical, pointed spine on the middle of their tabulum. This spine is about half as long as the largest infero-marginal spines. Many paxillae of the second and third rows and some of the disk paxillae are enlarged and bear a large, pointed, conical spine, about as long as the infero-marginal lateral spines. In the second row the spine-bearing

paxillae are the largest and occur in the greatest number. The spine-bearing paxillae of the fourth row are smaller and less numerous. Dorsally to the lateral paxillae there are about four, irregular rows of smaller, also circular, paxillae, which are, however, usually without an enlarged spine. Every large,

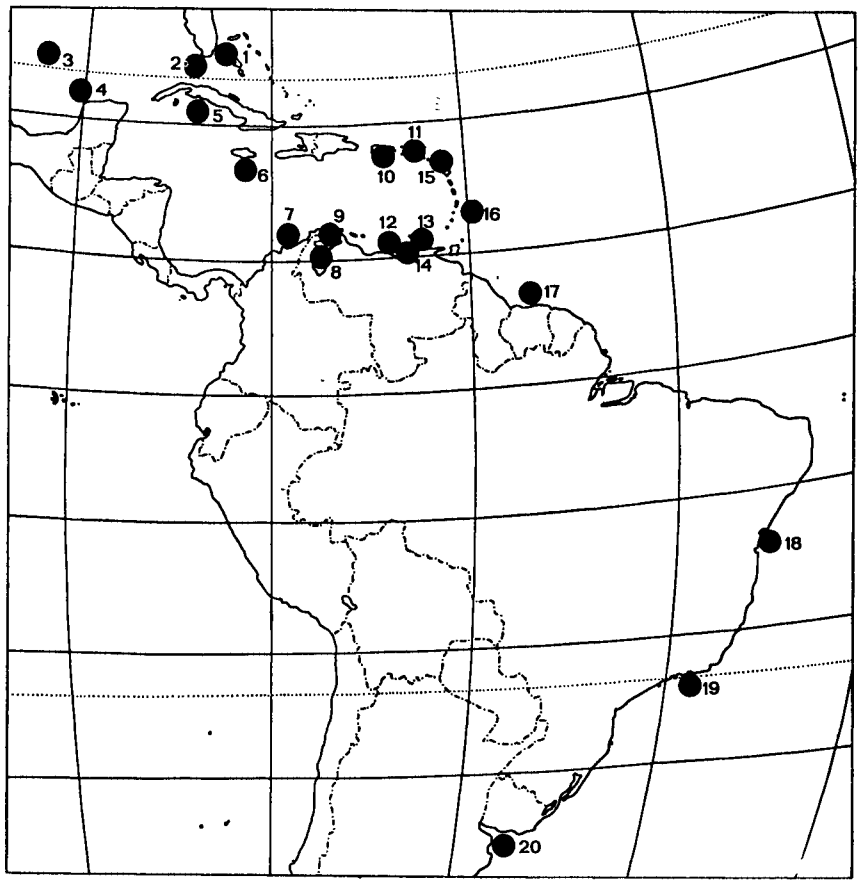


Fig. 7, *Luidia alternata* (Say), distribution along Atlantic coast of South America and in Caribbean. Explanation of numbers used: 1, Miami, Biscayne Bay, Florida; 2, Florida Keys; 3, Gulf of Mexico; 4, Yucatan; 5, Cuba; 6, Jamaica; 7, Riohacha, Guajira, Colombia; 8, Zulia, Venezuela; 9, Golfo de Venezuela; 10, Puerto Rico; 11, St. Thomas; 12 Isla la Tortuga; 13, Nueva Esparta; 14, Isla Coche and Quetepe, Golfo de Cariaco; Sucre; 15, Montserrat; 16, Lesser Antilles; 17, Surinam; 18, Bahia, Brazil; 19, Baia de Sepetiba; 20, Buenos Aires, Argentina.

spine-bearing paxilla of the disk is usually surrounded by smaller paxillae without such enlarged spines. The small paxillae on the disk and the dorsal surface of the arm are set with 1-3 central spinelets and one or two irregular

rows of, similarly shaped, marginal spinelets, about 15-20 in number. All paxillar spinelets are slender, rod-shaped or slightly thickened at their tips.

The madreporite is small, about as big as 3-4 surrounding paxillae. It is squeezed between the marginal and lower lateral paxillae, which overlap and almost completely hide it.

Over the whole breadth of each infero-marginal plate runs a transverse row of about five long, conical, pointed spines, which, very irregularly, increase in size in such a way that the exterior-most usually is the largest. This exterior lateral spine, however, is often smaller than the second; sometimes its size is only a fourth of that of the second spine. Between and around these large spines there are several smaller, slender, rod-shaped spines. The ad- and aboral edges of the plates are bordered by an irregular row of slender, marginal spinelets. In the furrows between the exterior parts of the plates there are many very small and slender, needle-like spinelets. Between all infero-marginal and adambulacral plates there is one small paxilliform ventro-lateral plate. In the proximal two fifths of the arm this ventro-lateral plate is accompanied by a larger, second one, which bears a high, trivalvate pedicellaria with sharply pointed jaws.

In the interradial areas (cf. fig. 6) the ventro-lateral plates are arranged in three very irregular "rows" and also bear similar pedicellariae.

The adambulacral plates are set with a transverse series of three spines: one large, curved, ad- and aborally flattened, inner (furrow) spine; one, slightly curved spine, which is the largest of all, and one exterior spine, which is straight, conical and not flattened at all. These three spines are situated on the aboral half of the plate. Adorally to the exterior spine there is a fourth, usually smaller spine. Exteriorly to the large spines there are usually several very small and slender spines. The largest of these small spines is always situated exteriorly and a little adorally to the large adoral spine.

Distribution (fig. 7). — Atlantic coast of America from the United States to Buenos Aires, Argentina; type locality: Florida Keys. Further records are from north of Florida; Florida: Jacksonville, Biscayne Bay, Miami, Florida Keys; Gulf of Mexico; Veracruz; Cuba; Jamaica; Puerto Rico; Yucatan, Jolbos Islands; Columbia: Riohacha, Guajira; Venezuela: Zulia, Golfo de Venezuela, Isla la Tortuga, Nueva Esparta, Isla Coche, Golfo de Cariaco, Quetepe, Sucre; St. Thomas; Montserrat; Lesser Antilles; Surinam; Brazil: Bahia, Baia de Sepetiba; Buenos Aires, Argentina.

Luidia ludwigi Fisher, 1906 (figs. 8b, 9, 10; pl. 2 figs. 1, 2, 4; pl. 4 fig. 3)

Luidia ludwigi Fisher, 1906: 122; 1911: 113.
Luidia rosaurae — John & A. M. Clark, 1954: 142.

Material examined: Twenty specimens from 15 different stations. Sta. A10: 1 specimen, R: 25 mm; Sta. A25: 1 specimen, R: 54 mm; Sta. B2: 1 specimen, R: 53 mm; Sta. C21: 1 specimen, R: 23 mm; Sta. F43: 1 specimen, R: 18 mm; Sta. I117: 5 specimens, R: 42, 52, 56, 56 and 66 mm; Sta. I119: 1 specimen, R: 50 mm; Sta. J112: 1 specimen, R: 89 mm; Sta. J113a: 1 specimen, R: 51 mm; Sta. K101: 1 specimen, R: 19 mm; Sta. M86: 1 specimen, R: 23 mm; Sta. M88: 1 specimen, R: 67 mm; Sta. M89: 1 specimen, R: 38 mm; Sta. M97: 2 specimens, R: 58 and 89 mm; Sta. M98: 1 specimen, R: 19 mm.

Diagnosis (after Fisher). — Rays five. R/r ratio about 8. Rays slender, very gradually tapering to a pointed extremity; dorsal surface well arched; sides of ray rounded; dorsal area with three or four series of quadrate paxillae on each side. Supero-marginal paxillae with small, two or three-jawed pedicellariae. Infero-marginal plates fairly narrow, arched, with one to three, usually two, lateral spines, and three to six ventral spinules, larger than spinelets of general surface, and on upper end a pedicellaria similar to that of adjacent paxillae. Ventro-lateral plates of interradial area and proximal half of ray each with a rather prominent, three-jawed pedicellaria. Adambulacral plates with curved furrow spine, three ventral spines, and one or two smaller spinules. Cf. pl. 2 figs. 1, 2, 4; pl. 4 fig. 3.

Description. — Five rather long and slender arms are present. The R/r ratio in the largest specimens is about 8. The colour-patterns of the dorsal surface of the body varies very much in the various specimens. Some specimens are dirty whitish, except for some darker spots on the arms; others are dark brown with only a few whitish spots on the sides of the arms. In the majority of the specimens the arms are more or less regularly banded with alternating whitish and dark brown bands. In most of the examined specimens a dark brown band runs dorsally along the whole length of the arm, from the centre of the disk to the end of the arm. In the specimens with a lighter colour this band is hardly noticeable or absent. The ventral surface of the body is (dirty) white. All specimens are preserved in alcohol.

On the dorsal surface of the body about four regular rows of oval lateral paxillae run along both sides of the arm. The dorsal lateral paxillae are smaller and more circular than the lower ones. Together with the marginal paxillae, which are slightly smaller, the lateral paxillae form regular, transverse rows. Dorsally to the lateral paxillae there are 6-8 very irregular rows of smaller, circular, dorsal paxillae. The central spinelets usually are larger than the marginal ones. The marginal paxillae often bear one, or sometimes two, bivalved pedicellaria, placed at the margin of the tabulum. The larger paxillae bear 5-10 thick, pointed, central spinelets, surrounded by a single or double row of smaller, thin, marginal spinelets. The smaller dorsal paxillae bear about four larger central spinelets and usually only one irregular row

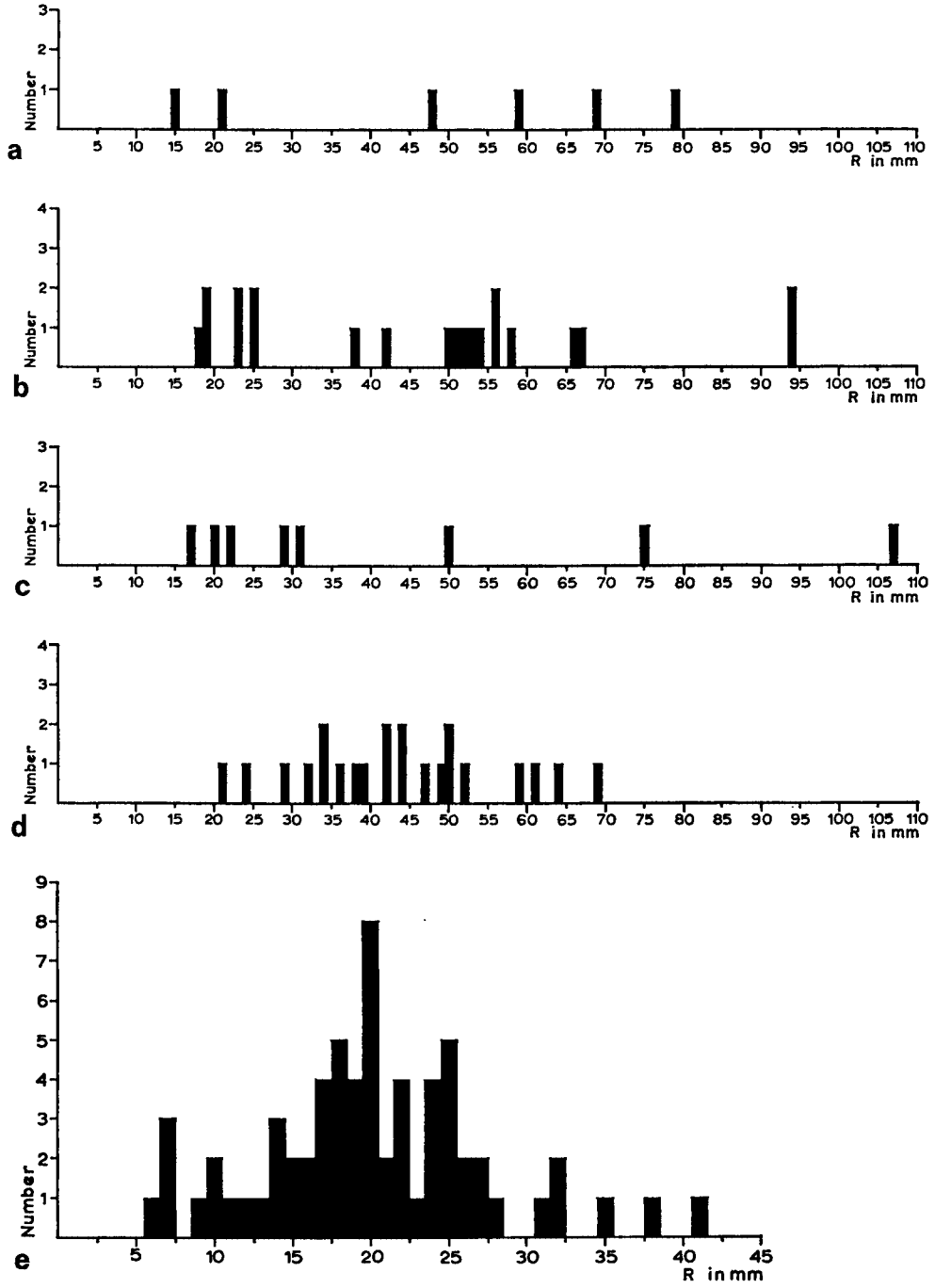


Fig. 8, Size variation of: a, *Goniaster tessellatus* (Lamarck); b, *Luidia ludwigi* Fisher; c, *Anthenoides peircei* Perrier; d, *Narcissia trigonaria* Sladen, and e, *Echinaster brasiliensis* Müller & Troschel. All specimens studied have been measured.

of marginal spinelets. In the interradial areas the lowest lateral paxillae usually broaden considerably.

The small madreporite is completely hidden by the lower lateral paxillae. It usually has the size of two or three paxillae. It is oval with radiating furrows on its surface. In some specimens the madreporite is larger, being as large as five of the covering paxillae between which it is squeezed in.

The infero-marginal plates are set with a transverse row of about seven long, conical, pointed spines, increasing in size towards the edge of the arm. Two large lateral spines form a fringe around the arms. The dorsal lateral spine is smaller than the second. Under the largest lateral spine there is a bivalvate pedicellaria, placed on the aboral half of the plate. Ad- and aborally to the larger infero-marginal spines some smaller and thinner spines are situated. Small and thin marginal spinelets fringe the dorsal and the ad- and aboral edges of the plates. These spinelets form a double row in the dorsalmost part of the plates. This part, above the lateral spines, greatly resembles the marginal paxillae, and usually also bears a bivalvate pedicellaria. In some specimens the ventral surface of the plates, particularly in the arm corners, is set with several pedicellariae. In the deep furrows between the exterior parts of the plates are many very thin, needle-like spinelets. Between each infero-marginal and adambulacral plate one ventro-lateral plate is situated. This ventro-lateral plate, in the proximal part of the arm, but occasionally as far as four fifths of the arm, bears a 3-4 valvate pedicellaria. In the distal part of the arm the small ventro-lateral plate is set with some very thin spinelets.

In the interradial areas (cf. pl. 4 fig. 3; fig. 9) there are a few more plates, also with 3-4 valvate pedicellariae, and one or two smaller plates with some thin spines.

The adambulacral plates bear an interior, transverse row of two long, curved, ad- and aborally flattened spines and exteriorly to it a longitudinal row of two straight conical spines, which are slightly smaller. Exteriorly to these four adambulacral spines there are two smaller spines and some slender spinelets.

Variability. — In some specimens there is only a single, lateral spine instead of two; in some others marginal plates with one or two lateral spines occur. The size of the more dorsal lateral spine may vary greatly, even in one specimen. A few specimens, usually the smaller ones, lack dorsal pedicellariae. Most specimens have pedicellariae on both the supero- and the infero-marginal paxillae. In some specimens a few lateral paxillae also bear pedicellariae while in some others only the infero-marginal "paxillae" bear one. The number of the ventro-lateral plates bearing a pedicellaria varies between

0, in the smallest specimens, and 45, in the largest. The number of pedicellariae on the ventral side of the infero-marginal plates varies, usually even in a single specimen, between 0 and 4, and is not related to body size, although the majority of the smaller specimens lack those pedicellariae. There is some

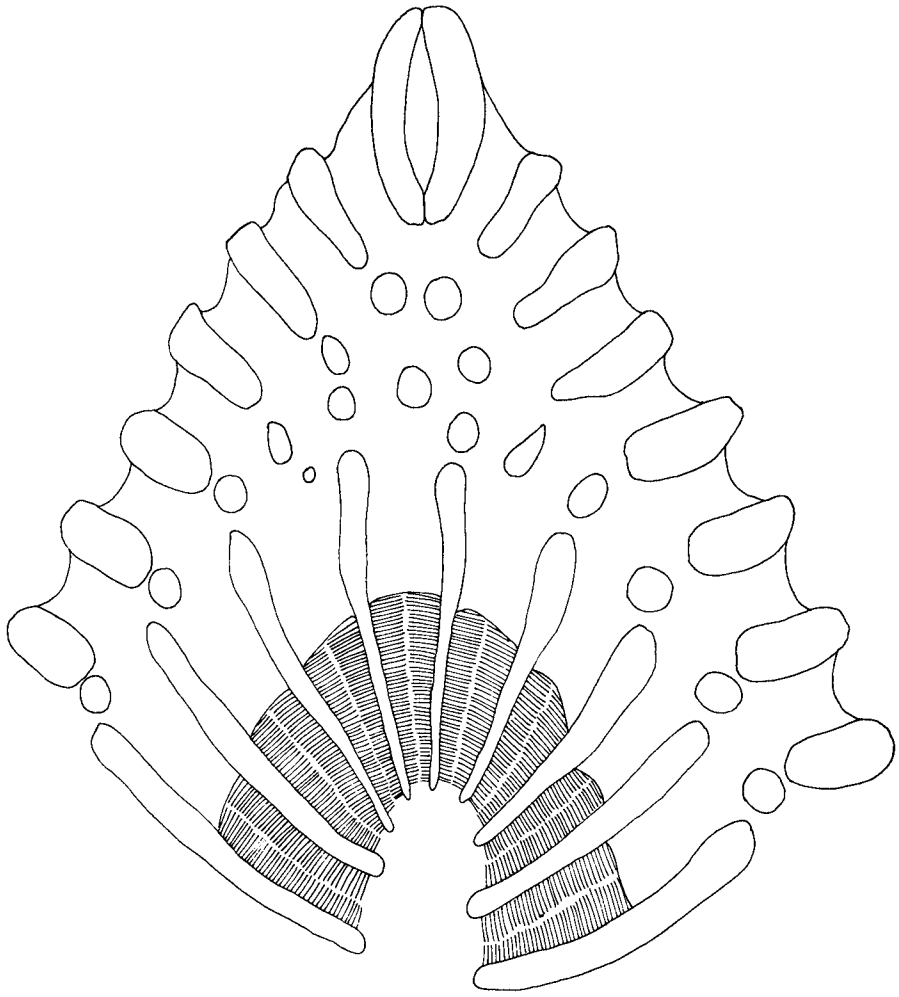


Fig. 9, *Luidia ludwigi* Fisher, ventro-lateral area, × 25.

variation in the thickness of the ventral infero-marginal spines. The variation in colour is mentioned in the description (cf. pl. 2 figs. 1, 2, 4). The size variation is illustrated in fig. 8b.

Discussion. — The presence of only one large lateral spine being the only

difference between *Luidia ludwigi* and *Luidia rosaurae,* and this being a variable feature, I am inclined to believe that these two species are synonymous. I do not believe that *Luidia scotti,* which is closely related to *Luidia ludwigi,* is synonymous with *Luidia doellojuradoi* Bernasconi (1941a: 117) as A. M. Clark (1953) suggests, because in *Luidia doellojuradoi* the lateral paxillae are smaller than the marginal ones and the R/r ratio is only 7. Without additional material I am unable to conclude whether or not *Luidia scotti* Bell (1917: 8) is synonymous with *Luidia ludwigi. Luidia armata* Ludwig (1905: 85) lacks the ventro-lateral plates in the arms so I think we can exclude this species from a possible synonymy with *Luidia ludwigi.*

Fig. 10, *Luidia ludwigi* Fisher, geographical distribution. Explanation of numbers used; 1, Santa Barbara, Santa Rosa; 2, Monterey Bay; 3, Surinam; 4, off Rio Orinoco.

Distribution (fig. 10). — Both sides of South and Central America; type locality: Albatross station 2970, in the vicinity of Santa Barbara Island, California. Also known from Monterey Bay, California. Further records are from Santa Barbara, Santa Rosa, San Pedro. South American records are from off Rio Orinoco and Surinam.

Astropecten riensis Döderlein, 1917 (figs. 11, 15; pl. 5 figs. 1-3)

Astropecten brasiliensis riensis Döderlein, 1917: 84. Bernasconi, 1956: 129; 1964a: 44. *Astropecten armatus riensis* — Tommasi, 1958: 13. — Brito, 1960: 9; 1968: 8.

Material examined: 104 specimens from 30 different stations off the Surinam coast. Sta. A9: 2 specimens, R: 13 and 24 mm; Sta. A10: 1 specimen, R: 30 mm; Sta. A15:

2 specimens, R: 35 and 39 mm; Sta. A25: 1 specimen, R: 30 mm; Sta. A27: 1 specimen, R: 15 mm; Sta. A68: 3 specimens, R: 6, 24 and 24 mm; Sta. B22: 1 specimen, R: 11 mm; Sta. B24: 8 specimens, R: 13, 13, 14, 16, 17, 17, 18 and 32 mm; Sta. C18: 1 specimen, R: 12 mm; Sta. D31: 1 specimen, R: 31 mm; Sta. E62: 3 specimens, R: 11, 17, 28 mm; Sta. F6: 20 specimens, R: 10, 11, 12, 13, 13, 14, 14, 16, 16, 18, 19, 19, 20, 22, 22, 25, 26, 28, 37 and 39 mm; Sta. F43: 5 specimens, R: 11, 19, 24, 27, and 37 mm; Sta. F44: 3 specimens, R: 26, 36 and 37 mm; Sta. F47: 1 specimen, R: 24 mm; Sta. H51: 3 specimens, R: 23, 35 and 39 mm; Sta. I70: 4 specimens, R: 17, 21, 23 and 27 mm; Sta. I115: 1 specimen, R: 16 mm; Sta. I116: 3 specimens, R: 21, 25 and 33 mm; Sta. I117: 1 specimen, R: 17 mm; Sta. I121: 1 specimen, R: 34 mm; Sta. J110: 3 specimens, R: 9, 16, 27 mm; Sta. J111: 1 specimen, R: 30 mm; Sta. K102: 4 specimens, R: 24, 25, 27, and 32 mm; Sta. K103: 1 specimen, R: 26 mm; Sta. K104: 6 specimens, R: 17, 26, 29, 30, 31, and 35 mm; Sta. L90: 8 specimens, R: 10, 11, 11, 14, 16, 18, 28 and 40 mm; Sta. M73: 9 specimens, R: 3, 5.5, 6, 17, 18, 19, 19.5, 22, and 38 mm; Sta. M86: 4 specimens, R: 15, 15, 25, and 35 mm; Sta. M88: 2 specimens, R: 22 and 34 mm.

Diagnosis. — Second row of adambulacral spines composed of three spines: one large spine in the middle and ab- and adorally one smaller spine. Only first supero-marginal plates bear an interor spine. Cf. pl. 5 figs. 1-3.

Description. — Arms rather long and slender, they are, however, relatively shorter than those of *Astropecten brasiliensis*. R/r ratio 3.5-4.5.

The paxillar area is, at the fifth supero-marginal plate, about as broad as two thirds of the whole arm width. Three "rows" of paxillae correspond to one supero-marginal plate. The paxillae are crowned with about ten spinelets: usually one or two central spinelets and about nine around them. The paxillar spinelets are all of equal size, and not, or only a little, thickened at their tips.

The madreporite is smaller than two marginal plates; it bears papillae, and paxillae overlap it almost entirely.

The supero-marginal plates are narrow and high, not to such an extent, however, as in *Astropecten brasiliensis*. They are covered with short spinelets, which become replaced, at the ad- and aboral sides of the plates and in the furrows between the plates, by very fine and slender spinelets. Around the large interior spine on the first plate the spinelets are slightly larger. The first plates bear one large, strong and pointed spine, separated from the inner edge of the plate by only one row of spinelets. From the second up to the last plate all bear one exterior spine, slightly smaller than the interior spines. The number of marginal plates varies with the size. At R = 37 mm there are about 28 plates at each side of the arm.

The infero-marginal plates are covered with short, flattened spines. On the ab- and adoral edges and in the furrows between the plates there are very fine and slender spinelets. On the aboral side of the plate there is a transverse row of strong, pointed spines, of which the exterior is the largest. On the adoral side is also a row of spines, smaller than on the aboral side and much decreasing in size towards the end of the arm. Exterior to these two rows

of spines are two large lateral spines, about as long as the infero-marginal plates. The adoral lateral spine is only a bit smaller than the aboral one. There is often a third lateral spine adoral to, or slightly above, the adoral large lateral spine. It is much thinner than the others and its size varies between a quarter to a half of that of the aboral spines.

In each interradial area there are six to eight (usually six) ventro-lateral plates placed in one row and covered with slender spines.

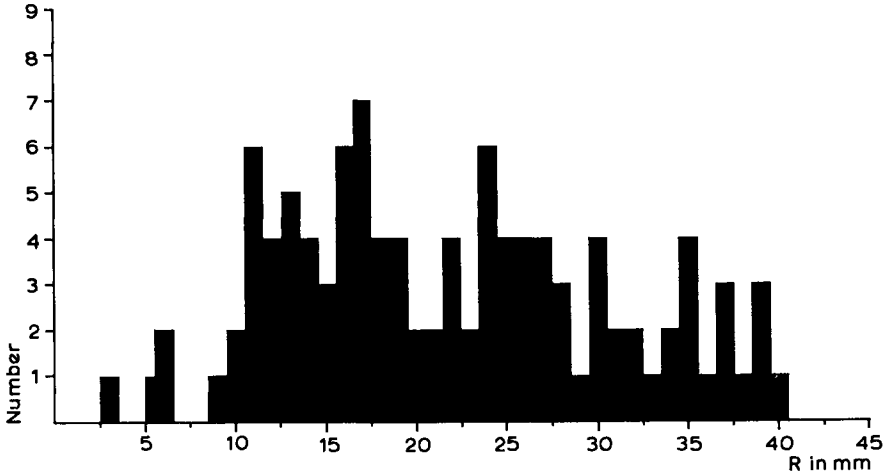


Fig. 11, *Astropecten riensis* Döderlein, size variation of the specimens studied.

The adambulacral plates bear two rows of three spines. In each row the median spine is the largest. This large spine in the inner row is keel-shaped and pointed. In the outer row it is strong, a little flattened and not so sharply pointed.

Variability. — The spine-pattern of the supero-marginal plates varies considerably.

a. Spine-pattern of the first supero-marginal plates: In one specimen the interior spine on the plate is absent, or is only very small. In one specimen the plate bears an interior and an exterior spine.
b. Spine-pattern of the second supero-marginal plate: In 41 specimens the second supero-marginal plate bears no exterior spine. In 23 specimens the plate bears no exterior spine or has a small one. In 10 specimens the spine on the second supero-marginal plate is situated between interior and exterior edges. In 2 specimens the plate bears an interior and an exterior spine. Three specimens show a gradual transition from interior to exterior spines. One specimen (F_{43}, R = 28 mm) has a

fairly irregular spine-pattern on its second supero-marginal plates: most plates bear or lack an interor spine; one plate has an exterior spine and one plate has both an exterior and an interior spine.

c. Spine-pattern of the third supero-marginal plate: In six specimens the third supero-marginal plate bears no exterior spine. In 19 specimens the plate bears no exterior spine or has a small one.

Only 7 specimens enterily fit the description given above.

The size of the adoral row of spines on the infero-marginal plates varies from one quarter to three fourths of the size of the aboral spines. The number of the ventro-lateral plates is six in the majority of the specimens; there are 20 specimens with eight, and six specimens with seven ventro-lateral plates.

The variation in size is shown in fig. 11.

Distribution (fig. 15). — Rio de Janeiro, Baia de Guanabara, Iha d'Agua, São Sebastião, São Paulo, Mar del Plata. Surinam, therefore, is the most northerly locality known at present.

Astropecten brasiliensis Müller & Troschel, 1842

(figs. 12, 15; pl. 5 fig. 4, pl. 6 fig. 3)

Astropecten brasiliensis Müller & Troschel, 1842: 68. — Sladen, 1889: 198.
Astropecten braziliensis — Verrill, 1915: 173.
Astropecten brasiliensis brasiliensis — Döderlein, 1917: 83. — Bernasconi, 1956: 127; 1964a: 44.
Astropecten brasiliensis armatus — John, 1948: 503.
Astropecten armatus brasiliensis — Tortonese, 1956: 326. — Tommasi, 1958: 12. — Brito, 1960: 8; 1960a: 66; 1968: 7.

Material examined: One specimen from the coast of Surinam (Station B17, R: 105 mm). Four specimens from Riohacha, Goajira, Chazalie Expedition, Station 53; R: 60, 63, 73 and 74 mm, I. T. Z., Amsterdam.

Diagnosis. — One small spine adoral to the large furrow-spine in the second row. Several supero-marginal plates bear an interior spine. The ventro-lateral plates are placed in only one row. The aboral row of spines on the infero-marginal plates is always well developed. Cf. pl. 5 fig. 4; pl. 6 fig. 3.

Description. — Arms long and slender; R/r = 105/17.

At the fifth supero-marginal plate the paxillar-area is only slightly narrower than two thirds of the whole arm width. At each plate there are about three transverse "rows" of paxillae. The paxillae are generally crowned with ten to twenty spinelets, which often form an interior and exterior circle. The paxillar spinelets are of equal size and none is obviously thickened at the end.

The madreporite is smaller than two marginal plates and has few papillae on its surface; paxillae overlap its edge.

The supero-marginal plates are very narrow and high. They are covered with short, thick and slightly flattened spinelets. These spinelets are, at the sides of the plates and in the furrows between them, replaced by very fine and slender spinelets. The first plates bear one or two strong interior spines.

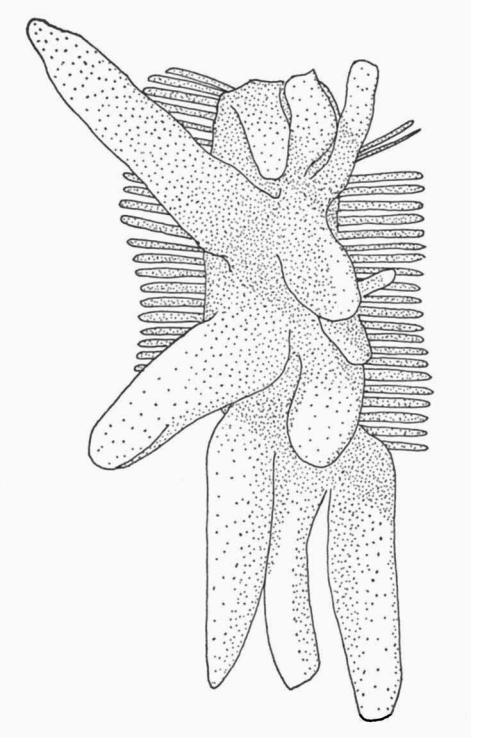


Fig. 12, *Astropecten brasiliensis* Müller & Troschel, Sta. B 17, R = 105 mm, fourth adambulacral plate. × 18.

The second up to the ninth or tenth plate bear one interior spine each, only a little smaller than that of the first plate, and also sharply pointed. From the tenth plate onwards there is also a smaller, exterior spine. On the distal half of the arm the picture becomes rather indefinite: either the interior or the exterior spine is absent. At the distal third of the arm they both have disappeared. There are about 53 supero-marginal plates on each side of the arm.

The infero-marginal plates are as in *A. riensis*. On the aboral side of these plates there is a row of long, pointed spines (about two thirds the length of the plate), of which the exterior is the largest. Exterior to this spine is the

large lateral spine, which has the length of one and a half plate. Adoral to the large lateral spine, or sometimes slightly above that spine, there is a smaller spine, only slightly longer than half the large lateral spine.

In each interradial area there are eleven or twelve ventro-lateral plates, arranged in one row and set with slender spines, of which one is distinctly larger than the others.

The adambulacral plates (cf. fig. 12) bear generally four rows of spines. The interior three spines are pointed and flattened; the median is the largest and keel-shaped. The second row consists of two or three spines: one adoral spine which is very large and flattened and one or two smaller aboral spines. The third row consists of about four spines, which become smaller and more interior towards the aboral side of the plate. The fourth row consists of about four small, slender and hardly flattened spines.

The four specimens from I. T. Z., Amsterdam, show a slightly different structure. The R/r ratios are: 74/17, 73/17, 63/13 and 60/13. The first 8-19 supero-marginal plates bear one large interior spine, which decreases in size towards the distal end of the arm. From the 2nd - 5th plate to the end of the arm there is a small exterior spine, which also decreases in size towards the end of the arm. The first 4-5 infero-marginal plates sometimes lack the small adoral lateral spine. In these specimens this spine is a little less than half as long as the large lateral spine and much thinner.

Discussion. — Because of their great variability and the great mutual resemblance, Döderlein (1917), considered *Astropecten armatus, A. brasiliensis, A. peruvianus, A. erinaceus* from America and *A. kochianus* from Japan to be conspecific. He used the specific name *A. brasiliensis*, believing this to be the oldest name, and distinguished the subspecies *A. brasiliensis riensis*, described by himself.

Later workers, as e.g., Boone (1933) and A. H. Clark (1940) did not agree with Döderlein, and distinguished between the above mentioned species. Tortonese (1956) assumed that *A. armatus, A. brasiliensis, A. erinaceus* and *A. peruvianus* are conspecific. In his opinion Döderlein did not define the position of *A.b. riensis* adequately and he therefore dropped this subspecies. He also argued that the oldest name is not *A. brasiliensis* Müller & Troschel, 1842, but *A. armatus* Gray, 1840. For zoogeographical reasons, Tortonese did not agree with Döderlein on the species *A. kochianus* and he considered this Japanese *Astropecten* to be an indepent, though related species.

In my opinion *A. riensis* is adequately distinguished at the specific level by the spine pattern of the supero-marginal plates and by the second row of adambulacral spines, a view shared by other investigators as Bernasconi (1956) and Tommasi (1958).

Because of their distributional patterns (cf. fig. 15) and their clear morphological differences — nothing is known of reproductive isolation — I consider *A. riensis* and *A. brasiliensis* to be independent species. Lack of material forces me to leave *A. peruvianus, A. erinaceus, A. armatus* and *A. kochianus* out of consideration.

Distribution (fig. 15). — Type locality: Brazil. North- and east coast of South America: I. de Tortuguilla, Cabo de la Vela, St. Vincent, Fernando Noronha, Bahia, I. de Trinidade, Rio de Janeiro, Baia de Guanabara, Angra dos Reis, São Sebastião, São Paulo, Santa Catarina, Rio Grande do Sul, Buenos Aires, Mar del Plata and Quequén. Its presence in Surinam waters fits very well in this distributional pattern.

Astropecten marginatus Gray, 1840 (figs. 13, 14a, b, 15; pl. 3 fig. 1)

Astropecten marginatus Gray, 1840: 181. — Müller & Troschel, 1842: 75. — Döderlein, 1917: 108, 174. — Tortonese, 1956: 320. — Bernasconi, 1955: 67. — Tommasi, 1958: 14. — Brito, 1960: 8; 1960a: 66; 1968: 7. — Tommasi, 1970: 5. — Downey, 1973: 29.

Material examined: 502 specimens from 12 different stations off the Surinam coast. Sta. A14: 1 specimen, R: 30 mm; Sta. E60: 72 specimens, R: 9-52 mm; Sta. F6: 1 specimen, R: 9 mm; Sta. F47: 2 specimens, R: 61 and 67 mm; Sta. H57: 1 specimen, R: 10 mm; Sta. 176; 152 specimens, R: 21-55 mm; Sta. K105: 1 specimen, R: 37 mm; Sta. L87: 188 specimens, R: 21-55 mm; Sta. M72: 9 specimens, R: 17-52 mm; Sta. M81: 33 specimens, R: 40-72 mm; Sta. M85: 29 specimens, R: 22-57 mm; M97: 3 specimens, R: 7, 11, 15 mm.

Diagnosis. — Infero-marginal plates protruding beyond supero-marginal plates and independently forming edge of arm. Body strongly flattened; arms petaloid. Cf. pl. 3 fig. 1.

Description. — The body is strongly flattened. The arms are petaloid, sharply pointed and rather short (R/r = 3.5-4).

The paxillar area is, at the fifth supero-marginal plate, slightly narrower than two thirds of the arm width. There are, at this plate, three transverse rows of paxillae (in smaller specimens, R ± 30 mm, two to three rows are present). The paxillae bear about twenty spinelets: one central spinelet and two circles of spinelets arranged around it; the inner circle consists of about six spinelets, the outer circle of about thirteen spinelets. In the smaller specimens there is no distinct central spinelet and the total number of spinelets is smaller. The paxillar spinelets are short and thick, those of the outer circle thinner than those of the inner circle.

Madreporite large, diameter larger than surface of three supero-marginal plates; the paxillae hardly overlap its edge. The madreporite has many radiating furrows and is separated from the supero-marginal plates by only two rows of paxillae.

The supero-marginal plates are narrow and very low. They are covered

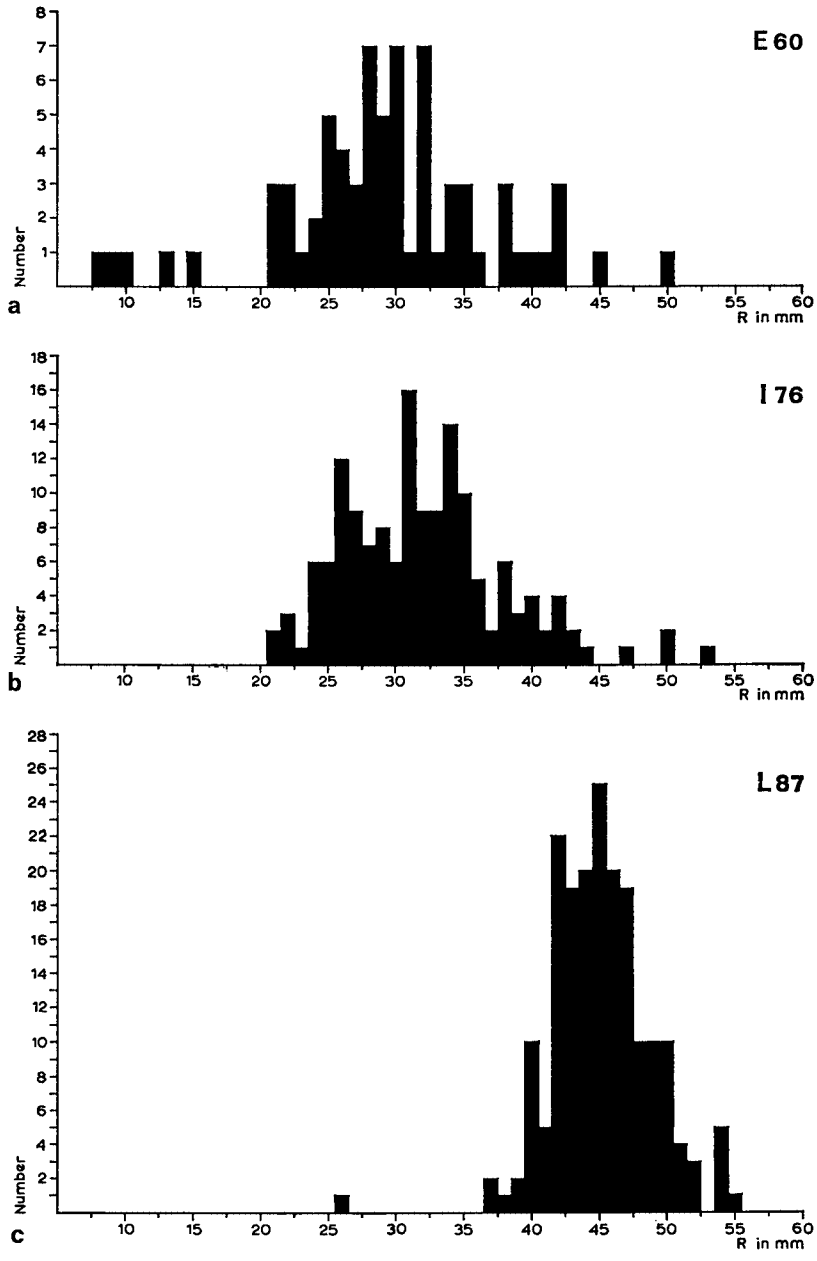


Fig. 13, *Astropecten marginatus* Gray, size variation. a, at Sta. E 60; b, at Sta. I 76; c, at Sta. L 87.

with short, thick granules, which become thinner at the ad- and aboral edges of the plates. In the fascioles between the plates there are very thin and fine, needle-like spinelets. The plates are absolutely spineless.

The infero-marginal plates are naked, except for an aboral, an interior

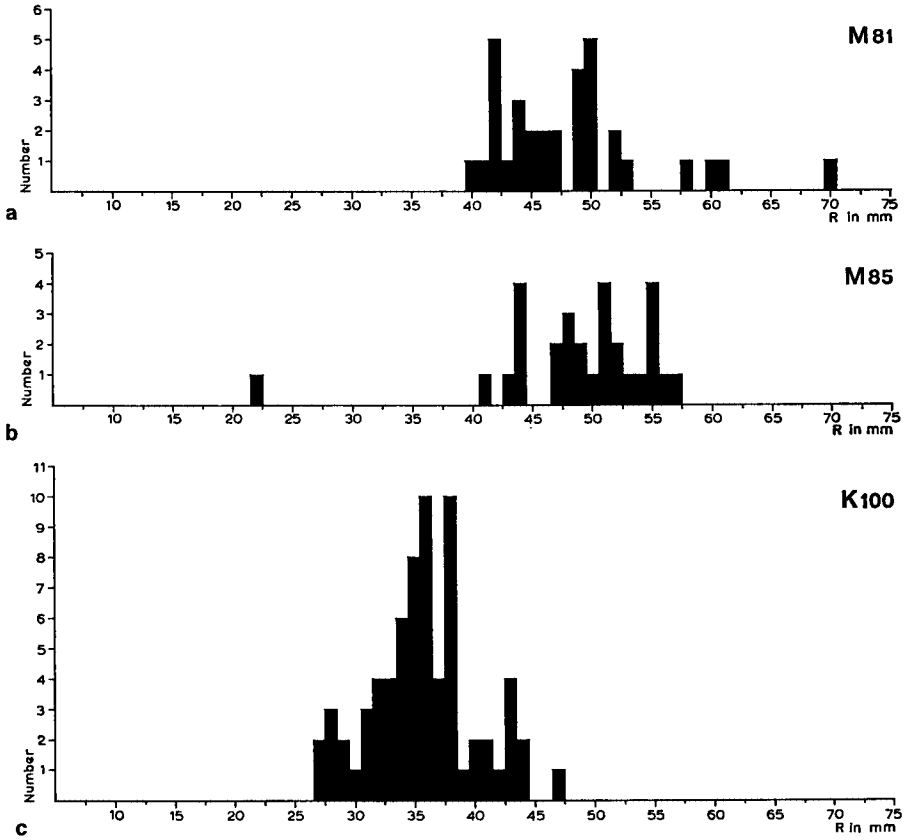


Fig. 14a, b, *Astropecten marginatus* Gray, size variation; a, at Sta. M 81; b, at Sta. M 85. c, *Astropecten americanus* Verrill, size variation at Sta. K 100.

and an exterior row of pointed spines. The exterior row is just under the large, lateral spines. The first ten plates, approximately, also bear an adoral row of spines, gradually becoming smaller, until, at about the tenth plate, it has completely disappeared. On the edges, between the plates, there is one row of short, thin spinelets. Each protruding, infero-marginal plate has at least two large, lateral spines, of which the adoral is only a little smaller than the aboral spine. Adoral to these spines there is often a very small (length 1/6-1/4 of that of the large spines), pointed spine. The first two plates have only one lateral spine, smaller than those of the other plates.

In each interradial area there are about six ventro-lateral plates; one spine on these plates is often very long.

The adambulacralia have three long and slender, interior furrow spines, of which the median is the largest. Exterior to these spines are two slender

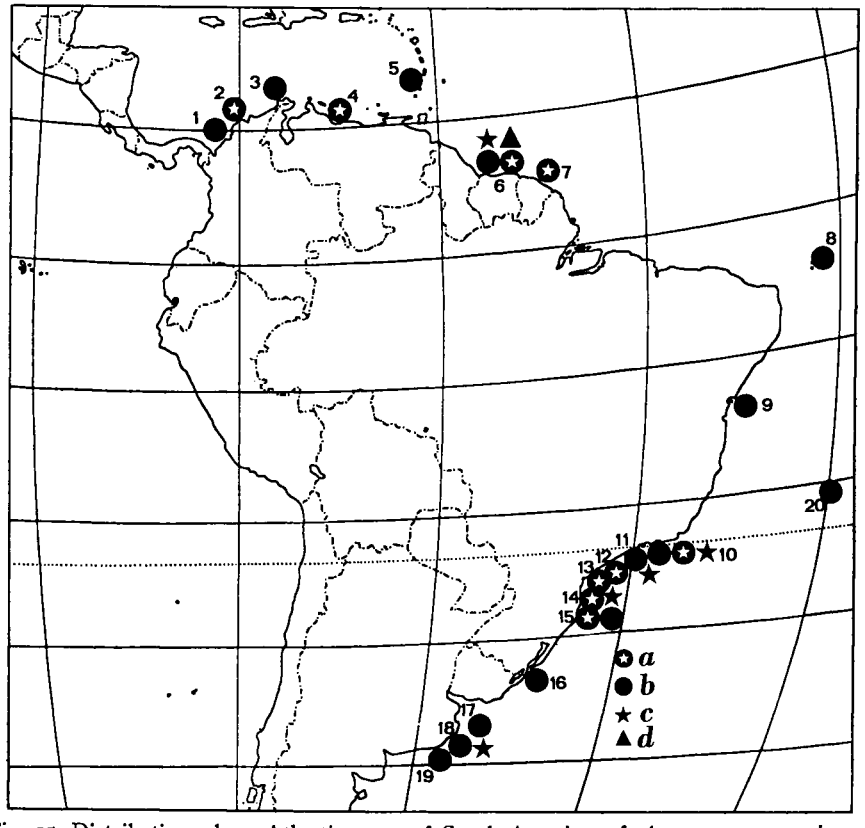


Fig. 15, Distribution, along Atlantic coast of South America, of *Astropecten marginatus* Gray (*a*); *A. brasiliensis* Müller & Troschel (*b*), *A. riensis* Döderlein (*c*), and *A. americanus* Verrill (*d*). Explanation of numbers used: 1, I. Tortuguilla, Colombia; 2, Santa Catalina, Colombia; 3, Cabo de la Vela, Colombia; 4, Puerto Cabello, Venezuela; 5, St. Vincent, Lesser Antilles; 6, Surinam; 7, French Guyana; 8, Fernando Noronha, Brazil; 9, Bahia; 10, Rio de Janeiro; 11, Angra dos Reis; 12, São Sebastião, Brazil; 13, São Paulo and Santos, Brazil; 14, Itajai, Brazil; 15, Santa Catarina, Brazil; 16, Rio Grande do Sul, Brazil; 17, Buenos Aires, Argentina; 18, Mar del Plata, Argentina; 19, Quequén, Argentina; 20, I. da Trinidade, Brazil.
(*A. brasiliensis* has also been found off São Sebastião and São Paulo).

spines. In the third row there are three spines: one large spine in the middle and, ab- and adorally to it, a slender spine. The fourth and fifth rows are irregular and consist of about two slender spines. Between the adambulacral plates are numerous, very thin and fine, needle-like spinelets.

Variability. — Expect for some variation in size and in the number of the ventro-lateral plates, this aspect seems to be of no particular interest.

Discussion. — The graphs illustrating the size-distribution (figs. 13, 14a, b) suggest the presence of two size groups. The size of the animal does not seem to be related to any factor, such as depth or bottom material.

Müller & Troschel (1842:75) also described a sea-star as *Astropecten marginatus* Nob. nov. sp. The description fits the present species; they have, however, overlooked the fact that the species had already been described by Gray (1840) under the same specific name.

Distribution (fig. 15). — North and east of South America: Santa Catalina; Puerto Cabello; French Guyana; Brazil: Rio de Janeiro, São Sebastião, São Paulo, Santos, Itajai and Santa Catarina. Its presence in the waters of Surinam fits the distributional pattern very well.

Astropecten americanus (Verrill, 1880) (figs. 14c, 15; pl. 3 fig. 4)

Archaster americanus Verrill, 1880b: 402; 1880c: 359; 1885: 542.
Astropecten americanus Verrill, 1894: 255; 1895: 133; 1915: 184. — Döderlein, 1917: 106. — Gray, Downey & Cerame-Vivas, 1968: 143. — Downey, 1973: 27.

Material examined: 70 specimens, all from station K100. R ranges from 27 to 47 mm.

Diagnosis. — At least two infero-marginal spines of equal size occur on each plate. Supero- and infero-marginal plates loosely covered with small, slender spines, which are enveloped by a skin-like sheath. Marginal plates with simple, fasciculate pedicellariae. Cf. pl. 3 fig. 4.

Description. — The disk and arms are flattened. The arms are long and slender (R/r = 5/1). The infero-marginal plates often protrude beyond the supero-marginals and alone form the edge of the arm. This, however, may be the result of bad preservation, as Döderlein (1917) suggests.

The paxillar-area, at the fifth marginal plate, is usually broader than half the arm-width. At this plate there are usually three rows of paxillae at every marginal plate. The paxillae are crowned with about eight thin spinelets, one of which is central while the others are arranged around it. The paxillae are all of equal size. Sometimes, especially in dorsal interradial areas and on the disk, the paxillae are replaced by pedicellariae, which are simple and have 2-5 jaws. The madreporite usually is smaller than two marginal plates. It has radial furrows, sometimes it shows some papillae, while paxillae overlap its edge.

The supero-marginal plates are loosely set with elongated granules and occasionally bear an interior spine. This becomes smaller distally and usually vanishes in the middle of the arm. I did not observe the fasciculate pedicellariae on the sides of the plates as mentioned by Döderlein.

The infero-marginal plates are loosely set with thick spines, which are covered by a thick, skin-like sheath. They bear an aboral row of long, thin and pointed spines, of which the exterior is the largest. On the first three plates there is a row of spines similar to or smaller than that on the adoral side. Above, and a little adoral to the aboral row of spines there is fairly long and thin, large lateral spine. Adoral to this spine, or sometimes more above it, there is a similarly shaped, but smaller spine. At their base there are often some bristle-like spinelets. Dorsal to the large lateral spine there is a simple pedicellaria with 3-5 jaws. The first plates have, according to Döderlein, only one lateral spine, while the other is replaced by a pedicellaria. In my opinion, however, the visible "lateral spine" is the last and exterior-most of the transverse, aboral row, and both the true lateral spines have disappeared. The large lateral spine is not replaced by a pedicellaria, but the row of above mentioned pedicellariae is continued.

The ventro-lateral area has about eight ventro-lateral plates, of which the spines are usually arranged as simple fasciculate pedicellariae. The spines of the adambulacral plates are thin and rod-shaped, except for the central spine of the interior row, which is large and flattened on the ad- and aboral sides. In the second row there are three, also thin and rod-shaped spines, which are slightly smaller. Exterior to these spines are some additional spines, which often form simple pedicellariae.

Variability. — The interior spine on the supero-marginal plates may be present or reduced in size, at times being fully absent. The number of the ventro-lateral plates sometimes varies. The size of the adoral lateral spine may vary between two extremes: from half to equal the size of the aboral lateral spine. There is some variation in size, as appears from fig. 14c.

Distribution (fig. 15). — East coast of North America in the deeper waters. Döderlein (1917): from 40°36′ N to 35°28′ N, 79-541 m depth. The species has also been found off Cape Hatteras. The record from Surinam waters means an extension of its known range.

Tethyaster vestitus (Say, 1825) (figs. 16, 17, 18, 19c; pl. 7 fig. 4)

Asterias vestita Say, 1825: 143.
Tethyaster vestitus — A. M. Clark & A. H. Clark, 1954: 12-16. — Tortonese, 1956: 331. — Tommasi, 1958: 15. — Cherbonnier, 1959: 168. — Brito, 1960: 9; 1960a: 67; 1968: 10. — Gray, Downey & Cerame-Vivas, 1968: 142. — Downey, 1973: 37.

Material examined: Twenty-six specimens from fifteen different stations. Sta. A9: 1 specimen, R: 82 mm; Sta. A27: 1 specimen, R: 26 mm; Sta. B2: 4 specimens, R: 15, 32, 51 and 106 mm; Sta. F6: 1 specimen, R: 169 mm; Sta. F41: 3 specimens, R: 21, 46 and 47 mm; Sta. F42; 2 specimens, R: 32 and 97 mm; Sta. G54: 1 specimen, R: 44 mm; Sta. G56; 1 specimen, R: 32 mm; Sta. H52: 1 specimen, R: 186 mm; Sta. H53: 1 specimen, R: 126 mm; Sta. I 116: 2 specimens, R: 58 and 88 mm; Sta. M86: 1 speci-

men, R: 59 mm; Sta. M88: 5 specimens, R: 22, 45, 48, 49 and 55 mm; Sta. M89: 1 specimen, R: 88 mm; Sta. M97: 1 specimen, R: 13 mm.

Diagnosis. — Infero-marginal plates with a median row of enlarged, flattened spines (five of such spines are present in specimens with R>90 mm). Ventro-lateral areas large, with numerous plates in definite series, and with

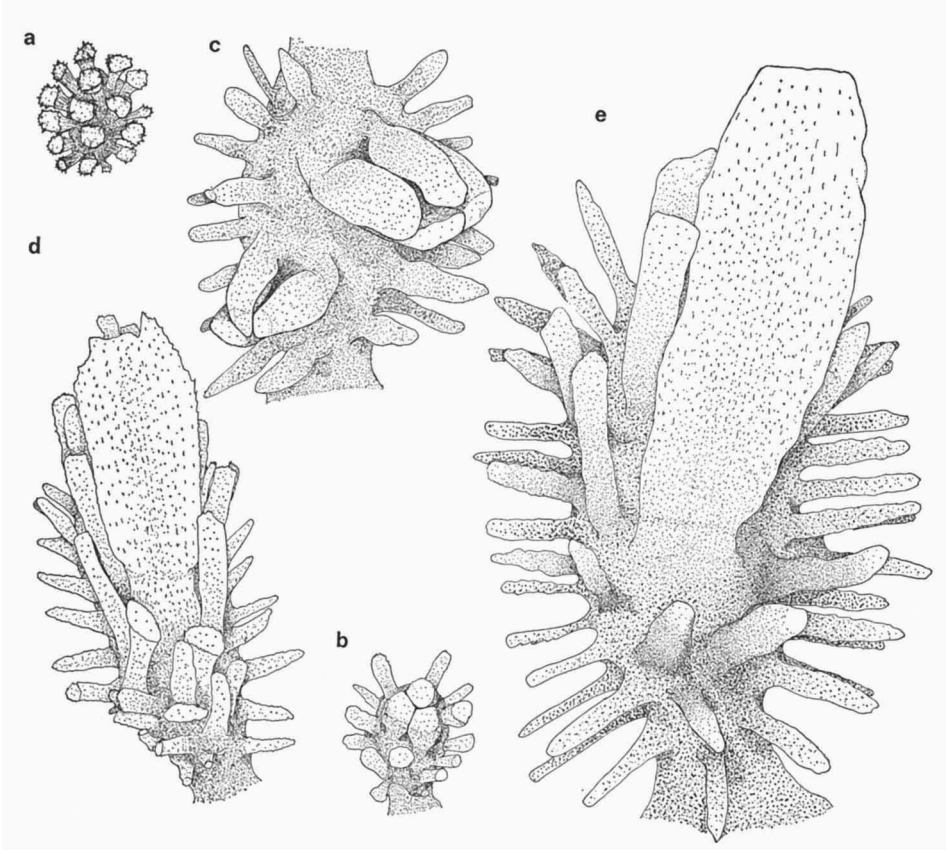


Fig. 16, *Tethyaster vestitus* (Say), ventro-lateral plates. a, R = 22 mm; b, R = 44 mm; c, R = 106 mm; d, R = 126 mm, and e, R = 186 mm. × 20.

an incomplete, unpaired, median row. Infero-marginal plates separated from adambulacralia by a series of ventro-lateral plates for the larger part of the ray. Fascioles are present between the marginal, adambulacral and ventro-lateral plates. Madreporite large and bare. Spine pattern on the adambulacralia resembles that of *Astropecten* (cf. figs. 12, 18).

Description. — Because of the excellent description by A. M. Clark & A. H. Clark (1954) it is unnecessary to redescribe this sea-star. A study of

the literature, however, indicated the need for a description of juvenile *Tethyaster*, several of which were taken off the coast of Surinam. It is appropriate, therefore, to describe the development. I assume that the smaller specimens at my disposal indeed are young specimens of *Tethyaster vestitus* for two reasons: a. The specimens obviously belong to the genus *Tethyaster* (cf. the diagnosis above) and *T. vestitus* is the only species with truncate infero-marginal spines that can be expected to live in this area. b. It was possible to trace the development back from the larger to the smaller specimens.

1. Development of the ventro-lateral plates and their spines.

In the smallest specimens (R: 13-22 mm) the ventro-lateral plates are covered with 2-5 club-shaped spinelets of 0.2-0.3 mm length, surrounded by a circle of 10-15, only slightly smaller and thinner spinelets (cf. fig. 16a). The plates are often almost circular. In the larger specimens (R: 33-44 mm) there is some differentiation in the spine pattern: the outer circle of spinelets becomes distinctly thinner and longer, while the central spinelets become less club-shaped and often form a fasciculate pedicellaria (cf. fig. 16b). The ventro-lateral plates of specimens with R ranging from 46 tot 52 mm usually bear about eight thick, central spinelets, of which a few are often arranged in fasciculate pedicellariae; the spinelets on the edges become more marginal and form a single or double irregular row.

In still larger specimens (R: 59-106 mm) the ventro-lateral plates become more elongate and the differentiation between the central and marginal spines becomes more obvious. The number of spines increases; the central spines gradually become more flattened, this, however, is a very variable feature (cf. fig. 16c). In the specimen with R = 126 mm (cf. fig. 16d) one large (2-2.5 mm), flattened spine occurs, surrounded by slender, often flattened spines of about 1.5 mm length. The largest specimens show a conspicuous, large, flattened, rectangular spine, which is 3-4 mm long and about 1 mm wide, surrounded by fairly long (1.5 mm), flattened spines, which again are surrounded by two irregular rows of fine and slender marginal spinelets (cf. fig. 16e).

2. Development of the infero-marginal plates and their spines.

In the smallest specimens (R: 13-22 mm) the infero-marginal plates are covered with short, thick, not or hardly flattened spinelets of about 0.2 mm length, which are a little thinner at the edges (cf. fig. 17a). In larger specimens (R: 26 mm) the central granules become more flattened and the marginal spinelets slenderer. In still larger specimens (R: 33 mm) there usually are 2-3 spinelets, which are about 0.1 mm longer than the others. In speci-

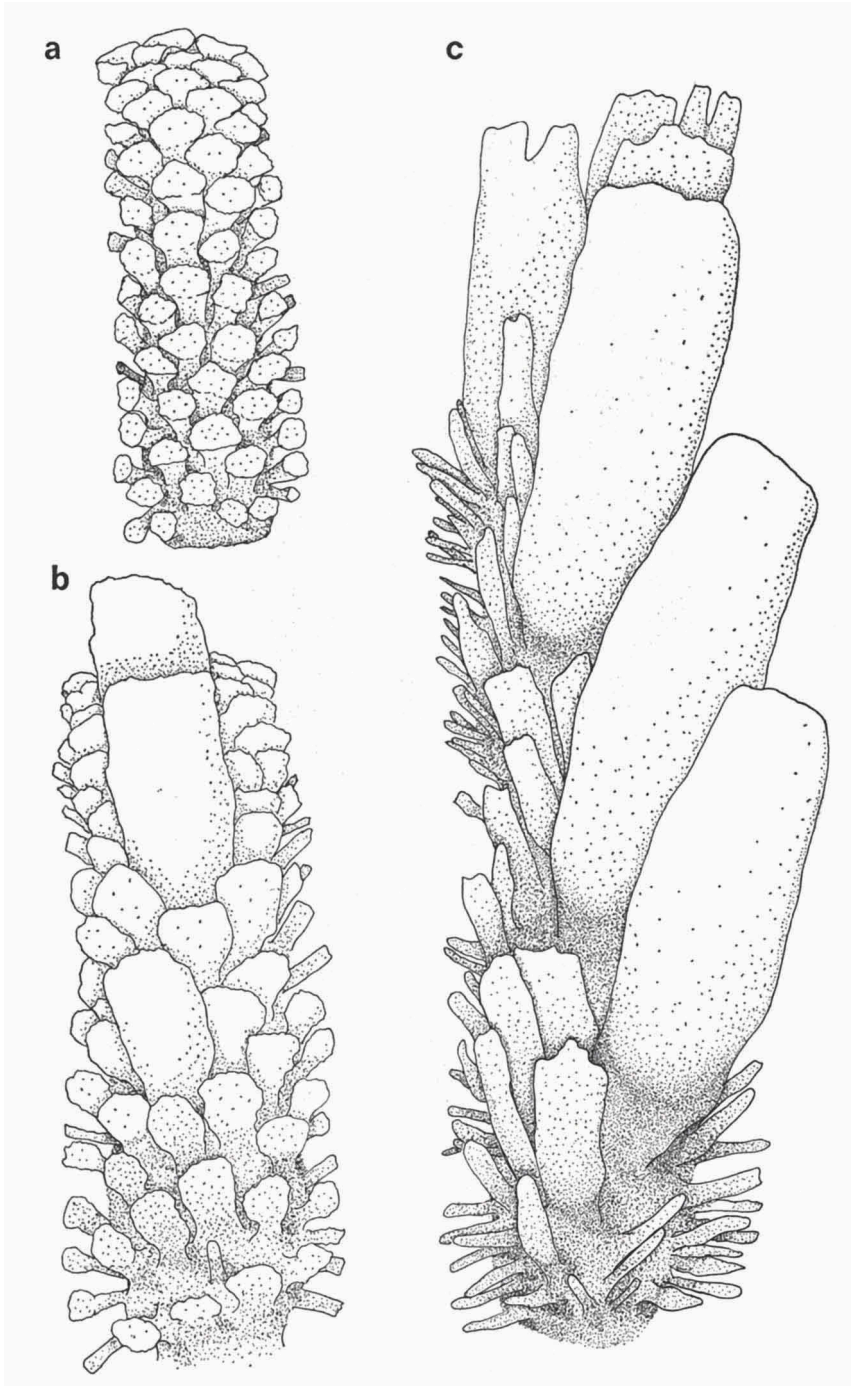


Fig. 17, *Tethyaster vestitus* (Say), Infero-marginal plates. a, R = 22 mm; b, R = 47 mm; c, R = 186 mm. a, b, × 30; c × 15.

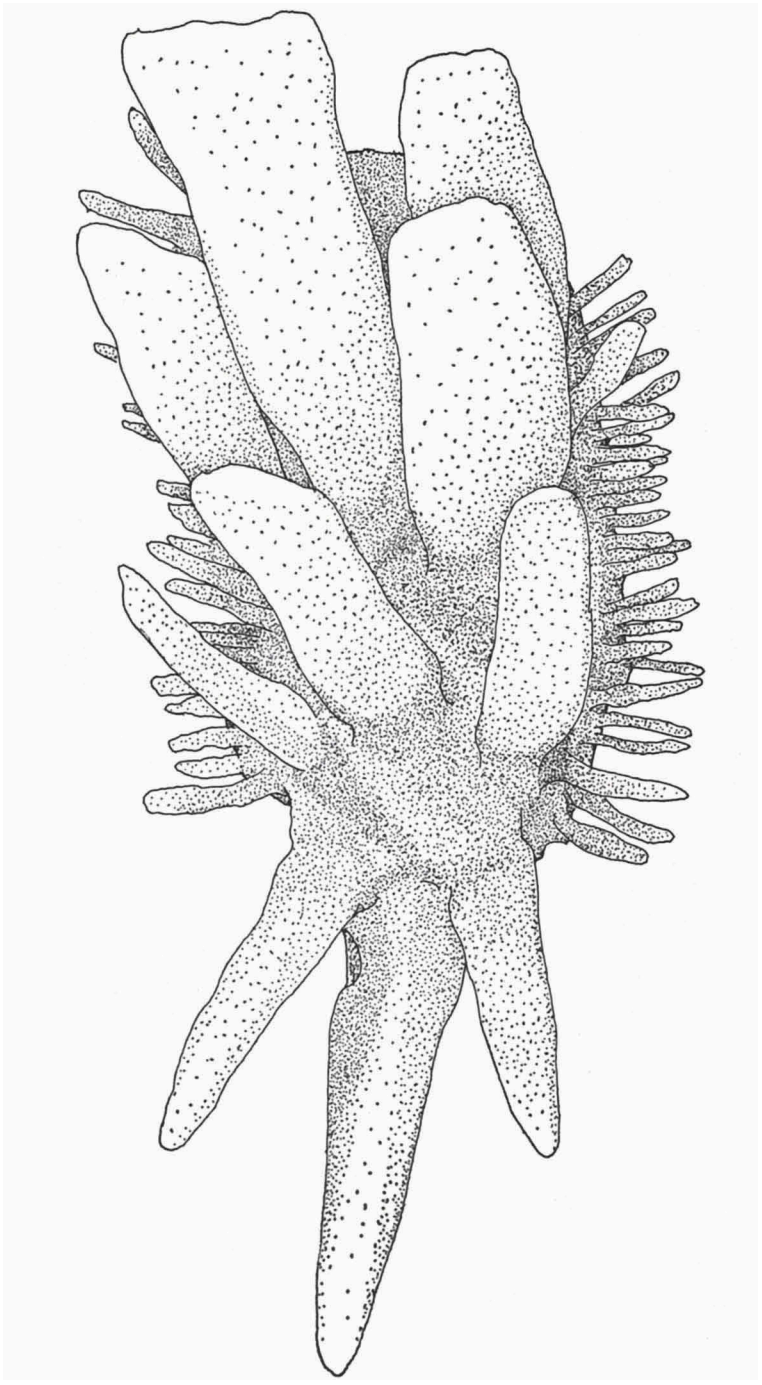


Fig. 18, *Tethyaster vestitus* (Say), adambulacral plate, R = 186 mm. × 20.

mens with R varying from 44 to 49 mm I usually observed among the short, flattened spinelets of 0.2 mm length 1-3 larger, flattened spines of about 1 mm length (cf. fig. 17b). The edges of the plates bear one irregular row of thin spines, which, together with the row on the other side, overlap the furrows between the plates. The larger specimens (R: 92-97 mm) have 3-5 large, flattened spines, about 2 mm long and about 0.8 mm wide, surrounded by rather long, slender or flattened spines. The specimen with R: 106 mm is rather peculiar in that the spines which surround the 2-5 large (1.6

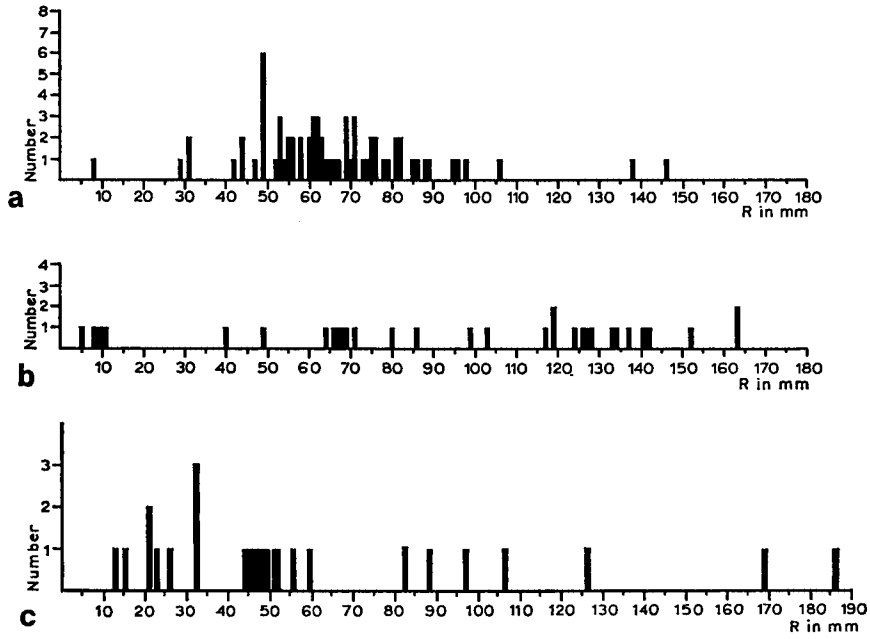


Fig. 19, Size variability of: a, *Luidia clathrata* (Say); b, *Luidia senegalensis* (Lamarck); c, *Tethyaster vestitus* (Say). All specimens studied have been measured.

mm) flattened spines are rod-shaped and slender and are not flattened. The three largest specimens (R: 126, 169 and 186 mm) bear, on their infero-marginal plates, about four, large (± 4 mm) flattened, rectangular spines, surrounded by flattened spines of about 1.5 mm length (cf. fig. 17c). On the ad- and aboral edges of the plates are two irregular rows of slender and fine spinelets, overlapping the furrows between the plates. In the exterior part of the furrows between the plates there are, in all specimens, numerous thin, fine and needle-like spinelets.

3. Development of the supero-marginal plates and their spines.

In the smallest specimens (R: 13-22 mm) the supero-marginal plates are

covered with short, club-shaped granules greatly thickened at their tips; these are a little thinner near the edges of the plates, but do not overlap the furrows between the plates. In larger specimens (R: 44-59 mm) the spines on the edges become relatively slenderer and often overlap the furrows. The specimen with R: 82 mm has an irregular row of slender spinelets on the ad- and aboral edges of the plates. In the middle of the supero-marginal plates of this specimen, close to the infero-marginal plates, is a larger granule, which increases in size towards the distal end of the arm to a length of 0.6 mm. The specimens with R: 88 and 97 mm do not show such an enlarged granule. In the specimen with R: 106 mm again the plate has an enlarged granule, hardly larger than the others and another in the middle of the plate close to the infero-marginal plates. The largest specimens all bear two irregular rows of thin and fine spinelets on the ad- and aboral edges of the plates, overlapping the furrows between the plates. The specimen with R: 126 mm bears, from the seventh to the penultimate supero-marginal plates, close to the infero-marginal plates, one conical spine, about 0.6 mm long. The specimen with R: 169 mm bears one flattened, pointed, 1.5-2 mm long spine on the fourth to the tenth supero-marginal plates, and one or two of such

List of measurements of *Tethyaster vestitus* (Say)

	Station:	R in mm:	R/r	R/M [1]	LKFAS in mm: [2]
1.	M97	13	2.2	21.5	0.5
2.	B2	15	2.5	21.4	0.6
3.	F41	21	2.8	21.0	0.8
4.	M88	22	2.7	14.7	0.8
5.	A27	26	2.9	13.0	1.0
6.	B2-G56-F42	32	3.2-3.2-3.6	14.4-16.0-12.8	1.1-1.1-1.3
9.	G54	44	3.4	17.6	1.6
10.	M88	45	3.7	15.0	1.4
11.	F41	46	3.3	15.3	1.4
12.	F41	47	3.4	18.8	1.7
13.	M88	48	3.6	16.0	1.6
14.	M88	49	3.7	16.3	1.6
15.	B2	51	3.9	14.6	1.3
16.	I116	52	3.7	13.0	1.7
17.	M88	55	3.9	18.3	1.8
18.	M86	59	3.3	14.7	2.1
19.	A9	82	3.6	14.9	2.8
20.	I116-M89	88	3.5-4.2	14.7 (2)	2.6-3.0
22.	F42	97	4.0	14.9	2.0
23.	B2	106	4.0	15.1	2.8
24.	H53	126	4.0	14.0	4.0
25.	F6	169	3.7	14.1	5.5
26.	H52	186	3.9	11.6	5.0

1) M = diameter of madreporite

2) LKFAS = the large keel-shaped furrow adambulacral spine

spines on the eleventh to penultimate plates. The largest specimen (R: 186 mm) has one spine on the fifth to the seventeenth plates, and one or two, flattened spines of about 1.5 mm length on the eighteenth to penultimate plates. In the exterior part of the furrows between the plates numerous thin, fine and needle-like spinelets are present.

4. Development of the adambulacral plates and their spines.

In the smallest specimens the spines are still slightly club-shaped and hardly or not at all flattened. In the specimens with R longer than 44 mm there is only variation in size (cf. the list of measurements). Especially the configuration of the interior six spines is very constant (cf. fig. 18).

5. During an increase of R from 13 to 186 mm, r increases from 6 to 48 mm and thus the R/r ration from 2.2 to 3.9, which means that the arms become relatively longer as the starfish grows older.

The variation in size is illustrated in fig. 19c.

Distribution. — Atlantic coast of America from New Jersey to Brazil. Cape May, N. J. (type locality); Diamond Shoal, North Carolina; Puerto Rico; Venezuela, off Orinoco River; Surinam; Brazil.

Goniaster tessellatus (Lamarck, 1816) (figs. 8a, 20; pl. 7 figs. 1-3; pl. 8 figs. 1-4; pl. 9 figs. 1-3; pl. 10 figs. 1-4; pl. 11 figs. 1-4)

Pentagonaster semilunatus Linck, 1733: 21.
Artocreatis tertia species Seba, 1761: 11.
Asterias granularis Gmelin, 1791: 3164.
Asterias tessellata Lamarck, 1816: 238. — Blainville, 1834: 238.
Goniaster tessellatus — L. Agassiz, 1835a: 143; 1835b: 191. — H. L. Clark, 1909: 110; 1946: 81. — Fisher, 1910: 172; 1911: 167. — Verrill, 1914: 286. — Halpern, 1969: 503; 1970: 256. — Downey, 1973: 46.
Goniaster cuspidatus Gray, 1840: 280; 1866: 10. — Tortonese, 1937: 55. — Madsen, 1950: 209. — John & A. M. Clark, 1954: 139. — A. H. Clark, 1954: 375. — A. M. Clark, 1955: 18. — Engel, Croes & Schroevers, 1960: 12. — Roa, 1967: 279.
Astrogonium cuspidatum — Müller & Troschel, 1842: 56. — Dujardin & Hupé, 1862: 394. — Perrier, 1869: 85; 1876d: 67.
Goniaster semilunatus — Martens, 1866: 86. — Koehler, 1909: 87.
Astrogonium dubium Perrier, 1869: 85.
Goniaster americanus Verrill, 1871: 130; 1899: 151; 1915: 104. — Perrier, 1875a: 1273; 1876c: 261; 1876d: 67. — Bernasconi, 1958: 13. — Cherbonnier, 1959: 107. — Gray, Downey & Cerame-Vivas, 1968: 148. — Flores & Martínez de Rodriguez, 1970: 4.
Goniaster africanus Verrill, 1871: 131; 1899: 156. — Perrier, 1875a: 1273; 1876c: 261; 1876d: 67.
Pentagonaster semilunatus — Perrier, 1876a: 24; 1876d: 64. — Rathbun, 1879: 148. — Sladen, 1889: 267. — Ludwig, 1899: 539.
Astrogonium semilunatum — Perrier, 1885: 37.
Phaneraster semilunatus — Perrier, 1894: 388.

Material examined: Six specimens from five different stations. Sta. E64: 2 specimens, R: 69 and 79 mm; Sta. F40: 1 specimen, R: 21 mm; Sta. F43: 1 specimen, R: 59 mm; Sta. H58: 1 specimen, R: 15 mm; Sta. H59: 1 specimen, R: 48 mm.

Diagnosis. — More or less pentagonal body, with five short triangular arms. R/r ratio 1.3 to 2.5. Aboral body surface with large, thick, conical spines. Pedicellariae usually present, spatulate and mostly situated on a smooth area, in a groove, in which their blades, when fully open, are concealed. Supero-marginal plates strongly elevated and bluntly pointed. About two adambulacral plates correspond with one ventro-lateral plate. Cf. pl. 7 figs. 1-3; pl. 8 figs. 1-4; pl. 9 figs. 1-3; pl. 10 figs. 1-4; pl. 11 figs. 1-4.

Description. — The body is pentagonal, with short, broad, triangular arms. The R/r ratio is 2-2.4 in animals of all sizes. The colour, in alcohol, is yellowish-brown or white. The dorsal surface of the body is convex and slightly depressed in the interradial areas.

The dorsal plates are very firm and densely covered with low granules of identical shape. Along the edge of the plates there is one series of equally low, more or less rectangular, slightly larger, marginal granules. Between the dorsal plates there are, particularly in the radii, very small intermediate plates, which usually are single, smooth-topped, roundish or polygonal ossicles on level with the other plates; sometimes several have fused together. Many dorsal plates bear a large, thick, blunt, conical spine. The interradial plates, the plates on the exterior part of the arm and those adjacent to the supero-marginal plates, always lack such a spine. A spine on the apical plate may be present or absent.

The madreporite is very large and conspicuous, and is irregularly shaped.

The naked supero-marginal plates are large, elevated and bluntly pointed, particularly in the interradii, and have one regular series of small, more or less rectangular, marginal granules. On the flanks of these hill-shaped plates there often are some smaller, bivalved, spatulate, concealed pedicellariae. The distal two or three pairs of supero-marginal plates are contiguous; the terminal plates usually are very small. Between the supero- and infero-marginal plates, except for the distal part of the arms, some flat, granular, intermediate plates are situated, which greatly resemble the dorsal plates, but are usually much smaller; sometimes, in the largest specimens, these plates are naked.

The infero-marginal plates usually correspond with the supero-marginal plates; their number in the distal part of the arm, however, is greater than in the supero-marginal series. The plates are large and naked, surrounded by rectangular marginal granules, but much lower than the supero-marginal plates and not conically pointed; one or two concealed pedicellariae are usually present. In most specimens the terminal infero-marginal plates bear a small, short, thick, and bluntly pointed conical spine. The ventro-lateral area is very large, and the polygonal ventro-lateral plates are densely covered with short granules; the marginal granules are only slightly different. In

some of the larger specimens the ventro-lateral plates, near the mouth, bear a short, thick, blunt spine or tubercle. The central part of some plates is nude and, in that case, very often has a concealed pedicellaria. The plates provided with pedicellariae are particularly numerous in the series adjacent to the adambulacral plates.

About two adambulacral plates correspond with one ventro-lateral plate. The adambulacral plates have an interior series of four, long, stout, rod-shaped spines. Exteriorly to these there are two, equally long but much thicker spines, and outside these there are about three, irregularly shaped, smaller spines. The exterior margin of the plates bears several marginal granules. In the distal part of the arm the third longitudinal series of adambulacral spines disappears, and often one of the thick spines of the second series increases very much in size.

The oral plates are set with about twelve rod-shaped furrow spines and about ten, slightly smaller spines, exteriorly to the latter ones; on the central part of the plate there are about eight even smaller spines.

Variability. — The smallest specimens (R: 15 and 21 mm, pl. 7 figs. 1-3) have fewer dorsal spines than the larger ones; in the smallest specimen the dorsal spines are no more than large but low tubercles. The ventro-lateral plates, in these uniformly granulated specimens, are without any naked spots and have fewer pedicellariae; the intermediate plates between the supero- and infero-marginal plates are hardly developed or absent. In larger specimens the ornamentation of the ventro-lateral plates varies from uniformly granular (R: 48 mm, cf. pl. 8 figs. 1, 2, 4) to the pattern shown by the spiny specimen (R: 59 mm cf. pl. 8 fig. 3; pl. 9 fig. 1; pl. 10 figs. 1, 2) described below. In some larger specimens the marginal plates may have two series of marginal granules. In the spiny specimen mentioned above, some dorsal plates bear more than one spine, sometimes fused together at their bases; the distal six infero-marginal plates are armed with a short, small and thick conical spine with blunt apex. The terminal supero-marginal plates sometimes bear a spine, similar to those on the infero-marginal plates. In nearly all ventro-lateral plates one to three granules are greatly enlarged and present as large, thick, unequally sized tubercles, becoming higher, but decreasing in number, in oral direction.

The other characters in the remaining specimens are quite constant, except for the numbers of marginal plates, as is indicated below.

R in mm:	15	21	48	59	69	79
Number of supero-marginal plates:	10	12	14	18	14	16
Infero-marginal plates:	12	16	18	22	20	22

The size variation is shown in fig. 8a.

Discussion. — Lamarck (1816) described a starfish as *Asterias tessellata*, which had been described by the pre-Linnean author Linck (1733) as *Pentagonaster semilunatus*. The species has about the same distribution as *Linckia guildingii*, occurring in the western Indo-pacific and on both sides of the warm Atlantic. In 1840 Gray described the same species as *Goniaster cuspidatus*, a name, which, although a junior synonym, has found wide use by later authors. Verrill (1871), however, described the American form as *Goniaster americanus* and the African form as *Goniaster africanus*, adding that he did not have "sufficient series of the East Indian *Goniaster cuspidatus* for examination to warrant him in making so positive a statement as to its distinctness from *Goniaster africanus*, but the published descriptions indicate important differences".

Perrier (1876a) investigated 24 specimens: 2 from Brazil, 10 from the west coast of Africa, 2 from China and 10 from unknown origin, and stated that this series did not leave any doubt on the specific identity of the different forms. He also stated this species, which he called *Pentagonaster semilunatus* Linck, 1733, to be indentical with *Astrogonium cuspidatum* Müller & Troschel, 1842, from the Indian Ocean, and with *Goniaster cuspidatus* Gray.

Verrill (1899; 1915) again maintained that in any case the American and African forms were specifically distinct for the following reasons:

1. The dorsal spines are smaller and more abundant in *Goniaster africanus* and there is some difference in the number and characters of the marginal plates. He himself conceded that these features cannot be depended upon to separate the species.

2. *Goniaster africanus* does not have any pedicellariae above or below. Later workers like Tortonese (1937) and Madsen (1950 found that specimens both from America and Africa had pedicellariae, though in very varying numbers; they even may be absent in some specimens from both regions.

3. The ventro-lateral plates in *Goniaster africanus* mostly have a central cluster of three to six or more unequal, rounded tubercles, much larger than the granules. Tortonese (1937) confirmed this being a difference, but stated that in the specimens from America the ventro-lateral plates near the mouth might bear a more or less developed, central conical spine, that the specimens from Africa bear 1-3 short spines, which are more distinct in larger specimens, and that in the specimens from the Indian Ocean the ventro-lateral plates are uniformly granular. In my specimens from Surinam I found all the intermediates between uniformly granular specimens and those provided 1-3 enlarged tubercles or short spines. Perrier (1876), also stated this cha-

racter not to be valuable, because both specimens, showing the former and the latter pattern, occurred in one locality.

4. The granules of the dorsal plates in *Goniaster americanus* are much larger and more rounded than in *Goniaster africanus*, with less differentiation of the marginal series. This character is not mentioned by any of the other authors; for lack of material I cannot contribute towards this feature.

5. The small intermediate dorsal plates seldom bear distinct rosettes of granules in *Goniaster africanus*, but usually appear as small, rounded or oval, smooth-topped ossicles, on a level with the other plates. This description also fits the specimens from Surinam very well.

6. *Goniaster africanus* has the distal pair of supero-marginal plates larger and more swollen than those that precede it; they are largely in contact medially. Tortonese (1937) who studied ten specimens from the Indian Ocean, St. Vincent (Cape Verde Islands), Buenos Aires, and two of unknown origin, also contributed some more arguments against Verrill's point of view. The terminal plates of his specimens from Cape Verde Islands are not swollen, on the contrary the animals resemble much more *Goniaster americanus* as represented by Verrill (1899, plate XXIVa).

The R/r ratio varies from 1.3 to 2.5 in specimens from America. The ratio's of specimens from the Indian Ocean and Africa fall in this range. Hence, I also have to disagree with Flores & Marínez de Rodríguez (1970), who studied 105 specimens from the coastal waters of Venezuela, compared their results with those of Bernasconi (1958) and Engel, Croes & Schroevers (1960) and concluded that the American form is a distinct species, because it has longer arms (R/r ratio 1.8 vs. 1.5). Summarising: Some small differences between the three forms may exist, but I do not hold these differences adequate to separate the specimens from the three centres of distribution specifically.

Verrill (1899) also investigated four specimens of *Pentagonaster parvus* Perrier, 1881, from the "Blake" Expedition, preserved in the Museum of Comparative Zoology, and states that they agree perfectly with specimens of *Goniaster americanus* of similar size, collected by the steamer "Albatross" in the West Indies. These specimens, according to Verrill, with the latter form a complete series connecting the smallest with full grown individuals of the same region. Between the specimens from Surinam, however, there are two young specimens of *Goniaster tessallatus* (R: 15 and 21 mm), which absolutely do not fit Perrier's description of *Pentagonaster parvus*: a. There are three longitudinal series of adambulacral spines, all consisting of 5-6 spines or granules. My juvenile *Goniaster tessellatus* show exactly the same

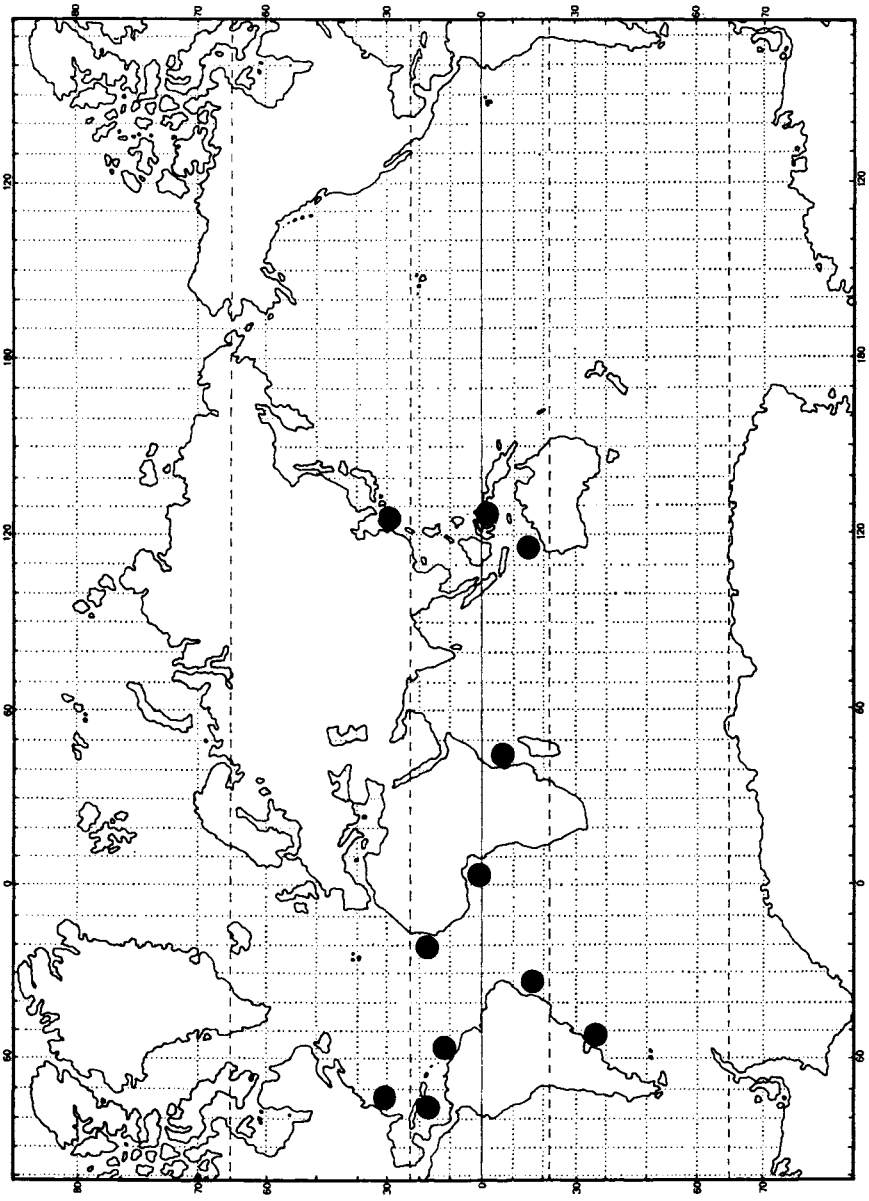


Fig. 20, *Gomiaster tessellatus* (Lamarck), geographical distribution.

spine-pattern as the adults. b. The ventro-lateral plates gradually become nude orally, except for a series of marginal granules. In the Surinam specimens of the same size all ventro-lateral plates are densely and uniformly covered with granules. c. Neither in his description, nor in his figure of *Pentagonaster parvus*, Perrier mentioned any sign of dorsal spines or even enlarged granules, which are, even in the smallest specimen from Surinam (R: 15 mm), very well visible, and which in the other specimen (R: 21 mm), smaller still than the type of *Pentagonaster parvus*, are already very well developed. d. The picture also shows that the sides of the body are far less concave than in my young specimens of *Goniaster tessellatus*. e. My specimens have more marginal plates.

Halpern (1969) also expresses the opinion that "*Tosia parva*" is a valid species.

Distribution (fig. 20). — Type locality: unknown. Atlantic coast of America from South Carolina, U.S.A., to Buenos Aires, Argentina. Atlantic coast of Africa from Senegal and the Cape Verde Islands to Rolas Island, near the equator. Indo-Westpacific area off Zanzibar, Celebes, Moluccas, Australia and China.

Tosia clugreta spec. nov. (pl. 4 fig. 2; pl. 9 fig. 4; pl. 12 figs. 1, 2, 4)

Material examined: One specimen from station M97, R: 27, r: 18 mm (holotype).

Diagnosis. — Body pentagonal, flat, with five very short rays; R/r ratio 1.5. Dorsal plates naked, except for a single, marginal series of rectangular granules. Terminal pair of supero-marginal plates enlarged but not swollen; larger than any other plate, corresponding with about four distal infero-marginal plates. Marginal plates with marginal granules and small additional granules on their surface. Ventro-lateral plates completely covered with prismatic granules. Cf. pl. 4 fig. 2; pl. 9 fig. 4; pl. 12 figs. 1, 2, 4.

Description. — The flat, pentagonal body has five short rays; R/r ratio is 1.5. The colour is white, the specimen being preserved in alcohol 70%. Colour in life unknown.

The dorsal plates are slightly convex and smooth, except for a single series of rectangular marginal granules. The plates are smaller and more circular in the radii, larger and polygonal in the centre and the interradii. The five primary plates are somewhat larger than the other dorsal plates. From the centre of the disk to the supero-marginal plates there are about ten radial, and about five interradial dorsal plates. Occasionally, one or a few small, dispersed granules are present on the dorsal plates. No such organs as glassy bosses or pedicellariae are to be found.

The small, triangular madreporite is surrounded by three, large, more or less reniform plates.

Between four central dorsal plates some very small granules are visible, covering the anus; one of these plates is the apical plate. There is only one, very small, secundary plate.

The terminal pair of supero-marginal plates is much enlarged, but not swollen. The plates are longer than wide and (almost) entirely in contact with each other. One pair of terminal supero-marginal plates is not enlarged to such an extent as the others and in this case the pre-terminal, supero-marginal plates are partly in contact. The infero-marginal plates gradually decrease in size towards the tip of the arm; they are greater in number than the supero-marginal plates. About four distal infero-marginal plates correspond to the enlarged terminal, supero-marginal plates (cf. the ratio of supero/infero-marginal plates listed below). The supero-marginal plates are bordered by one series of more or less rectangular, marginal granules, smaller than those of the dorsal plates. The infero-marginal plates usually have more rows of marginal granules. The dorsal, and ventral surfaces respectively, of the supero- and infero-marginal plates, are very loosely set with small, round granules, often rubbed off, leaving small circular pits. Laterally, however, and particularly in the interradii, the plates are very densely covered with these granules. The distal pair of infero-marginal plates, except for the marginal granules, is completely naked. The ratio of supero/infero-marginal plates for the five sides is: 4/12, 5/14, 6/14, 5/12 and 7/14. The small terminal plates are naked and sometimes partly bordered by very small, marginal granules. The marginal granules around the marginal plates are often slightly enlarged in the corners between the supero- and infero-marginal plates. The large ventro-lateral area is triangular. The ventro-lateral plates are polygonal, often hexagonal, and all densely covered by short, more or less prismatic granules.

The adambulacral plates bear a furrow series of four to six, usually five, thick, straight, slightly compressed spines of about 1 mm length. Usually the most proximal furrow-spine of the series is situated behind the most distal spine on the plate proximal to it. Exteriorly to this furrow-series there are about four, more or less regular series of three to four spines, gradually decreasing in size towards the outer edge of the plate: the spines in the second row are half as long as those of the furrow-series; the most exterior spines are only slightly larger than the ventro-lateral granules. In the distal part of the arm, where the adambulacral plates are much narrower, one spine of the second series grows to a considerable size, being the largest spine on the plate. The oral plates bear a furrow-series of about nine spines, increasing

in size towards the mouth. Except for their size and rhomboid shape the oral plates resemble the adambulacral plates very much. The specimen completely lacks pedicellariae.

Discussion. — Together with *Tosia parva* (Perrier, 1881), cf. Halpern, 1969, to which it is most closely related, this new species is remarkable amongst the remaining species of *Tosia* by having additional granules on the surfaces of the marginal plates and by having five adambulacral furrow-spines. A comparison with the description of one of Halpern's specimens of *Tosia parva* (R: 22 mm) and of 3 specimens of the same species examined by Downey (1973: 54; R: 12, 18 and 22 mm) shows the following differences between the two species: The ratio supero/infero-marginal plates is considerably smaller in *T. clugreta* than in *T. parva*. No mention is made of any enlargement of the terminal pair of supero-marginal plates in *T. parva*, on the contrary. There also seem to be differences between the two species in the granulation of the dorsal, marginal and ventro-lateral plates. As, however, this feature generally tends to be rather variable and, as unfortunately, Halpern (1969) does not discuss the variation within the 22 specimens of *T. parva* he investigated, I am not certain to what degree these differences are valid.

Distribution. — Type locality: Station M97, off the Surinam coast. Holotype in the Rijksmuseum van Natuurlijke Historie, Leiden, Netherlands, Echin. no. 4613.

Etymology. — The specific name *clugreta* has been created as a dedication to my parents, Mr. Kluuk (= Ludovicus) G. M. Walenkamp and Mrs. Greet (= Margaretha) A. A. Walenkamp-Broerse; it is a combination of their Christian names.

Anthenoides peircei Perrier, 1881 (figs. 8c, 21; pl. 12 fig. 3; pl. 13 figs. 1-4; pl. 14 figs. 1, 3, 4; pl. 15 fig. 2)

Anthenoides peircei Perrier, 1881: 23; 1883: 247; 1894: 38. — A. Agassiz, 1888: 103. — Sladen, 1889: 326. — Verrill, 1915: 113. — H. L. Clark, 1941: 49. — John & A. M. Clark, 1954: 139. — Halpern, 1970: 272. — Flores & Martinez de Rodríguez, 1970: 5. — Downey, 1973: 48.
Anthenoides brasiliensis Bernasconi, 1956a: 33; 1956b: 131; 1960: 24; 1963: 20; 1966: 165.

Material examined: Eight specimens from five different stations. Sta. J112: 1 specimen, R: 31 mm; Sta. J113a: 2 specimens, R: 50 and 75 mm; Sta. L95: 3 specimens, R: 17, 22 and 29 mm; Sta. L96: 1 specimen, R: 107 mm; Sta. M97: 1 specimen, R: 20 mm.

Diagnosis. — Large pentagonal disk with five short, slender, pointed arms. Body covered with granular membrane, which more or less obscures plate-outlines in adults. Hexagonal dorsal plates without any spines. Anus

clearly visible. Adambulacral spines in two longitudinal series. Large valvate pedicellariae, accompanied by enlarged granules, on ventro-lateral plates. Cf. pl. 12 fig. 3; pl. 13 figs. 1-4; pl. 14 figs. 1, 3, 4; pl. 15 fig. 2.

Description. — The large pentagonal disk has five short, slender, pointed arms. The R/r ratio in larger specimens is 2.5-3.

The dorsal side of the body is convex, lower in the interradii, and has numerous, more or less regular, hexagonal plates, covered, in larger specimens, with a thick granular membrane which more or less obscures the outline of the plates. This membrane is much thinner in smaller specimens. Between all dorsal plates, except between those in the interradii, around the anus and the most distal plates, papulae-holes are visible. In the radii three longitudinal series of large hexagonal plates alternate with longitudinal series of smaller hexagonal plates, gradually and transversely decreasing in number until, in the distal fourth of the Radius, the supero-marginal plates of both sides of the arm are adjacent. The anus is distinctly visible and surrounded by an irregular circle of short, thick spines. In the largest specimen a valvate pedicellaria incidentally occurs on the dorsal plates.

The madreporite is naked, large, circular and its surface has many radiating furrows.

The supero-marginal plates are covered with a thick granular membrane in the largest specimens; the membrane is thinner and has less and smaller granules in the smaller specimens. The supero-marginal plates do not bear any enlarged spines or granules. In the interradii the plates are larger and broader than in the radii. The tip of the arm is formed by one peltate plate with a large furrow on its ventral surface. The plate, in the few, small, undamaged specimens, is distally crowned with three dorsal and four ventral spines; a large and a much smaller spine occurs on both sides of the furrow.

Ventrally, the infero-marginal plates, particularly in the interradii, are covered with more and heavier granules than the supero-marginal plates.

In the largest specimen some infero-marginal plates bear a large, valvate pedicellaria on their ventral surface. In the largest specimens there are many short, thick, often flattened and pointed spines along the exterior margin of the plates. Going from the interradii to the radii these spines decrease in number and increase in size until there is only a single thick, sharply pointed, aboral spine left, which disappears on the most distal plates. In smaller specimens this exterior edge, in the interradii, has only some enlarged granules; in the smallest specimens no enlarged spines or granules are to be found. The largest and broadest infero-marginal plates are found in the interradii.

The triangular ventro-lateral area reaches to half the Radius. The numerous hexa- or pentagonal ventro-lateral plates are covered by a thick, very granu-

lar membrane, particularly granulate above the fascioles between the plates. In smaller specimens the membrane is thinner and less granular. On most plates there are some enlarged, hemispherical granules. The number of valvate pedicellariae on the plates increases with the size of the body. The ventro-lateral plates of the smallest specimens lack pedicellariae. In the largest specimen every plate in the proximal two thirds of the series, adjacent to the adambulacralia, bears a large, valvate pedicellaria, which is not oriented in any distinct direction. The other plates occasionally bear such a pedicellaria. It is remarkable that in the same individual some ventro-lateral areas are more closely set with granules than others.

The adambulacral plates bear two longitudinal series of spines. The interior series consists of about seven, fairly long, slender, rod-shaped, identical spines. The most adoral one, however, usually is smaller than the others and situated a little more exteriorly. In the smallest specimens there usually are only six of such spines. The exterior series consists of about three thick, bluntly pointed spines, which, in the largest specimens, often are slightly flattened. The adoral spine is smaller than the other two. Often, however, the aboral one is smaller than the adoral two, or as small as the adoral spine. In the largest specimens a simple pedicellaria often is to be found between the two series on the adoral side of the plate or adoral to the exterior series. Exteriorly to the outer series there are usually some granules. The adambulacral margins of the oral plates are set with about seven spines, much resembling the inner adambulacral spines and increasing in size towards the mouth. The oral surface bears four large, flattened spines. There is a fasciole between this marginal, interior part of the oral plates and the central, aboral part. The margins of the aboral part, parallel to the adambulacral furrow, bear three to five, thick, conical spines. Between these spines, on the central part of the plates, several enlarged granules are situated.

Variability. — Increase in size of the body runs parallel to the development of the granular membrane, covering the body, from very thin, with a few, very small granules to very thick, with numerous large granules. The number of dorsal and ventro-lateral plates also increases in relation to the body-size. The minute granules on the exterior edge of the infero-marginal plates of the smallest specimens become short, thick spines in the larger specimens. The marginal plates in the larger specimens are relatively larger and broader. The number of pedicellariae, both the valvate on the ventro-lateral and infero-marginal plates, and the simple ones on the adambulacral plates, increases with the size of the body. The smallest specimens lack pedicellariae altogether. The exterior series of adambulacral spines develops from a few granules into a series of large, transversely flattened spines, as do

the marginal spines on the central part of the oral plates. In the individual specimens there is some variation in number and size of the granules in the different ventro-lateral areas, in the size of the spinelets along the exterior edge of the infero-marginal plates in the different interradii and in the number of the pedicellariae in the various interradial areas. The variation in size is illustrated in fig. 8c.

Discussion. — In 1956 Bernasconi described a new species of the genus *Anthenoides* as *Anthenoides brasiliensis*. Seventy-five years earlier, in 1881, Perrier had described the species *Anthenoides peircei*.

In her "observaciones" Bernasconi mentions that *Anthenoides brasiliensis* greatly resembles *A. peircei* in shape and general aspect. In fact the differences between the two species as listed by Bernasconi are: *Anthenoides brasiliensis* has narrower infero-marginal plates in the interradii, fewer valvate pedicellariae and hemispherical granules on its ventro-lateral plates, while these are smaller and more dispersed, and less granuliform along the exterior edge of the infero-marginal plates than in *A. peircei*; these granuliform spines are infirm in *A. brasiliensis* and both surfaces of the animal are less granular than in *A. peircei*. *A. peircei* occurs near the Antilles and off the north coast of Cuba; *A. brasiliensis* off the coast of Brazil from 30° 43′ S to 23°45′ S. After having investigated another two newly obtained (1958) specimens of *A. brasiliensis*, Bernasconi said that there is some variation in the number of the valvate pedicellariae on the various ventro-lateral plates of the series adjacent to the adambulacral plates and in the number of the accompanying, hemispherical granules. The other rows may bear some enlarged granules and, incidentally, a pedicellaria. The infero-marginal plates may bear more, infirm granuliform spines. H. L. Clark (1941) the only author recording newly caught specimens of *A. peircei* since Perrier, had 19 specimens at his disposal with the R ranging from 40 to 165 mm. He states that the proportion of r's to R's is essentially the same in the largest and in the smallest, R/r 2.5-2.75 (Bernasconi: *Anthenoides brasiliensis*: R/r: 2.9 and 2.7), that changes during growth are almost wholly due to the development of the granular membrane, which more or less obscures plate-outlines in adults, and the increase in number of pedicellariae and spines on the infero-marginal plates, and that this last-named feature shows much diversity among the larger specimens.

The specimen originally described by Perrier (1881) has R: 80 mm. Perrier (1883) also investigated two larger specimens (R: 131 and 156 mm) and found the hemispherical granules on the ventro-lateral plates and the enlarged granules along the exterior edge of the infero-marginal plates stronger than in the smaller specimen.

R in the specimens from Surinam ranges from 17 to 107 mm. The description of Bernasconi fits the smaller specimens very well. The larger individuals, however, show the differences used by Bernasconi to discriminate between *Anthenoides brasiliensis* and *A. peircei*. The description by Perrier

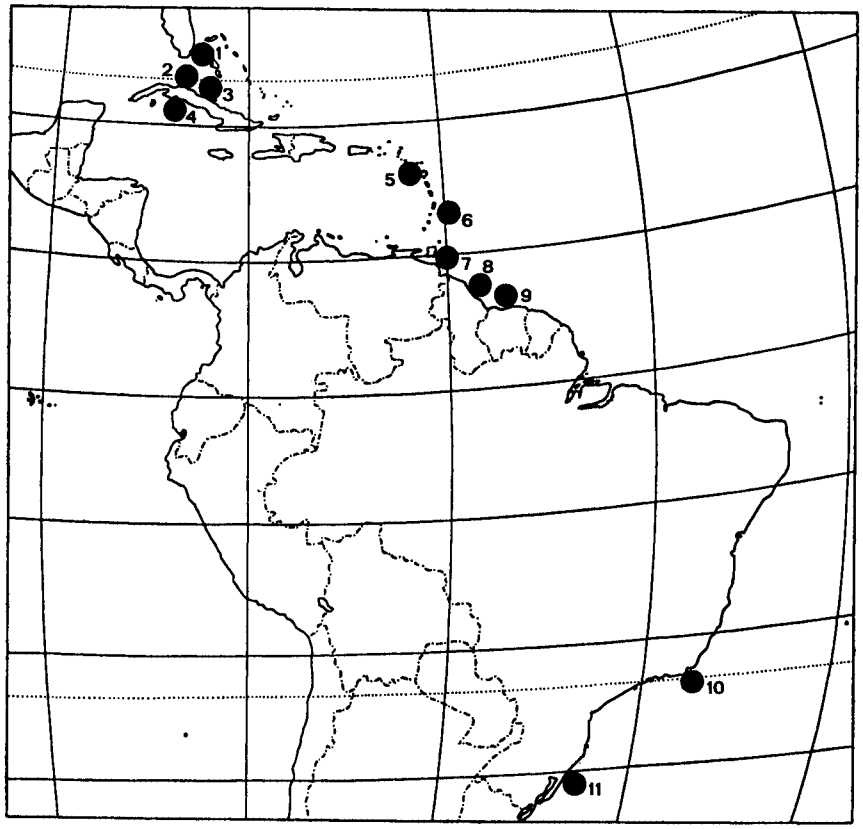


Fig. 21, *Anthenoides peircei* Perrier, distribution in Caribbean and along Atlantic coast of South America. Explanation of numbers used; 1, St. Lucie, Florida; 2, Matanzas, Cuba; 3, Cayo Romano, Camaguey; 4, Bahia de Cochinos, Santa Clara; 5, Guadeloupe; 6, Barbados; 7, off Rio Orinoco; 8, Guyana; 9, Surinam; 10, Cabo Frio; 11, Palmares do Sul.

of *Anthenoides peircei* thus fits the largest specimens. My specimens show a gradual transition in all features from the smaller to the larger ones. For these reasons I am inclined to believe that Bernasconi's *Anthenoides brasiliensis* is not a new species, but a juvenile form of *Anthenoides peircei*. As the two names in my opinion are synonyms, I have used the older: *Anthenoides peircei*.

Distribution (fig. 21). — Caribbean area and north and east coasts of

South America. St. Lucie, Florida; Cuba: northern coast between Cayo Romano, Camaguey and the Bahia de Matanzas; Bahia de Cochinos, southern coast of Santa Clara province, Cuba; Guadeloupe; Barbados (type locality); off Rio Orinoco; British Guyana; Surinam; Brazil: from Cabo Frio to Palmares do Sul.

Rosaster alexandri (Perrier, 1881) (fig. 22; pl. 4 fig. 1; pl. 14 fig. 2; pl. 15 fig. 1)

Pentagonaster alexandri Perrier, 1881: 22; 1883: 241. — Sladen, 1889: 256.
Rosaster alexandri — Perrier, 1894: 387. — Verrill, 1899: 197; 1915: 111. — Fisher, 1919: 240. — H. L. Clark, 1941: 41. — Madsen, 1951: 89. — A. H. Clark, 1954: 375. — Halpern, 1970: 208. — Downey, 1973: 54.

Material examined: One specimen from station M97. R: 36 mm, r: 14 mm.

Diagnosis. — Body pentagonal, with fairly long, slender arms. Five enlarged dorsal plates in interradii forming pentagon around anus, in this pentagon there are eight smaller plates. Dorsal plates are paxilliform. Two longitudinal series of spines on adambulacral plates: five rod-shaped slender spines in the inner series and about three thicker ones in the outer series. Cf. pl. 4 fig. 1; pl. 14 fig. 2; pl. 15 fig. 1.

Description. — The body is pentagonal, with rather long, slender arms. The R/r ratio is 2.6.

Many dorsal plates, shaped as real paxillae are present. The dorsal plates, as in *Mediaster*, are basally connected by small ossicles. The plates in the the radii are circular and set with 6-12 central granules, surrounded by a fringe of marginal spinelets. Between these plates there are many papular holes. The plates in the interradii and on the centre of the disk have a less regular form and do not show any size difference between the central and marginal spinelets. Five interradial plates, near the centre of the disk, are obviously enlarged and form a pentagon in which eight smaller plates and the anus, covered with very small spines, are situated. Adjacent to one of these enlarged plates lies the madreporite, smaller than the enlarged plate, but larger than the remaining plates and marked by many fine, radiating grooves.

Each ray has about 30 supero-marginal plates on each side, gradually decreasing in size towards the tip of the arm. The plates are set with numerous short granules and join at the base of the arm. Only six plates on each side of the body are not contiguous with those of the other side. On the arms the plates may be asymmetrical with respect to each other and there even may be some additional, smaller plates between the two series. The infero-marginal plates correspond with the supero-marginal plates. In the distal half of the arm, however, there usually is an extra plate. Distal to this extra plate the two series correspond again. Consequently each ray has about 32

infero-marginal plates. The infero-marginal plates have the same shape and granulation as the supero-marginal plates. Where the two series of supero-marginal plates meet, on the other, ventral side of the body, the infero-marginal and adambulacral plates also join. In each Radius about thirty, irregularly polygonal, ventro-lateral plates are to be found, distinctly separated from, and granulated similar to the marginal plates.

The adambulacral plates bear two longitudinal series of rod-shaped spines, viz., an interior series with usually five slender, transversely flattened spines

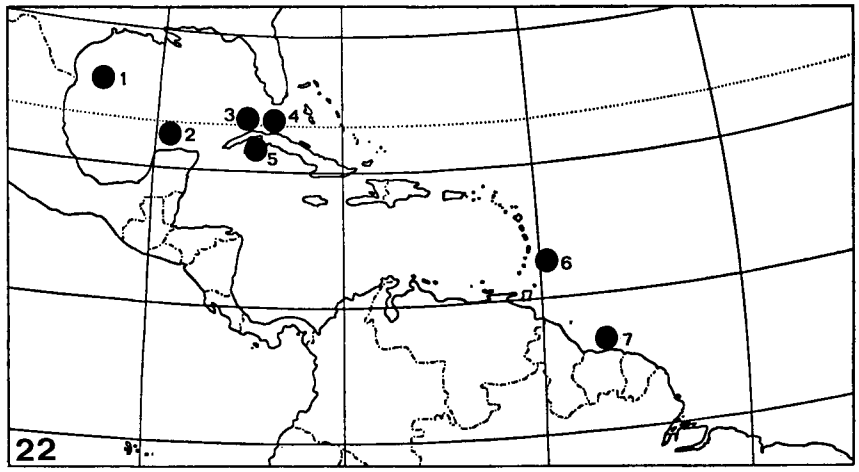


Fig. 22, *Rosaster alexandri* (Perrier), distribution in Caribbean area and along tropical Atlantic coast of South America. Explanation of numbers used: 1, Gulf of Mexico; 2, Yucatan; 3, Havana; 4, Matanzas; 5, Golfo de Batabano; 6, Barbados; 7, Surinam.

and an outer one with 2-3 larger, conical spines. Ad- and aborally to this series there often is a much smaller, pointed spine. Exterior to the outer series some granules are situated, similar to those of the ventro-lateral plates. The oral plates are small, with a distinct, interradial furrow.

Discussion. — This is the largest specimen of *Rosaster alexandri* yet taken, but the generic and specific characters are not in any appreciable way different from those shown by smaller specimens. I can therefore support the opinion of H. L. Clark (1941) that it seems clear that this species is not the juvenile stage of some larger Goniasterid.

Distribution (fig. 22). — Caribbean area: Straits of Florida, Gulf of Mexico, off Yucatan, Havana, Matanzas, Golfo de Batabano, Barbados. North coast of South America: Surinam.

Nymphaster subspinosus (Perrier, 1881) (fig. 23; pl. 15 figs. 3, 4; pl. 16 fig. 1)

Pentagonaster subspinosus Perrier, 1881: 21; 1883: 234.
Nymphaster subspinosus — Sladen, 1889: 295. — Verrill, 1899: 185. — H. L. Clark, 1941: 40. — A. H. Clark, 1954: 375. — Halpern, 1970: 228. — Downey, 1973: 54.

Material examined: One specimen from station B22. R: 117 mm, r: 28 mm.

Diagnosis. — Body pentagonal, with long, slender arms. Supero-marginal plates join in mid-radius for nearly their whole length. Dorsal plates, in radii, hexagonal, distinctly separated and with large papular hole near each angle of hexagon. Both dorsal, marginal and ventro-lateral plates covered with short granules. Supero-marginal plates in interradii smaller than in base of arms. Enlarged, pointed granules may occur on infero-marginal plates. Cf. pl. 15 figs. 3, 4; pl. 16 fig. 1.

Description. — The body is pentagonal, with long, slender arms. The R/r ratio is 4.2.

The dorsal side of the body is covered with hexagonal plates, distinctly separated from each other and with a large papular hole near each angle of the hexagon. In the interradial area the form of the plates is less regular, they are less distinctly separated and there are no papular holes. The most regularly shaped plates are to be found in the middle of the radii, running in straight series. Near the supero-marginal plates, particularly in the interradii, the plates are much smaller and more closely packed. Each plate has 20-30 short, thick granules, of which some central ones often are slightly enlarged. Many dorsal plates have a small, bivalved pedicellaria hidden between their granules. Between four apical plates a small circle of very small, short, pointed spines, covering the anus, is visible.

Close to the anus, at a distance of two dorsal plates, the clearly visible, circular madreporite is situated; it is as large as 2-3 dorsal plates and its surface is marked by many fine, radiating grooves.

The supero-marginal plates are completely covered with granules, as are the dorsal plates, but they have no enlarged granules, except for some along the exterior margin of the plates. In the intact arms there are about 86 plates per ray. At the side of the pentagon, formed by the dorsal plates, the supero-marginal plates, although also much broader than long, are smaller than those at the angles of the pentagon, at which places the largest supero-marginal plates are to be found. From the base to the distal part of the arm the plates gradually become narrower. At the middle of the ray, the plates are as long as broad, distally they are longer than broad. The supero-marginal plates, although they already meet at the base of the arm, do not always quite correspond. Sooner or later, in some arms in the proximal, in others in the distal

part of the arm, the supero-marginal plates become displaced with respect to each other and even alternate. On their lateral face the plates often bear a small, bivalved pedicellaria.

The infero-marginal plates, like the dorsal, the supero-marginal and the ventro-lateral plates, are completely covered with short granules. Along their exterior edge the plates bear some granules, which are slightly enlarged and may even form, particularly in the base of the arm, a short, pointed spine. The plates gradually decrease in size from the interradii to the tip of the arm. In the interradii the plates are about twice as broad as long; more distally they gradually become narrower until, at the tip of the arm, they are small, naked, and about twice as long as broad.

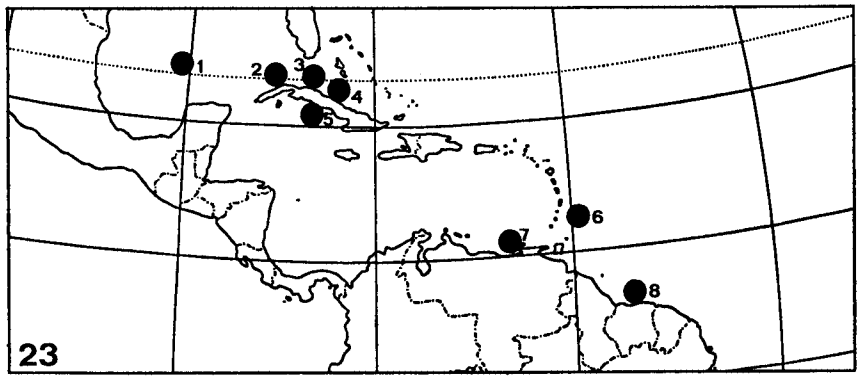


Fig. 23, *Nymphaster subspinosus* (Perrier), geographical distribution in Caribbean and along N. E. coast of South America. Explanation of numbers used: 1, Gulf of Mexico; 2, Havana; 3, Matanzas; 4, Caibarien; 5, Bahia de Cochinos; 6, Barbados; 7, Cariaco; 8, Surinam.

The large ventro-lateral area extends for about a third of the rays. The ventro-lateral plates are irregularly polygonal. The central granules are slightly larger than the marginal ones. Pedicellariae are very rare. The adambulacral plates bear an interior, longitudinal series of about eleven, transversely flattened, rod-shaped spines. The two aboral spines of this series usually are situated a little apart and are not flattened. Exteriorly to this series there are 10-15 large granules, decreasing in size towards the ventro-lateral plates. There are about ten furrow-spines on each side of the small oral plates.

Distribution (fig. 23). — Florida. Caribbean area: Gulf of Mexico; Cuba: Havana, north coast between Caibarien and Matanzas, Bahia de Cochinos, south coast of Santa Clara province; Barbados (type locality). North coast of South America: Cariaco, Venezuela; Surinam; Brazil (00° 18′ N . Doubtfully recorded from the Bay of Biscay, eastern Atlantic.

Oreaster reticulatus (Linnaeus, 1758) (pl. 16 figs. 3, 4)

Asterias reticulata Linnaeus, 1758: 661. — Lamarck, 1816: 556.
Pentaceros reticulatus — Gray, 1840: 276; 1866: 6. — Perrier, 1876a: 62; 1878: 21. — A. Agassiz, 1877: 108. — Vinguier, 1879: 193. — Sladen, 1889: 344. — H. L. Clark, 1898: 5. — Hummelinck, 1933: 304.
Oreaster reticulatus — Müller & Troschel, 1842: 45.
Oreaster lapidarius — Grube, 1857: 342.
Oreaster gigas — Lütken, 1859: 64; 1864: 161. — Verrill, 1867: 278.
Oreaster reticulatus — Bell, 1884: 78. — Döderlein & Hartmeyer, 1910: 151. — Verrill, 1915: 100. — H. L. Clark, 1919: 53; 1933: 22; 1941: 50. — Boone, 1933: 80. — Döderlein, 1936: 318. — Engel, 1939: 3. — A. H. Clark, 1940: 442; 1954: 375. — Caso, 1944: 248; 1961: 59. — Bernasconi, 1956: 135; 1960: 25. — Tommasi, 1958: 16. — Thomas, 1960: 167. — Brito, 1960a: 67; 1962: 3; 1968: 5. — Ummels, 1963: 73. — Roa, 1967: 280. — Gray, Downey & Cerame-Vivas, 1968: 146. — Downey, 1973: 60.

Material examined: One dried specimen from station H52. R: 144 mm; r: 61 mm.

Diagnosis (after Ummels, 1963). — Body distinctly and regularly stellate, R/r ratio as a rule 2.1-2.4, with high, convex central disk and distinct reticulum on the aboral side. Number of arms 5, rarely 4 or 6. On aboral side with distinct circular or pentagonal figure, formed by apical and interradial plates and their spines. Carinal plates do not form a keel, and bear only one spine. Supero-marginal plates bear larger and fewer spines than infero-marginal plates. Adambulacral furrow bordered by two series of spines, inserted on adambulacral plates; inner series composed of 3-5 thin spines; the outer of 1 (rarely 2), rather flat spines without rounded tips. Adambulacralia do not bear alveoles for pedicellariae; all pedicellariae have saucer-shaped basal parts. Both oral and aboral sides covered with polygonal granules; granules on oral side heavier. Cf. pl. 16 figs. 3, 4.

Description. — The colour of the whole body is uniformly yellowish-brown. The specimen I had before me perfectly fits the numerous, often very thorough, descriptions made by previous authors.

Distribution. — Type-locality: specified by Linnaeus (1758): as "Habitat in M. Indico". Atlantic coast of America, from South Carolina, U.S.A., to Abrolhos Reefs, Brazil. Caribbean area: Bahamas, Antilles, Surinam.

Linckia guildingii Gray, 1840 (fig. 24; pl. 16 fig. 2)

Linckia guildingii Gray, 1840: 285; 1866: 14. — Müller & Troschel, 1842: 33. — Perrier, 1875: 408; 1878: 16. — A. Agassiz, 1877: 105. — Sladen, 1889: 409. — H. L. Clark, 1898: 6; 1901: 340; 1919: 54; 1933: 24. — Döderlein & Hartmeyer, 1910: 152. — Fisher, 1911: 242; 1919: 401. — Verrill, 1915: 96. — Van der Horst, 1927: 163. — Engel, 1939: 4. — A. H. Clark, 1940: 442; 1954: 376. — Caso, 1941: 155; 1943: 87; 1961: 70. — Bernasconi, 1955: 68. — Tommasi, 1958: 17. — Brito, 1962: 3. — Ummels, 1963: 81. — Roa, 1967: 279. — Downey, 1968: 41; 1970: 81; 1973: 66.
Lincka pacifica Gray, 1840: 285. — Studer, 1884: 27.
Linckia diplax Müller & Troschel, 1842: 30. — Studer, 1884: 27.

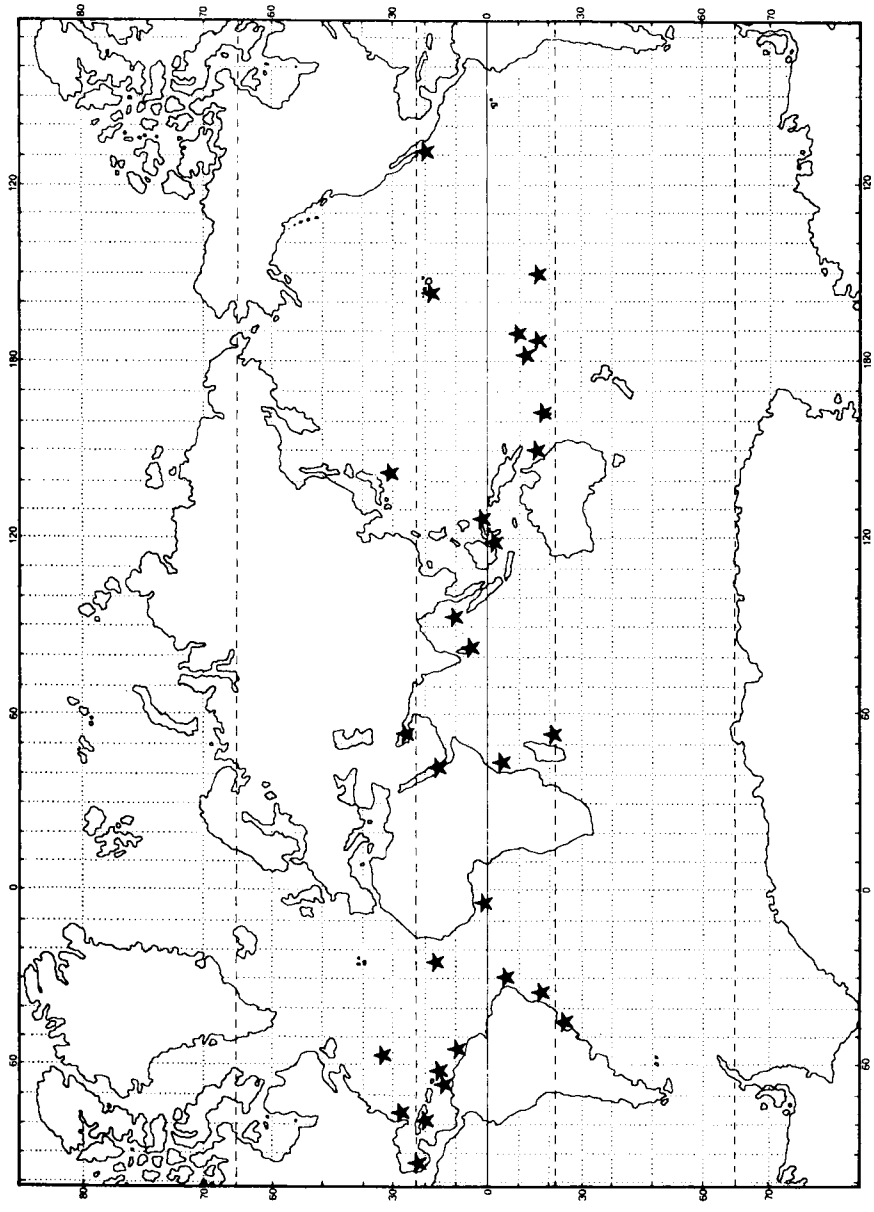


Fig. 24, *Linckia guildingii* Gray, geographical distribution.

Ophidiaster ornithopus Müller & Troschel, 1842: 31. — Lütken, 1859: 80.
Linckia ornithopus — Lütken, 1859: 80. — Verrill, 1867: 344.

Material examined: One specimen from station F46. R: 142 mm.

Diagnosis. — Rays five, other numbers may, however, occur. Arms long, slender, more or less cylindrical, flattened on oral side; laterally bearing three regular, longitudinal rows of plates. Papular areas between aboral plates equal in size or larger than plates, with 15-40 pores in each of them. Dorsal granules small. Cf. pl. 16 fig. 2.

Description. — It is unnecessary to add to the vast number of descriptions made before. For a detailed description and figures I refer to Ummels (1963).

Distribution (fig. 24). — St. Vincent (type locality). The species occurs in all warm waters of the world. Atlantic: Bermudas, Florida, Caribbean area, Gulf of Mexico, Surinam, Brazil, south to Ubatuba. Cape Verde Islands, Guinea. Indian Ocean: Persian Gulf, Red Sea, Zanzibar, Madagascar, Mauritius, Ceylon, Andaman Islands, Indonesia, Moluccas. Pacific Ocean: Queensland, New Caledonia, Fiji, Tonga, Samoa, and Hawaiian Islands, Tahiti, west coast of Mexico, Japan.

Narcissia trigonaria Sladen, 1889 (figs. 8d, 25, 26; pl. 17 figs. 1-4; pl. 18 figs. 1, 2)

Narcissia trigonaria Sladen, 1889: 414. — Verrill, 1915: 97. — Tommasi, 1966: 244. — Brito, 1968: 5. — Gray, Downey & Cerame-Vivas, 1968: 147. — Downey, 1973: 64.

Material examined: Twenty two specimens from five different stations. Station F38: 1 specimen, R: 61 mm; Sta. F39: 1 specimen, R: 69 mm; Sta. G7: 1 specimen, R: 34 mm; Sta. G56: 15 specimens, R: 21, 24, 32, 36, 39, 42, 42, 44, 47, 49, 49, 50, 50, 52, 59 and 64 mm; Sta. H58: 4 specimens, R: 29, 34, 38 and 44 mm. Two specimens from Testigos (Antilles) from the I.T.Z., Amsterdam, R: 32 and 36 mm.

Diagnosis. — Pointed arms fairly long and slender, triangular in cross-section and with median keel, composed of larger, proximally slightly swollen plates. Three series of four or three adambulacral spines. R/r ratio ranging from 3.7 to 6.5 (cf. Tommasi, 1966). Small entrenched, spatulate pedicellariae may be present. Cf. pl. 17 figs. 1-4; pl. 18 figs. 1, 2.

Description. — The body has five long, slender, fairly stiff arms, tapering to a point and triangular in cross-section. The R/r ratio ranges from 3.7 to 6.5. The colour of specimens preserved in alcohol is creamy-white; the colour of dried specimens is pale orange. Colour in live unknown.

The mid-dorsal plates usually are proximally slightly enlarged and regularly arranged to form a more or less median keel. The other dorsal plates are roundish, and, like the marginal and ventro-lateral plates, covered with small,

uniform granules. The dorsal plates, except for the two series along the median interradial line and those of the most distal part of the arm, are surrounded by isolated pores. Entrenched, spatulate pedicellariae are to be found in varying numbers (fig. 25b).

The roundish or rounded triangular madreporite has about the same size as the surrounding plates. "It is situated rather nearer the centre than midway

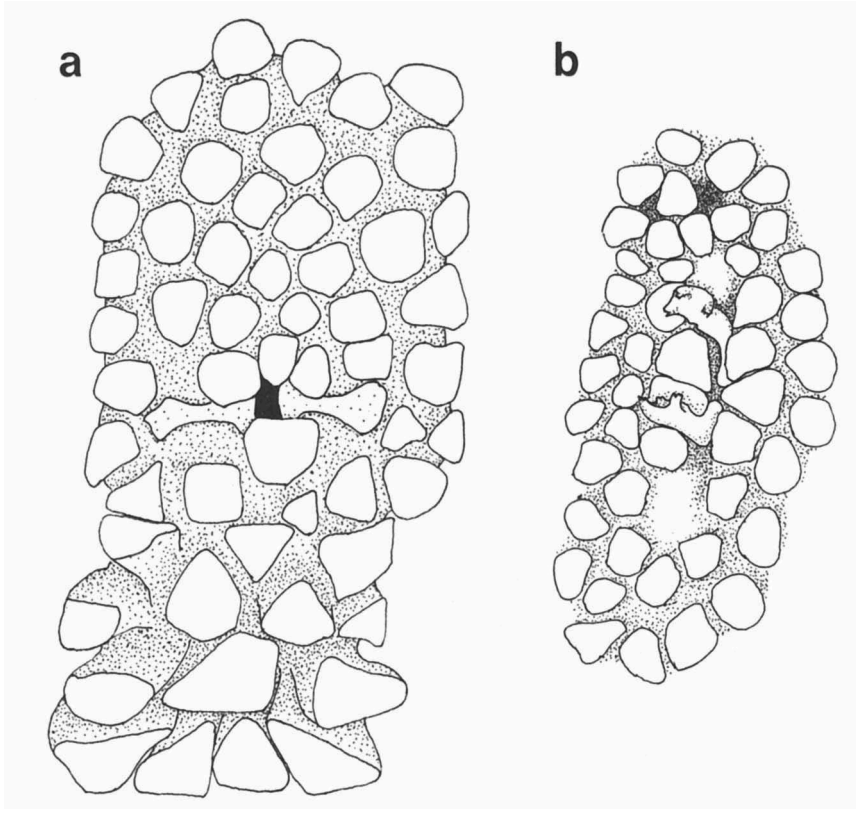


Fig. 25, *Narcissia trigonaria* Sladen. a, ventro-lateral and adambulacral plates. Sta. G 56, R = 44 mm; b, dorsal plate with pedicellariae and papulae, Sta. F 38, R = 61 mm.

between that point and the margin, and lies within the steep declivity of the median interradial line. The striae upon its surface are very fine and show much convolution" (Sladen, 1889).

The anus is slightly eccentric in position and covered by small spinelets, about twice as long as the surrounding granules.

The marginal plates are distinct and slightly convex. They are situated in two corresponding series of more or less rectangular plates; the supero-

marginal plates often are more circular, particularly dorsally, and the infero-marginal plates are more quadrate. At the dorso-adoral angle of each infero-marginal plate one papular pore is present. In the arm one supero- and one infero-marginal plate, together with one or two ventro-lateral plates (two in a longitudinal series), form a transverse series. Series and plates are neatly separated by narrow channels. Again, and this is also the case with the ventro-lateral plates, a variable number of marginals shows a small pedicellaria.

The terminal plates are fairly large, granulated, and often set with very small, glassy bosses. They may occasionnally bear 1-3 enlarged terminal granules. In the ventro-lateral area, there usually are four plates on each side of the median, interradial line, which is represented by a narrow channel. The number of ventro-lateral plates rapidly decreases transversely: from about the fifth infero-marginal plate only a single row of plates runs between the infero-marginal and adambulacral plates. Near the tip of the arm the plates become narrower and finally disappear. The granulation becomes slightly coarser towards the adambulacral plates. No ventral papular pores are present.

The adambulacral plates, which roughly correspond with the ventro-lateral plates, are armed with three longitudinal rows of spines (fig. 25a). The furrow-series consists of four, sometimes five or three, more or less flattened spines, imbricately arranged, the adoral one usually slightly shorter and about twice as broad as the others. The broad and flattened or rod-shaped, four or three spines of the second series are shorter than the furrow-series and usually thicker. The adoral spine of this series often is a little more remote from the furrow or may even be counted with the third series. The outer series consists of four granules not much larger than the neighbouring ventro-lateral ones. Some additional granules may be found outside this series. Only one adambulacral plate in all specimens examined bears a pedicellaria.

Variability. — Though none of my specimens from Surinam completely lacked pedicellariae, the number of these organs varies considerably. On the dorsal plates the pedicellariae are quite numerous. In the smallest specimens their number is fewer than in the larger ones. The distal part of the arm always lacks pedicellariae. The number of pedicellariae in the marginal plates varies independently of the size of the animal, from very few to one on almost every plate. The supero-marginal plates usually bear more pedicellariae than the infero-marginal plates, although the opposite may also occur. On the ventro-lateral plates too the number of pedicellariae varies independently of size of the specimen, from very few to one on almost every plate

of the arm. Some specimens (R: 21, 24, 36 and 47) lack pedicellariae on these plates.

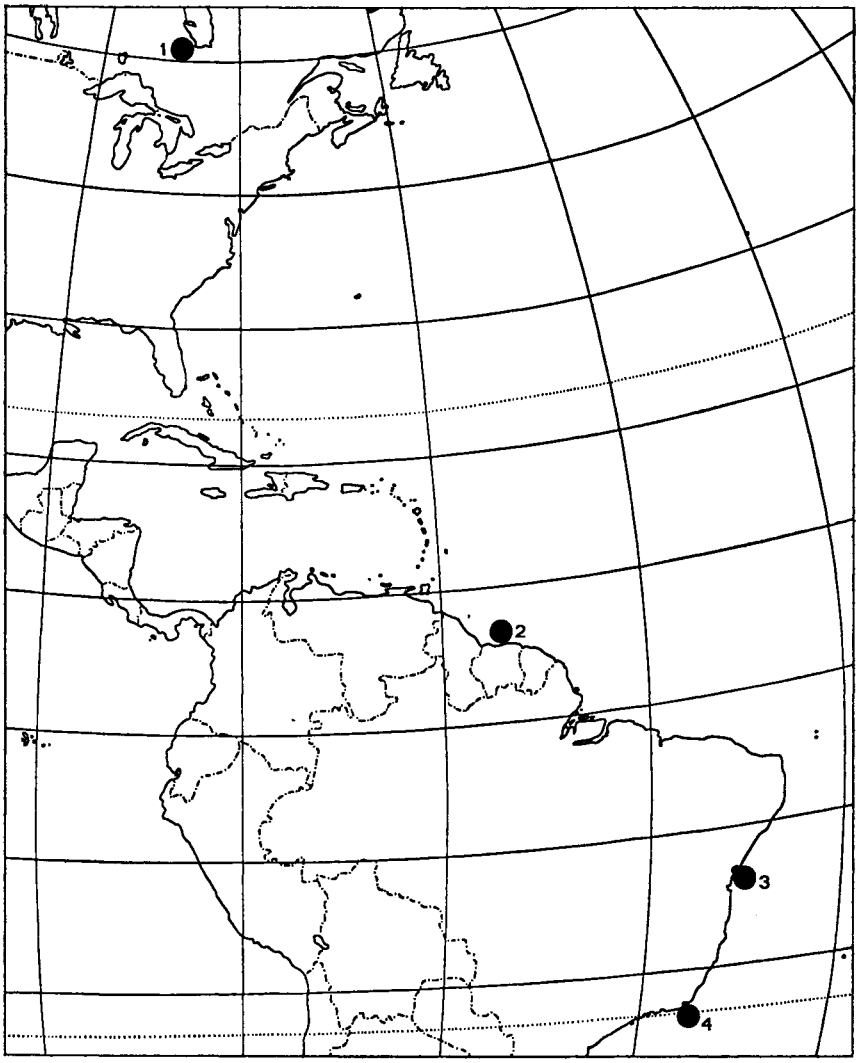


Fig. 26, *Narcissia trigonaria* Sladen, distribution in western Atlantic. Explanation of numbers used: 1, West Florida; 2, Surinam; 3, Bahia; 4, Cabo Frio.

The supero-marginal plates may be quite circular and the angles of the quadrate infero-marginal plates may be rounded. The variation in size is shown in fig. 8d.

Discussion. — The Surinam specimens differ from previously described

specimens of *Narcissia trigonaria* by their general aspect, being more solid, and by the presence of pedicellariae.

I am very much inclined to consider *Narcissia trigonaria* conspecific with *N. canariensis* d'Orbigny of East Atlantic waters. According to Sladen (1889) *N. trigonaria* is to be distinguished from *N. canariensis* by the shorter and broader rays, by the tubercular character of the dorsal plates on the median keel of the rays, by the size and convexity of the marginal plates, as well as by the differences in adambulacral armature.

The rays of *N. canariensis* generally are longer, but the R/r ratios are quite variable and there certainly is an overlap. I have investigated a considerable number of specimens of *N. canariensis* in the British Museum (Natural History) and I could not find any noteworthy differences in the dorsal or the marginal plates of the two species. The adambulacral armature in all specimens of the genus *Narcissia* consists of three series of four or three, rarely five, spines. A fourth series of a few additional granules may be present. Pedicellariae do not seem to be present on the earlier investigated specimens of *Narcissia trigonaria*, as they are on *N. canariensis* and on my specimens from Surinam. This character, however, also is subject to some variation and only few specimens of *N. trigonaria* have so far been investigated.

Adults of *Narcissia canariensis* seem to be bigger (R: 172 mm), but in this species a larger number of specimens has been studied.

For reasons of bio-geography I have named my specimens *Narcissia trigonaria*, realising their possible conspecificity with *N. canariensis*; thorough investigation may very well prove that the specimens will have to bear this latter, older, name.

Distribution (fig. 26). — Off Bahia (type locality), West Florida, Surinam, Bahia, Cabo Frio (Ilha dos Porcos).

Echinaster brasiliensis Müller & Troschel, 1842 (figs. 8e, 27; pl. 18 fig. 3, 4)

Echinaster brasiliensis Müller & Troschel, 1842: 22. — Lütken, 1859: 93. — Perrier, 1875: 367. — Rathbun, 1879: 148. — Ludwig, 1882: 7. — Sladen, 1889: 553, 808. — Ives, 1890: 324. — Verrill, 1915: 41. — Bernasconi, 1956b: 137. — Tommasi, 1958: 22; 1970: 17. — Brito, 1960a: 66; 1962: 2; 1968: 13. — Gray, Downey & Cerame-Vivas, 1968: 156. — Downey, 1973: 88.

Material examined: 65 specimens from 28 different stations.

Sta. A9: 4 specimens, R: 16, 19, 19 and 20 mm; Sta. A10: 2 specimens, R: 17 and 18 mm; Sta. A27: 1 specimen, R: 16 mm; Sta. A68: 3 specimens, R: 21, 23 and 25 mm; Sta. B2: 5 specimens, R: 7, 14, 15, 18 and 24 mm; Sta. C21: 2 specimens, R: 6 and 11 mm; Sta. D30: 1 specimen, R: 28 mm; Sta. D31: 1 specimen, R: 20 mm; Sta. D32: 4 specimens, R: 17, 17, 21 and 22 mm; Sta. D33: 3 specimens, R: 20, 20 and 24 mm;

Sta. E62: 1 specimen, R: 10 mm; Sta. F6: 3 specimens, R: 7, 10 and 20 mm; Sta. F38: 4 specimens, R: 18, 25, 25 and 26 mm; Sta. F40: 1 specimen, R: 9 mm; Sta. F41: 3 specimens, R: 12, 19 and 20 mm; Sta. F41: 3 specimens, R: 12, 19 and 20 mm; Sta. F42: 3 specimens, R: 22, 24 and 25 mm; Sta. F43: 2 specimens, R: 13 and 20 mm; Sta. G7: 2 specimens, R: 18 and 19 mm; Sta. G55: 5 specimens, R: 7, 24, 26, 32 and 35 mm; Sta. H51: 2 specimens, R: 27 and 32 mm; Sta. H52: 2 specimens, R: 22 and 25 mm; Sta. H53: 1 specimen, R: 41 mm; Sta. I116: 1 specimen, R: 17 mm; Sta. I117: 1 specimen, R: 14 mm; Sta. I 121: 1 specimen, R: 27 mm; Sta. J111: 1 specimen R, 14 mm; Sta. M88: 3 specimens, R: 15, 20 and 22 mm; M98: 3 specimens, R: 18, 31 and 38 mm.

Diagnosis. — Five, fairly long and slender arms. R/r ratio c. 5. About 9 longitudinal rows of small, acutely conical spines, not much larger than outer adambulacral spines. Adambulacral plates with four spines, of which most interior is rudimentary or absent. Madreporite prominent, circular, with many granules and grooves. Cf. pl. 18 figs. 3, 4.

Description. — The body has five, long and slender, cylindrical arms. The R/r ratio is about five. The colour, in specimens preserved in alcohol, varies from whitish to dark rust-brown.

There are no clear differences between dorsal, lateral and marginal plates, which are all set with small, hyaline granules under a fairly thick skin. The plates usually bear a small, acutely conical spine, not much larger than the outer adambulacral spines. The spines on the most dorsal series of plates are smaller and fewer in number. The supero-marginal spines, if the animal is viewed from above, form the border of the arms. There usually are nine longitudinal series of spines, except for the smaller specimens. Between the dorsal plates there are large papular areas, often larger than the enclosed plates; laterally these areas become smaller until, on the ventral surface, there is only one papular hole at a time. Ten large, partially granular, apical plates, together with ten smaller, non-granular plates, form a large pentagon on the disk.

One of the large plates on the sides of the pentagon is the madreporite, which is prominent, circular, with many granules and irregular grooves.

The anus, bordered by smaller spines, is visible between the apical spine in the centre of the pentagon, and one of the large plates on the side of the pentagon.

Between the supero- and infero-marginal series there are, proximally, some smaller, usually naked plates.

The fairly small, adambulacral plates usually bear four spines: two straight, conical, exterior spines, which resemble the other spines on the body very much, and one, but usually two, smaller, more or less curved, ad- and aborally flattened, interior spines. The adambulacral spines may form straight transverse series, or inner and outer spines may alternate in various ways.

The oral plates have on both sides three spines on the same level as the

inner series of exterior adambulacral spines, and one spine on both sides on the level of the outer series of exterior, adambulacral spines. Under the two most orally situated spines about four smaller, straight spines are to be found, placed deep in the furrow.

Variability. — The colour in the specimens preserved in alcohol varies from all whitish to dark rust-brown. The brown colour, however, may origi-

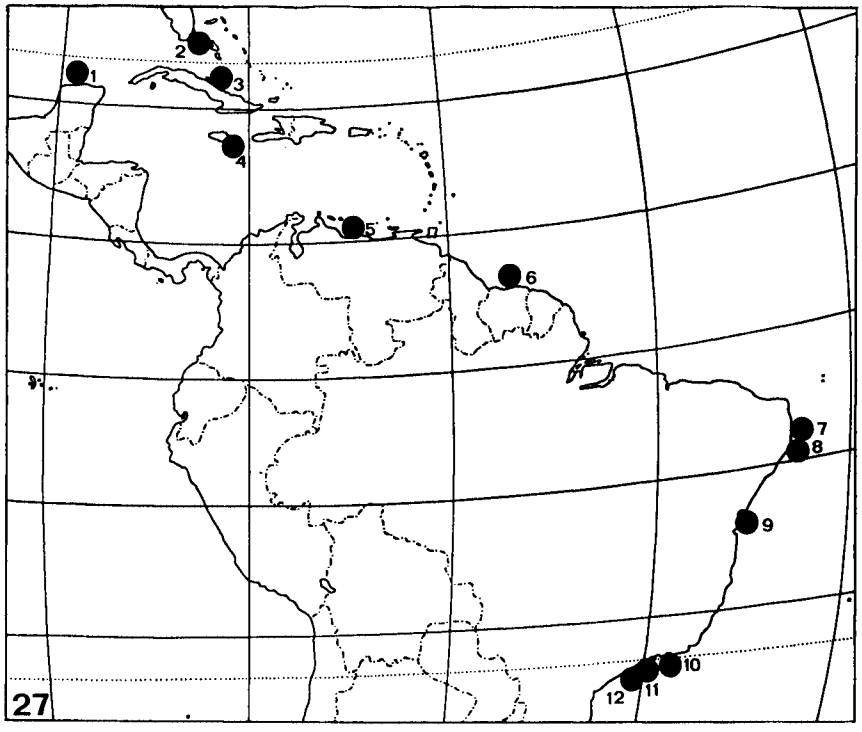


Fig. 27, *Echinaster brasiliensis* Müller & Troschel, distribution in Caribbean and along Atlantic coast of South America. Explanation of numbers used: 1, Yucatan; 2, Florida; 3, Cuba; 4, Jamaica; 5, Puerto Cabello; 6, Surinam; 7, Pernambuco; 8, Rio Formoso; 9, Bahia; 10, Rio de Janeiro; 11, Ubatuba, São Sebastião; 12, São Paulo.

nate from other animals, once preserved in the same alcohol; the specimens from one jar all have the same colour.

The number of spines on the adambulacral plates may vary from two to five. The number of spines on the most dorsal series of plates varies from one to fifteen. There may be a large variation in the arrangement of the adambulacral spines. The size of the dorsal papular areas may also vary slightly. The size variation is illustrated in fig. 8e.

Distribution (fig. 27). — North Carolina, Florida, U.S.A.; Caribbean area and north and east coasts of South America: Kingston, Jamaica; Cuba;

Yucatan; Puerto Cabello, Venezuela; Surinam; Brazil: Pernambuco, Rio Formoso, Bahia, Rio de Janeiro, Ubatuba (type locality), São Sebastião, São Paulo.

Echinaster modestus Perrier, 1881 (fig. 28; pl. 6 figs. 1, 2)

Echinaster modestus Perrier, 1881: 7; 1883: 206. — Verrill, 1915: 43. — H. L. Clark, 1941: 55. — A. H. Clark, 1954: 376. — Downey, 1973: 87.

Material examined: Three specimens from two different stations. Station G56: 2 specimens, R: 26 and 36 mm, r: 5.5 and 7 mm; Station H57: 1 specimen, R: 33, r: 8 mm.

Diagnosis. — Five long, slender, gradually tapering arms, proximally slightly convex. Dorsal surface formed of openly reticulated plates, leaving larger, sunken, papular areas, containing groups of 2-5 papulae. Dorsal and lateral spines very small, forming about nine irregular rows, with scattered

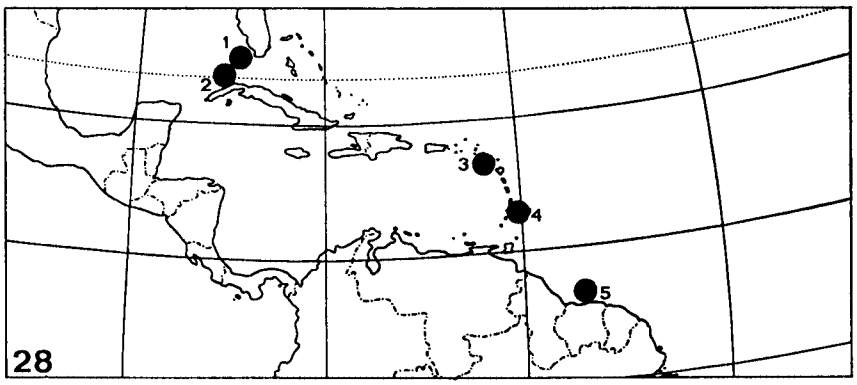


Fig. 28, *Echinaster modestus* Perrier, distribution in Caribbean and along Atlantic coast of N. E. South America. Explanation of numbers used; 1, South Florida; 2, Playa Baracoa, Cuba; 3, Montserrat: 4, St. Vincent; 5, Surinam.

spines between them. Marginal plates indistinct. One straight, obtuse adambulacral spine, and two, sometimes three, slightly smaller spines exteriorly. In the ambulacral furrow there usually is a fourth, smaller, ad- and aborally flattened, curved spine. Madreporite small, circular, prominent with radiating grooves and a fringe of small, acute spines. Cf. pl. 6 figs. 1, 2.

Description and discussion. — Perrier (1881) wrote that the adambulacral plates in the furrow bear one thick, short, cylindrical, obtuse spine, strengthened interiorly with an equally thick, but slightly shorter spine, and sometimes by a certain number of smaller spines, placed transversely one behind the other. In 1883, however, he wrote: "strengthened exteriorly....."

Verrill (1915) only refers to Perrier's specimens and also writes that the transverse series of spines is situated exteriorly to the furrow-spine. I am inclined to believe that Perrier and Verrill overlooked the flattened interior

spine, which may be absent, or very small or pressed against the large furrow-spine. In my specimens the regular row of ventro-lateral spines is interrupted at about one third of the arm, instead of at half its length. In several rays there is hardly any regularity noticeable in the nine rows of spines. The species is very rare, only five specimens have so far been caught.

Distribution (fig. 28). — Montserrat (type locality). West of South Florida, 25°33′ N, 84°21′ E. Playa Baracoa, Havana Province, Cuba. St. Vincent. Surinam.

Literature cited

Agassiz, A., 1877. North American Starfishes. — Mem. Mus. comp. Zool., Harvard, 5(1, iv): 1-137.

——, 1888. Three Cruises of the United States Coast and Geodetic Survey Steamer "Blake" in the Gulf of Mexico, in the Caribbean Sea, and along the Atlantic Coast of the United States, from 1877 to 1880. XIX Characteristic Deep-Sea Types. Echinoderms. — Bull. Mus. comp. Zool. Harv., 15 (2): 84-127, figs. 338-421.

Agassiz, L., 1835a. Notice sur les fossiles du terrain cretacé du jura neuchâtelois. — Mém. Soc. neuchât. Sci. nat., 1: 126-145, pl. 14.

——, 1835b. Prodome d'une monographie des Radiares ou Échinodermes. — Mém. Soc. neuchât. Sci. nat., 1: 168-199.

Bell, F. J., 1884. Contributions to the systematic arrangement of the Asteroidea II. The species of Oreaster: 57-87.

——, 1917. Echinodermata. Part I. Actinogoniata. — Brit. Antarct. Terra Nova Exped., 1910, Nat. Hist. rep., Zool., 4 (1): 1-10.

Bernasconi, I., 1941. Los equinodermos de la expedicion del buque oceanografico "Comodore Rivadavia" A. R. A. — Physis, 19 (51): 37-50.

——, 1941a. Dos nuevas especies argentinas de "Luidia". — Physis, 19: 117-118.

——, 1943. Los Asteroideos sudamericanos de la familia Luidiidae. — An. Mus. argent. Cienc. nat., 41: 1-20.

——, 1955. Equinoideos y Asteroideos de la colleccion del Instituto Oceanografico de la Univ. de San Pablo. 1ª Contribución. — Bolm. Inst. Oceanogr., S. Paulo, 6 (1/2): 51-77.

——, 1956a. Dos nuevos equinodermos de la costa de Brasil. — Neotropica, 2 (8): 33-35.

——, 1956b. Enquinoideos y Asteriodeos de la colleccion del Instituto Oceanografico de la Univ. de San Pablo. 2a Contribución. — Bolm. Inst. Oceanogr., S. Paulo, 7 (1/2): 119-148.

——, 1957. Otra nueva especie de Asteroideo brasileño. — Neotropica, 3 (11): 33-34.

——, 1958. Asteroideos de la colleccion del Instituto Oceanografico de la Universidad de San Pablo. — Bolm. Inst. Oceanogr., S. Paulo, 9: 13-21.

——, 1960. Los Equinodermos de la campana 1958 del buque oceanografico "Capitan Canepa" A. R. A. — Actas Trab. I Congr. sudamer. Zool. 1959, 2: 21-32.

——, 1963. Goniasteridae. Asteroideos Argentinos. IV. — Revta. Mus. argent. Cienc. nat. Bernardino Rivadavia, 9 (1): 1-25, pls. 1-5.

——, 1964. Asteroideos Argentinos. Claves para los ordines, familias, subfamilias y generos. — Physis, 24: 241-277.

——, 1964a. Distribución geografica de los equinoideos y asteroideos de la extremidad austral de Sudamerica. — Bol. Inst. Biol. Mar., 7: 43-50.

——, 1966. Los Equinoideos y Asteroideos colectados por el buque oceanografico R/V "Vema", frente a las costas Argentinas Uruguayas sur de Chili. — Revta. Mus. argent. Cienc. nat. Bernardino Rivadavia, 9: 147-175.

BLAINVILLE, H. M. D. DE, 1834. Manuel d'Actinologie ou de Zoophytologie. — Paris, F. G. Levrault: i-viii, 1-644. Atlas, 100 pls.

BOONE, L., 1933. Scientific results of cruises of the yachts "Eagle" and "Ara", 1921-1928, W.K. Vanderbilt commanding. — Bull. Vanderbilt mar. Mus., Huntington, 4: 68-102.

BRITO, I. M., 1960. Asteróides dos Estados do Rio de Janeiro e de São Paulo. — Cent. Estud. zool. Univ. Brasil, Avulso, 5: 1-13, pls. 1-3.

——, 1960a. Asteroides e Equinoides brasileiros das colecoes do C. E. Z. — Actas Trab. I Congr. sudamer. Zool. 1959, 2: 61-68.

——, 1962. Ensaio de catalogo dos equinodermas do Brasil. — Cent. Estud. zool. Univ. Brasil, Avulso, 13: 1-11.

——, 1963. Asteroidos dos Estados do Rio de Janeiro e de São Paulo. — An. Acad. Bras. Cienc, 36: 566.

——, 1968. Asteroides e equinoides do Estado da Guanabara e adjacencias. — Bolm. Mus. nac. Rio de J., 260: 1-51.

CADENAT, J., 1941. Les Echinodermes da la côte occidentale d'Afrique. Description d'une astérie nouvelle de la région du Cap Blanc. — Annls. Soc. Sci. nat. Charente-Infér., (n. ser.) 3: 53-67.

CASO, M. E. 1941. Contribución al Conocimiento de los Asteridos de Mexico. I. La existencia de Linckia guildingii en la costa Pacifica. — An. Inst. Biol. Univ., Méx., 12 (1): 155-160.

——, 1943. Contribución al conocimiento de los Asteridos de Mexico. Tesis, Mexico: 1-137.

——, 1944. Estudios sobre asteridos de Mexico. Algunas especies interesantes de asteridos litoralis. An. Inst. Biol. Univ., Méx., 15 (1): 237-259.

——, 1961. Estado actual de los conocimiento acerca de los Equinodermos de Mexico. — Fac. Sci. U. N. A. M., Mexico, 1961: 1-388.

CHERBONNIER, G., 1959. Echinodermes de la Guyane Française. — Bull. Mus. Hist. Nat. Paris (2) 31(1): 105-261.

——, 1962. Echinodermes des côtes du Cameroun, recoltées par A. Crosnier en Décembre 1962-Janvier 1963. — Bull. Mus. Hist. Nat. Paris, (2) 35 (2): 179-193.

CLARK, A. H., 1940. Echinoderms of the Smithsonian-Hartford expedition, 1937, with other West-Indian records. — Proc. U. S. natn. Mus., 86: 441-456.

——, 1954. Echinoderms of the Gulf of Mexico. — Fish. Bull., U. S. Fish. Wildlife Serv., 55 (89): 373-379.

CLARK, A. M., 1953. Notes on the Asteroids in the British Museum (Nat. Hist.) III Luidia, IV Tosia and Pentagonaster. — Bull. Br. Mus. nat. Hist., Zool., 1: 379-412.

——, 1955. Echinodermata of the Gold Coast. — J. West Afr. Sci. Ass., 1 (2): 16-56, figs. 1-23, pls. I-II.

CLARK, A. M. & CLARK, A. H., 1954. A revision of the sea-stars of the genus Tethyaster. — Smithson. Misc. Coll., 122 (11): 1-27.

CLARK, H. L., 1898. The Echinoids and Asteroids of Jamaica. — Johns Hopkins Univ. Circ., 18 (137): 4-6.

——, 1899. Further Notes on the Echinoderms of Bermuda. — Ann. New York Acad. Sci., 12: 117-138, pl. 4.

——, 1901. Bermudan Echinoderms. — Proc. Boston Soc. nat. Hist., 16: 339-345.

——, 1909. Notes on some Australian and Indo-Pacific Echinoderms. — Bull. Mus. comp. Zool. Harv., 52: 107-135.

——, 1919. The distribution of the littoral Echinoderms of the West Indies. — Pap. Dep. mar. Biol. Carnegie Instn. Wash., 13: 49-74.

——, 1933. A handbook of the littoral Echinoderms of Porto Rico, etc. — Scient. Surv. P. Rico and Virgin I., 16(1): 4-137.

——, 1941. Reports on the scientific results of the Atlantic expeditions to the West Indies under the joint auspices of the University of Havana and Harvard University. The

Echinoderms (other than Holothurians). — Mem. Soc. Cubana. Hist. Nat., 15: 1-154.
CLARK, H. L., 1946. The Echinoderm fauna of Australia. Its composition and its origin. — Publ. Carnegie Instn. Washington, 566: 1-567.
DÖDERLEIN, L., 1917. Die Asteriden der Siboga-Expedition. I. Die Gattung Astropecten und ihre Stammesgeschichte. — Siboga Exped., Livr. 81 (Mon. 46a) Leiden 1917: 1-191, pls. I-XVII.
——, 1920. Die Asteriden der Siboga-Expedition. II. Die Gattung Luidia und ihre Stammesgeschichte. — Siboga Exped., Livr. 88 (Mon. 46b) Leiden 1920: 25-293, pls. XVIII-XX.
——, 1936. Die Asteriden der Siboga-Expedition. III. Die Unterfamilie Oreasterinae. — Siboga Exped., Livr. 126 (Mon. 46c) Leiden 1936: 191-369, pls. XXI-XXXII.
DÖDERLEIN, L. & HARTMEYER, R., 1910. Westindische Seeigel und Seesterne. — Zool. Jber. Neapel, Suppl., 11: 145-156.
DOWNEY, M. E., 1968. A note on the Atlantic species of the genus Linckia. — Proc. Biol. Soc. Wash., 81: 41-44.
——, 1970. Drachmaster bullisi, New Genus and Species of Ophidiasteridae (Echinodermata: Asteroidea), with a Key to the Caribbean Species of the Family. — Proc. Biol. Soc. Wash., 83: 77-82, figs. 1-6.
——, 1973. Starfishes from the Caribbean and Gulf of Mexico. — Smithson. Contr. Zool., 126: 1-158.
DUJARDIN, M. F. & M. H. HUPÉ, 1862. Histoire naturelle des zoophytes. Échinodermes. — Libraire Encyclopédique de Roret, Paris: 1-627, pls. 1-10.
ENGEL, H., 1939. Echinoderms from Aruba, Curaçao, Bonaire and Northern Venezuela. — — Capita Zool., 8 (44): 1-12.
ENGEL, H., A. F. CROES & G. F. SCHROEVERS, 1960. Les Astérides recoltées par l'expédition du navire-école belge "Mercator" 1935-1936. — Bull. Inst. r. Sci nat. Belg., 36 (54): 1-15.
FISHER, W. K., 1906. New Starfishes from the Pacific coast of North America. — Proc. Wash. Acad. Sci., 8: 111-139.
——, 1910. New genera of starfishes. — Ann. Mag. nat. Hist., (8) 8: 171-173.
——, 1911. Asteroidea of the North Pacific and adjacent Waters. Part I Phanerozonia and Spinulosa. — Bull. U. S. nat. Mus., 76: 1-419.
——, 1919. Contributions to the biology of the Philippine Archipelago and adjacent regions. Starfishes of the Philippine seas and adjacent waters. — Bull. U. S. natn. Mus., 100 (3): 1-703.
——, 1940. Asteroidea. — Discovery Reports, 20: 69-306.
FLORES, C. & A. MARTÍNEZ DE RODRÍGUEZ, 1970. Status de la familia Goniasteridae (Asteroidea: Phanerozonia) en la región oriental de Venezuela. — Bol. Inst. Oceanogr. Univ. Oriente, Cumana, 9: 3-8, figs. 1-6.
FORBES, E., 1841. A History of British Starfishes, and other Animals of the Class Echinodermata. London, 1841: 1-267.
GMELIN, J. F., 1791. Echinodermata. In: Linnaeus, C., Systema Naturae (ed. 13), 1 (6): 3160-3201.
GRAY, J. E., 1840. A synopsis of the genera and species of the class Hypostoma (Asterias, Linnaeus). — Ann. Mag. nat. Hist. (1) 6: 175-184, 275-290.
——, 1866. Synopsis of the Species of Starfish in the British Museum, London: iv, 1-18.
GRAY, I. E., M. E. DOWNEY & M. J. CERAME-VIVAS, 1968. Seastars of North Carolina. — Fish. Bull., U. S. Fish Wildlife Serv., 67: 127-163.
GRUBE, A. E., 1857. Diagnosen einiger neuen Echinodermen. — Arch. Naturgesch., 23: 340-344.
HALPERN, J. A., 1969. The validity and generic position of Pentagonaster parvus Perrier (Echinodermata: Asteroidea). Biological Investigations of the Deep Sea 50. — Proc. Biol. Soc. Wash., 82: 503-506.

HALPERN, J. A., 1970. Goniasteridae (Echinodermata; Asteroidea) of the Straits of Florida. Biological investigations of the Deep Sea 51. — Bull. Mar. Sci. 20 (1): 193-286.

HORST, C. J. VAN DER, 1927. Bijdragen tot de kennis der fauna van Curaçao. Asteroidea. — Bijdr. Dierk., 25: 163-164.

HUMMELINCK, P. WAGENAAR, 1933. Zoologische Ergebnisse einer Reise nach Bonaire, Curaçao und Aruba im Jahre 1930. 1. Reisebericht. — Zool. Jb. (Abt. Syst., Ök., Geogr. Tier.), 64 (3): 289-326, figs. 1-14.

IVES, J. E., 1890. Echinoderms from the Northern coast of Yucatan and the Harbor of Vera Cruz. — Proc. Acad. nat. Sci. Philad., 2: 337-341, pl. VIII.

JOHN, D. D., 1948. Notes on Asteroids in the British Museum (Nat. Hist.). I. The species of Astropecten. — Novit. zool., 42: 485-508.

JOHN, D. D. & A. M. CLARK, 1954. The "Rosaura" Expedition. 3. The Echinodermata. — Bull. Br. Mus. nat. Hist., Zool., 2: 139-162.

KOEHLER, R., 1909. An Account of the Deep-Sea Asteroidea, Collected by the Royal Indian Marine Survey Ship "Investigator". 1. Les Astéries de Mer profonde. — Publ. Trustees Indian Mus. Calcutta: 1-144, pls. 1-13.

——, 1911. Echinodermes. In: Mission en Mauritanie occidentale. — Act Soc. linn. Bordeaux, 65: 19-20.

——, 1912. Deuxième expédition Antarctique Française (1908-1910) commandée par le Dr. Jean Charcot, Sciences Naturelles: Documents scientifiques. Echinodermes (Asteries, Ophiures et Echinides): 1-272.

LAMARCK, J. B. P. A. de, 1816. Histoire naturelle des animaux sans vertèbres (ed. 1), 2: 1-568.

LINCK, J. H., 1733. De Stellis Marinis. — Lipsiae: i-xxiv, 1-107, pls. 1-42.

LINNAEUS, C., 1758. Systema Naturae (ed. 10), 1: 1-824.

LUDWIG, H., 1882. Verzeichniss der von Prof E. van Beneden an der Küste von Brasilien gesammelten Echinodermen. — Mém. cour. Acad. r. Sci. Belg., 44 (4): 1-26.

——, 1899. Echinodermen des Sansibargebietes. — In: VOELTZKOW, Wissenschaftliche Ergebnisse der Reisen in Madagaskar und Ost-Afrika in den Jahren 1889-1895. Abh. Senckenberg Naturforsch. Ges., 21: 537-563.

——, 1905. Seesterne der "Albatross" Expedition. — Mem. Mus. comp. Zool. Harv., 23: i-xii, 1-292, pls. 1-35.

LÜTKEN, C. F., 1859. Bidrag til kundskab om de ved kysterne af Mellemog Syd-Amerika levende Arter af Söstjerner. — Vid. Medd. Dansk Naturh. Foren., 1859: 25-97.

——, 1864. Kritiske Bemaerkninger om forskjellige Söstjerner (Asterider) med Beskrivelse af nogle nye Arter. — Vid. Medd. Dansk. Naturh. Foren., 1864: 123-169.

——, 1871. Forsatte kritiske og beskrivende Bidrag til Kundskab om Sötjernerne (Asteriderne). — Vid. Medd. Dansk Naturh. Foren., 1871: 227-304.

MADSEN, F. J., 1950. The Echinoderms collected by the Atlantide Exp. 1945-1946. I Asteroidea. With remarks on other seastars from tropical and Northern West Africa. — Atlantide Rep., 1: 167-222.

——, 1951. Asteroidea. — Report of the Swedish Deep-Sea Expedition, 1947-1948, 2, Zoology (6): 73-92, figs. 1-2.

MARTENS, E. VON, 1866. Ueber Ostasiatische Echinodermen. — Arch. Naturgesch., 31 (1): 57-88.

MÜLLER, J. & F. H. TROSCHEL, 1842. System der Asteriden: 1-135.

PERRIER, E., 1869. Recherches sur les Pédicellaires et les Ambulacres des Astéries et des Oursins. Pt. 1. — Annls. Sci. nat., 12: 197-304.

——, 1875. Révision de la collection de Stellérides du Muséum d'Histoire Naturelle de Paris. — Archs. Zool. exp. gén., 4: 265-450.

——, 1875a. Sur la classification et la synonymie des Stellérides. — Compt.-Rend. Hebd. Seanc. Acad. Sci. 81: 1271-1273.

——, 1876a. Révision de la collection de stellérides du Museum d'Histoire Naturelle de Paris. — Archs. Zool. exp. gén., 5: 1-304.

PERRIER, E., 1876b. Diagnoses of new species of Asteridae and Linckiidae in the British Museum. — Ann. Mag. nat. Hist., (4) 17: 34-36.

——, 1876c. On the Classification and Synonymy of the Stellerida. — Ann. Mag. nat. Hist., (4) 17: 259-261.

——, 1876d. Les Stellérides des Iles du Cap-Vert. — Bull. Soc. Zool. France, 1: 63-71.

——, 1878. Etude sur la répartition geographique des Astérides. — Nouv. Archs. Mus. Hist. nat., Paris, (2) 1: 1-108.

——, 1881. Reports on the results of dredging under the supervision of A. Agassiz in the Gulf of Mexico, 1877-1878, by the U. S. C. S. Steamer "Blake". XIV. Description sommaire des espèces nouvelles d'Astérides. — Bull. Mus. comp. Zool. Harv., 9 (1): 1-31.

——, 1883. Mémoire sur les Etoiles de mer recueillis dans la mer des Antilles et le Golfe de Mexique ("Blake Exp."). — Nouv. Arch. Mus. Hist. nat., Paris, (2) 6: 127-276.

——, 1885. Première note préliminaire sur les échinodermes recueillis durant les campagnes des dragages sous-marins du "Travailleur" et du "Talisman". — Annls. Sci. nat., (6) 19 (8): 1-72.

——, 1894. Echinodermes. I Stellérides. Expéditions scientifiques du Travailleur et du Talisman pendant les années 1880, 1882, 1883. — Arch. Missions Sci. Lit. Paris, (3) 9: 1-432.

RATHBUN, R., 1879. A list of the Brazilian Echinoderms, with notes on their distribution. — Trans. Conn. Acad. Arts Sci., 5: 139-159.

ROA, E. Z. DE, 1967. Contribucion al estudio de los Equinodermos de Venezuela. — Acta biol. venez., 5: 267-333.

SAY, TH., 1825. On the species of the Linnaean genus Asterias inhabiting the coast of the United States. — J. Acad. Nat. Sci. Philad., 5 (1): 141-154.

SEBA, A., 1761. Locupletissimi rerum naturalium thesauri accurata descriptio et iconibus artificiosissimis expressio, per universam physices historiam, etc., 3. — Amsterdam: 1-212, pls. 1-116.

SLADEN, W. P., 1889. Report on the Asteroidea collected during the voyage of H. M. S. "Challenger" during the years 1873-1876. — Challenger reports, 30 (51): 1-893.

SPENCER, W. K., 1951. Early Palaeozoic Starfish. Royal Soc. London, Philos. Trans., (B) 235: 87-129, pls. 2-8, figs. 1-24.

SPENCER, W. K. & C. W. WRIGHT, 1966. Asterozoans. In: Moore, R. C. (ed). Treatise on Invertebrate Paleontology. Part U. Echinodermata 3, 1: 4-107, figs. 1-89.

STUDER, T., 1884. Verzeichnis der während der Reise S. M. S. "Gazelle" um die Erde 1874-1876 gesammelten Asteriden und Euryaliden. — Abh. Akad. Wiss. Berlin, 1884: 1-64.

THOMAS, L. P., 1960. A note on the feeding habits of the West Indian Seastar Oreaster reticulatus (L.). — Q. Jl. Fla. Acad. Sci., 23: 167-168.

TOMMASI, L. R., 1958. Os Equinodermas do littoral de São Paulo. II Diadematidae, Schizasteridae, Brissidae, Cidaroidae (Echinoidea) e Asteroidea do bento costeiro. — Contrções. Inst. oceanogr. Univ. S. Paulo, 2: 1-27.

——, 1966. Distribuiçao geografica de alguns Equinodermas do Brasil. — Revta. bras. Biol., 26: 239-246.

——, 1970. Lista dos asteroides recentes do Brasil. — Contrções. Inst. oceanogr. Univ. S. Paulo, 18: 1-61.

TORTONESE, E., 1937. Gli Echinodermi del Museo di Torino. Part III Asteroidea. — Boll. Mus. Zool. Anat. Comp. Torino, 45: 27-132.

——, 1956. Su alcune specie di Astropectinidae con descrizione de un novo Astropecten — Ann. Mus. Civ. Stor. Nat. Genova, 68: 319-334.

UMMELS, F., 1963. Asteroids from the Netherlands Antilles and other Carribbean localities (Oreasteridae, Ophidiasteridae, Asterinidae and Luidiidae). — Stud. Fauna Curaçao, 15: 72-101.

VERRILL, A. E., 1867. Notes on the Radiata in the Museum of Yale College, 1-3. — Trans. Conn. Acad. Arts Sci., 1 (2) art. V: 247-351.

——, 1871. Descriptions of Starfishes and Ophiurans from the Atlantic coast of America and Africa. — Ann. J. Sci., 2: 130-133.

——, 1872. On Radiata from the coast of North Carolina. Brief Contr. to Zool. No. XXII. — Am. J. Sci., 3: 432-483.

——, 1880a. Notice of the remarkable Marine Fauna occupying the outer banks off the southern coast of New England. — Am. J. Sci., (3) 20 (119): 390-403.

——, 1880b. Notice of recent additions to the marine invertebrata of the northeastern coast of America, with descriptions of new genera and species and critical remarks on others, II. Mollusca, with notes on Annelida, Echinodermata, etc., collected by the United States Fish Commission. — Proc. U. S. natn. Mus., 3: 356-405.

——, 1885. Results of the Explorations made by the Steamer "Albatross" off the Northern Coast of the United States in 1883. — Annual Report of the Commissioner for Fish and Fisheries for 1883: 503-699, pls. 1-44.

——, 1894. Descriptions of new species of starfishes and Ophiurans with a revision of certain species formely described; mostly from the collections made by U. S. commission of fish and fisheries. — Proc. U. S. natn. Mus., 17: 243-297.

——, 1895. Distribution of Echinoderms of Northeastern America. — Am. J. Sci., (3) 49: 127-141; 199-212.

——, 1899. Revision of certain Genera and Species of Starfishes with descriptions of new forms. — Trans. Conn. Acad. Arts Sci., 10: 145-234.

——, 1901. Addition to the Fauna of the Bermudas from the Yale Expedition of 1901. — Trans. Conn. Acad. Arts Sci., 11: 15-62.

——, 1914. Monograph of the Shallow-Water Starfishes of the North Pacific Coast, from the Arctic Ocean to California, with Revisions of Various Extra-Limital Genera and Species. — Harriman Alaska Series, 14: 1-420, pls. 1-110.

——, 1915. Report on the starfishes of the West Indies, Florida and Brasil including those obtained by the Bahamas expedition from the Univ. of Iowa in 1893. — Bull. Labs. nat. Hist. St. Univ. Ia., 7 (1): 1-232.

VERVOORT, W., 1967. Zoological exploration of the continental shelf of Surinam. In: Scientific investigations on the shelf of Surinam, H.Nl.M.S. Snellius. — Hydrographic Newsletter, Spec. Publ. 5: 61-81.

——, 1971. Zoological exploration of the continental shelf of Surinam II. In: Scientific investigations on the shelf of Surinam, H.Nl.M.S. Luymes. — Hydrographic Newsletter, Spec. Publ. 6: 37-55.

VINGUIER, C., 1879. Anatomie comparée du Squelette des Stellérides. — Archs. Zool. exp. gén., 7: 33-250.

EXPLANATION OF THE PLATES

Plate 1.

Figs. 1-3, *Luidia barimae* John & A. M. Clark; 1-2, r = 16 mm: 1, detail of disk, dorsal side; 2, ventral side. 3, two specimens, r = 13 and 16 mm, dorsal side and arm fragment, ventral side.

Fig. 4, *Luidia senegalensis* (Lamarck); dorsal side, × 0.3.

Plate 2.

Figs. 1, 2, 4, *Luidia ludwigi* Fisher; dorsal side of three specimens to demonstrate variation in colouration.

Fig. 3, *Luidia barbadensis* Perrier; ventral side, × 1.7.

Plate 3.

Fig. 1, *Astropecten marginatus* Gray; R = 35 mm, dorsal side.

Fig. 2, *Luidia clathrata* (Say); dorsal side, × 0. 6.

Fig. 3, *Luidia alternata* (Say); Sta. F 47, R = 72 mm, dorsal side.

Fig. 4, *Astropecten americanus* Verrill; Sta. K 100, R = 40 mm, dorsal side.

Plate 4.

Fig. 1, *Rosaster alexandri* (Perrier); Sta. M 97, R = 36 mm, detail of dorsal side of the arm.

Fig. 2, *Tosia clugreta* spec. nov., holotype; Sta. M 97, R = 27 mm, ventro-lateral area.

Fig. 3, *Luidia ludwigi* Fisher; ventro-lateral area with pedicellariae.

Fig. 4, *Luidia alternata* (Say); Sta. F 47, R = 72 mm, detail of basal, dorsal part of the arm.

Plate 5.

Figs. 1-3, *Astropecten riensis* Döderlein; R = 23 mm; 1, detail of adambulacral plates; 2, part of ventral side; 3, dorsal side.

Fig. 4, *Astropecten brasiliensis* Müller & Troschel; Sta. B17, R = 105 mm, dorsal side.

Plate 6.

Figs. 1-2, *Echinaster modestus* Perrier; 1, two specimens from Sta. G56, R = 36 and R = 26 mm, dorsal side; 2, detail of disk, dorsal side.

Fig. 3, *Astropecten brasiliensis* Müller & Troschel; Sta. B 17, R = 105 mm, detail of first supero-marginal plates.

Plate 7.

Figs. 1-3, *Goniaster tessellatus* (Lamarck); 1-2, Sta. F 40, R = 21 mm: 1, ventral side; 2, dorsal side; 3, Sta. H 58, R = 15 mm, part of ventral side.

Fig. 4, *Tethyaster vestitus* Say, Sta. H 52, R = 186 mm, dorsal side.

Plate 8.

Figs. 1-4, *Goniaster tessellatus* (Lamarck); 1-2, Sta. H 59, R = 48 mm: 1, ventral side; 2, detail of ventral surface showing ventro-lateral area; 3, Sta. F 43, R = 59 mm, detail of dorsal side; 4, Sta. H 59, R = 48 mm, detail of dorsal side.

Plate 9.

Figs. 1-3, *Goniaster tessellatus* (Lamarck); 1, Sta. F 43, R = 59 mm, ventral side; 2-3, Sta. E 64, R = 79 mm: 2, ventro-lateral area; 3, detail of dorsal side.
Fig. 4, *Tosia clugreta* spec. nov., holotype; Sta. M 97, R = 27 mm, dorsal side.

Plate 10.

Figs. 1-4, *Goniaster tessellatus* (Lamarck); 1-2, Sta. F 43, R = 59 mm: 1, detail of ventral arm surface; 2, ventro-lateral area. 3-4, Sta. E 64, R = 69 mm: 3, ventro-lateral area; 4, detail of dorsal side.

Plate 11.

Figs. 1-4, *Goniaster tessellatus* (Lamarck); 1, 3, Sta. E 64, R = 69 mm: 1, dorsal surface; 3, ventral surface. 2, 4, Sta. E 64, R = 79 mm: 2, dorsal surface; 4, ventral surface.

Plate 12.

Figs. 1, 2, 4, *Tosia clugreta* spec. nov.; holotype, Sta. M 97, R = 27 mm: 1, ventral side; 2, part of dorsal side; 4, lateral view of marginal plates.
Fig. 3, *Anthenoides peircei* Perrier; Sta. J 113 a, R = 50 mm, dorsal side.

Plate 13.

Figs. 1-4, *Anthenoides peircei* Perrier; 1, 2, 4, Sta. L 96, R = 107 mm: 1, ventral side; 2, dorsal side; 4, detail of arm basis. 3, Sta. J 113a, R = 50 mm, part of ventral side.

Plate 14.

Figs. 1, 3, 4, *Anthenoides peircei* Perrier; Sta. J. 113a, R = 75 mm: 1, dorsal side; 3, ventral side arm basis; 4, ventro-lateral area.
Fig. 2, *Rosaster alexandri* (Perrier), Sta. M 97, R = 36 mm; dorsal side.

Plate 15.

Fig. 1, *Rosaster alexandri* (Perrier); Sta. M 97, R = 36 mm, detail of dorsal side.
Fig. 2, *Anthenoides peircei* Perrier; Sta. L 96, R = 107 mm, ventro-lateral area.
Figs. 3-4, *Nymphaster subspinosus* (Perrier); Sta. B 22, R = 117 mm, details of ventral arm bases.

Plate 16.

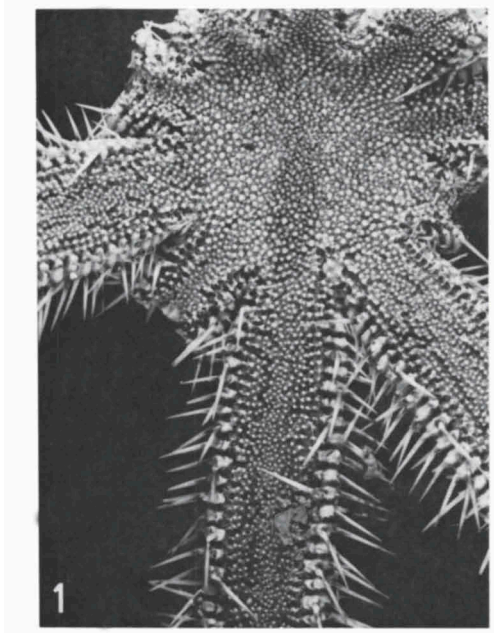
Fig. 1, *Nymphaster subspinosus* (Perrier); Sta. B 22, R = 117 mm, dorsal side.
Fig. 2, *Linckia guildingii* Gray; Sta. F 46, R = 142 mm, dorsal side.
Figs. 3-4, *Oreaster reticulatus* (L.); Sta. H 52, R = 144 mm: 3, dorsal side; 4, ventral side.

Plate 17.

Figs. 1-4, *Narcissia trigonaria* Sladen; 1, ventral side; 2, dorsal side; 3, detail of ventral side, showing pedicellariae on the marginals; 4, detail of dorsal surface, showing anus, median keel and pedicellariae in the interradii.

Plate 18.

Figs. 1-2, *Narcissia trigonaria* Sladen; dorsal side of two specimens showing the position of the anus, the median keel and the pedicellariae in the interradii.
Figs. 3-4, *Echinaster brasiliensis* Müller & Troschel; 3, two specimens, R = 25 mm, showing dorsal (upper) and ventral (lower) side; 4, R = 25 mm, detail of disk dorsally.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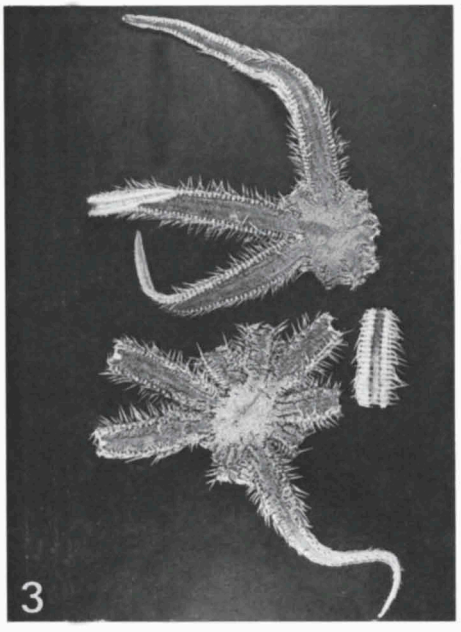
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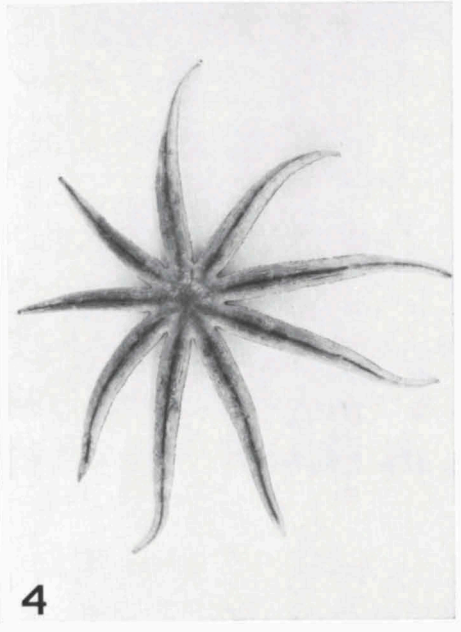
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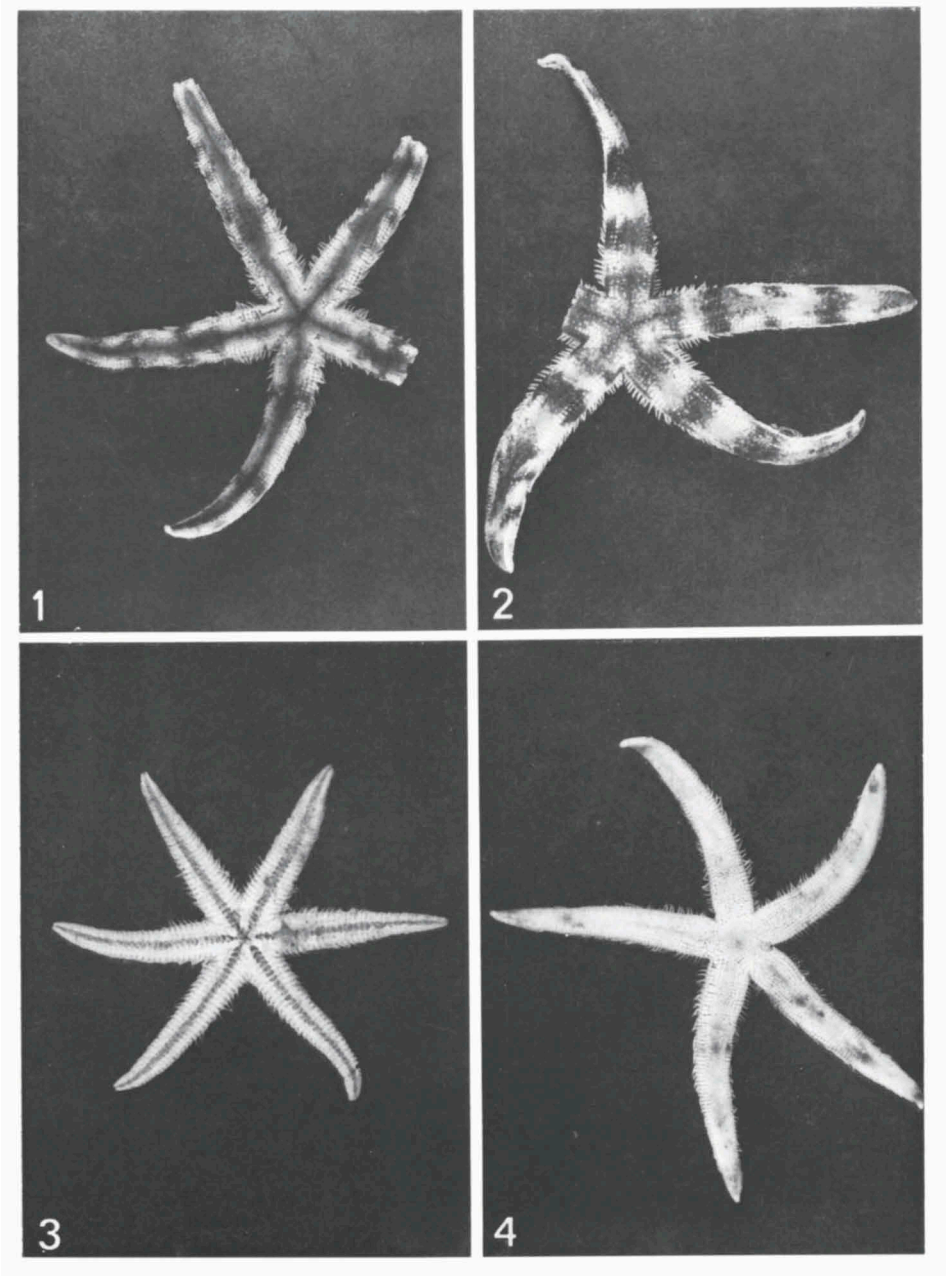
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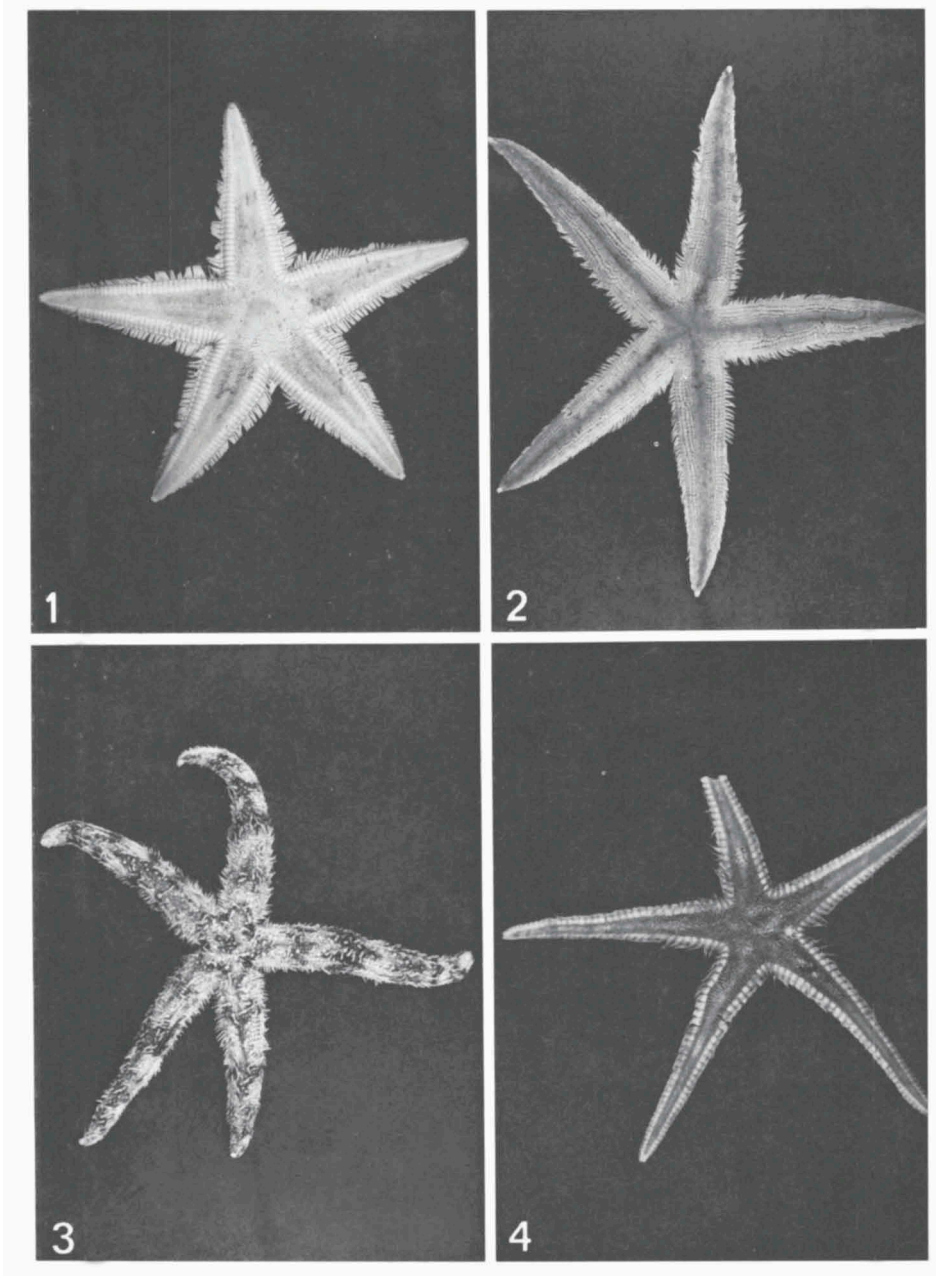
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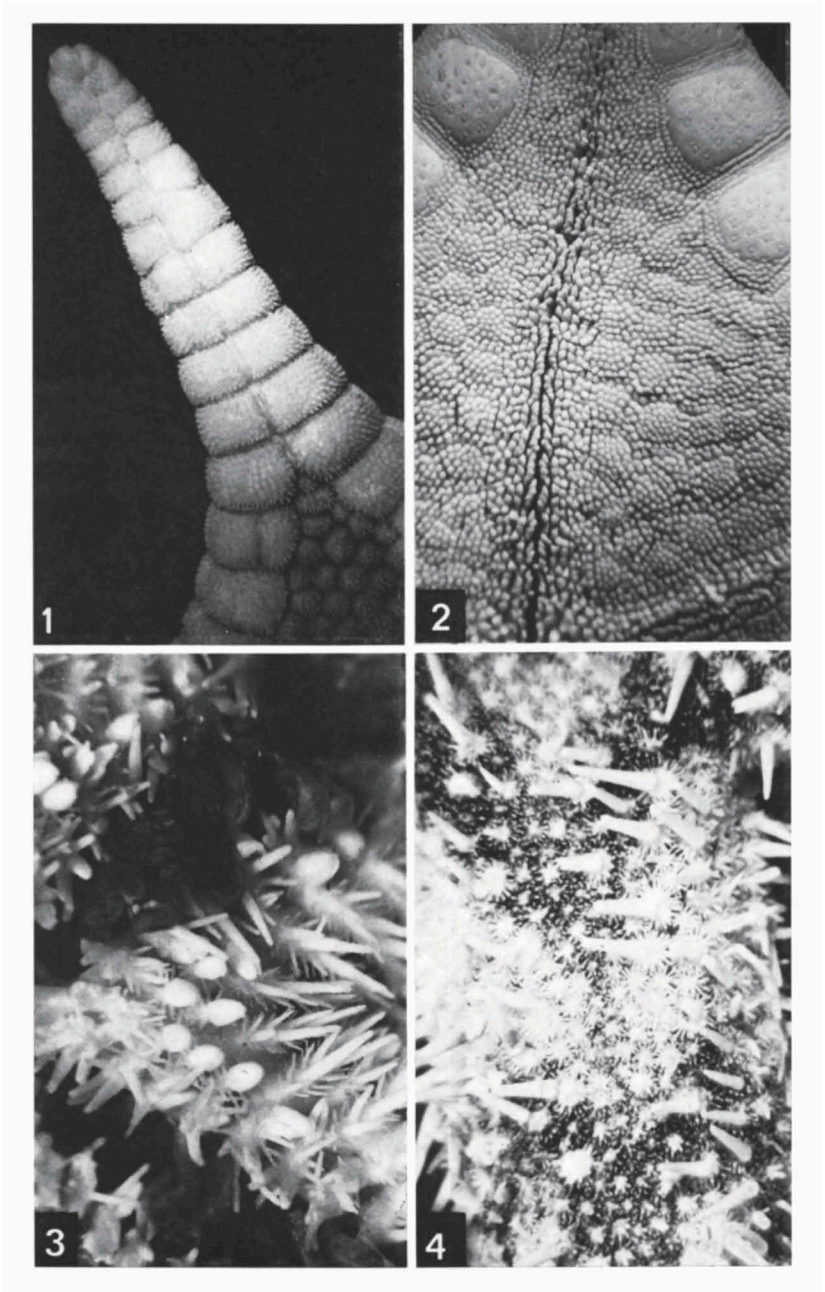
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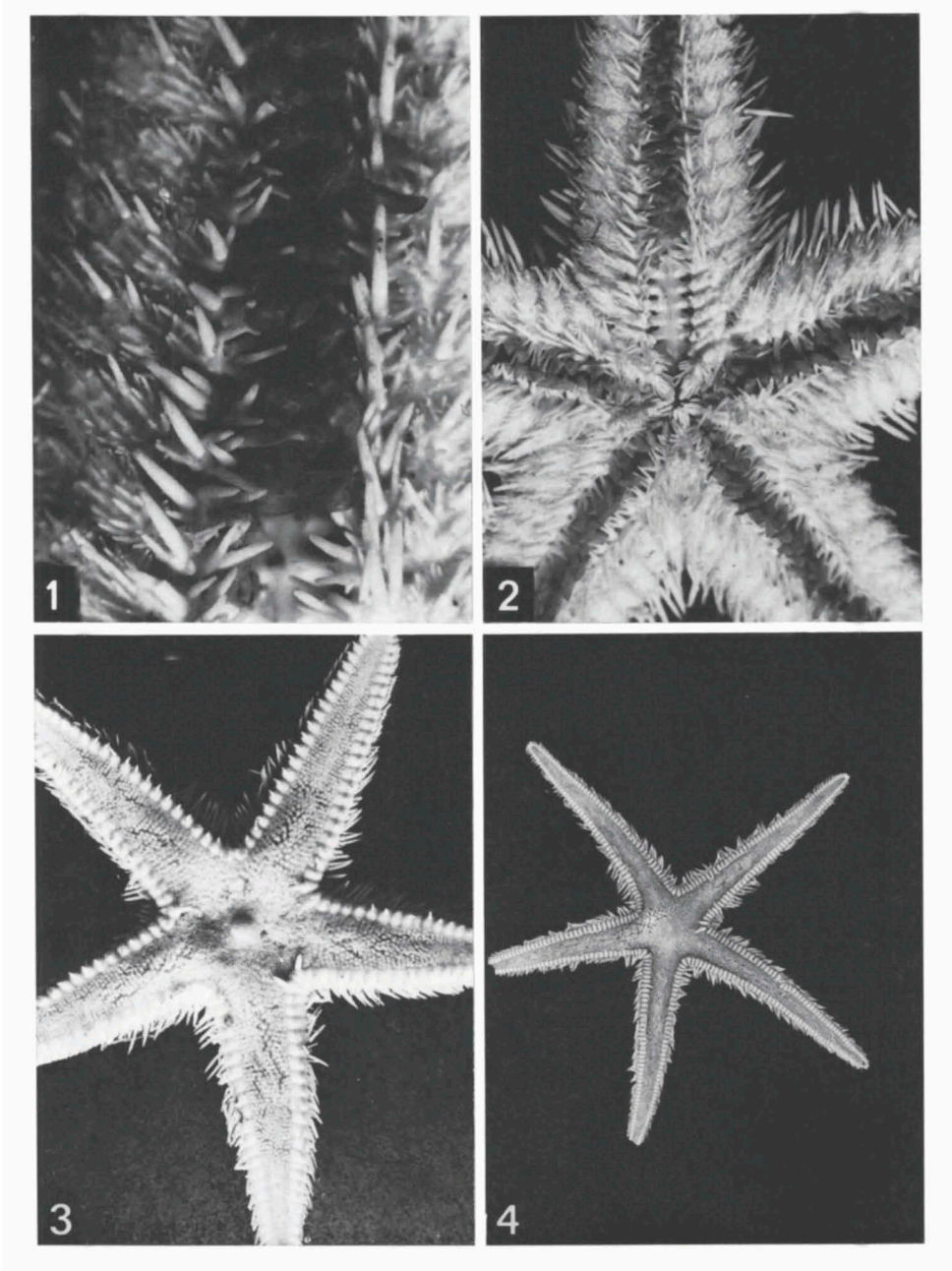
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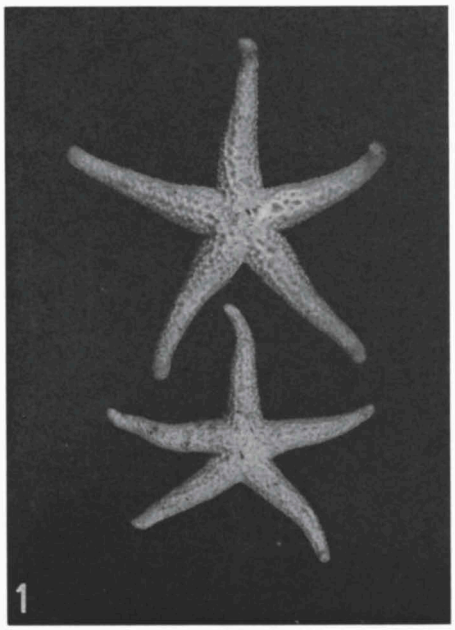
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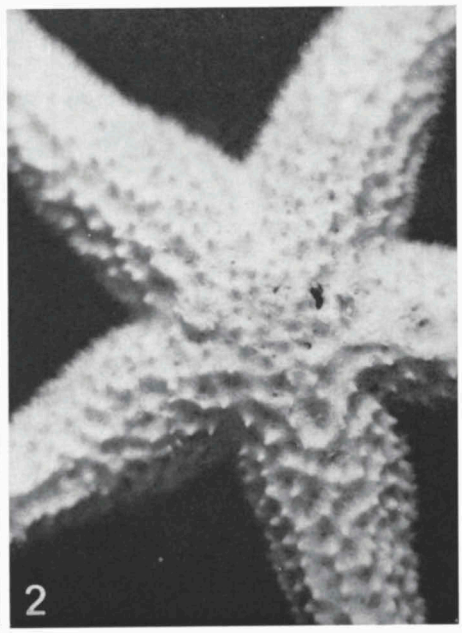
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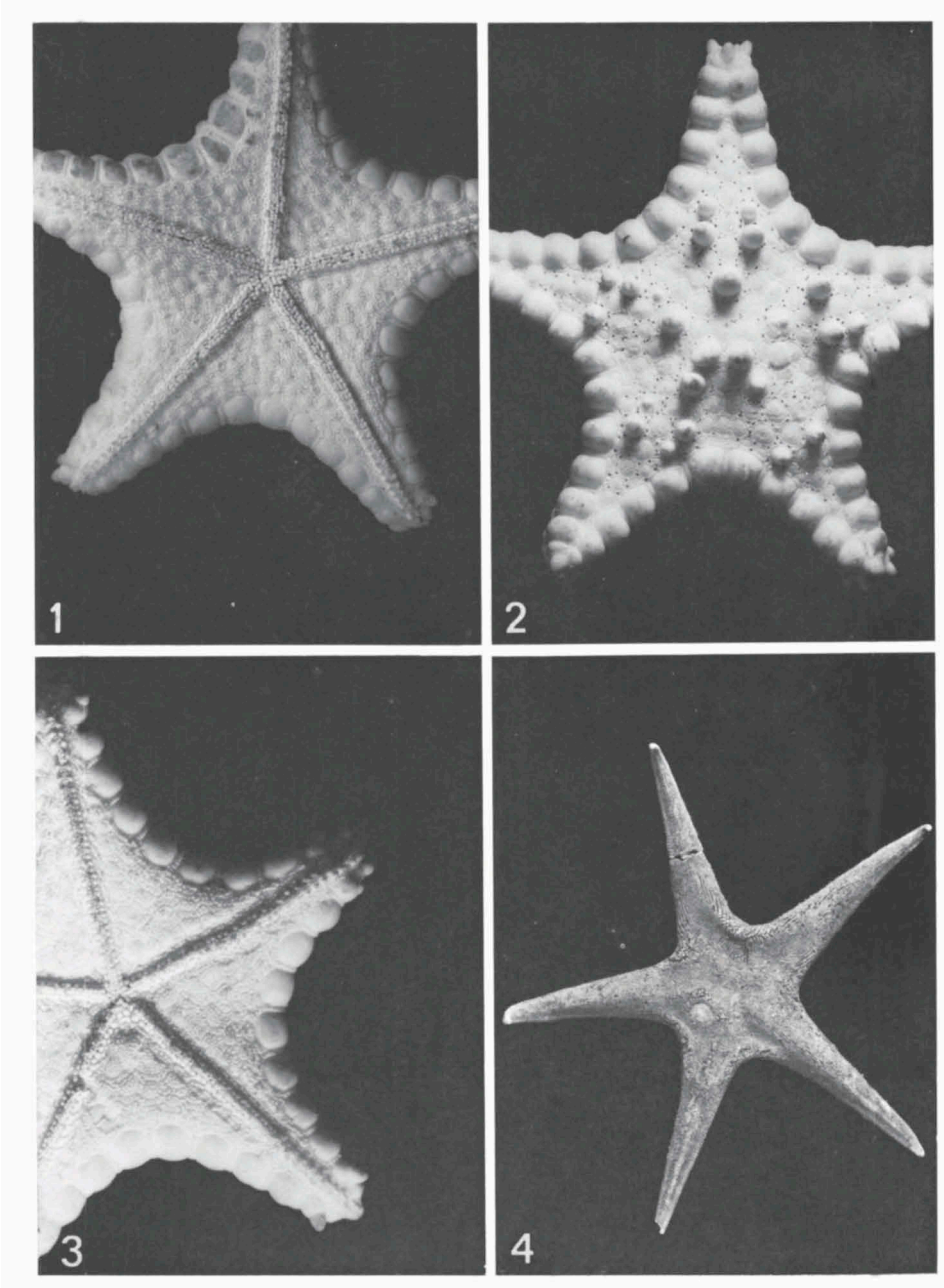
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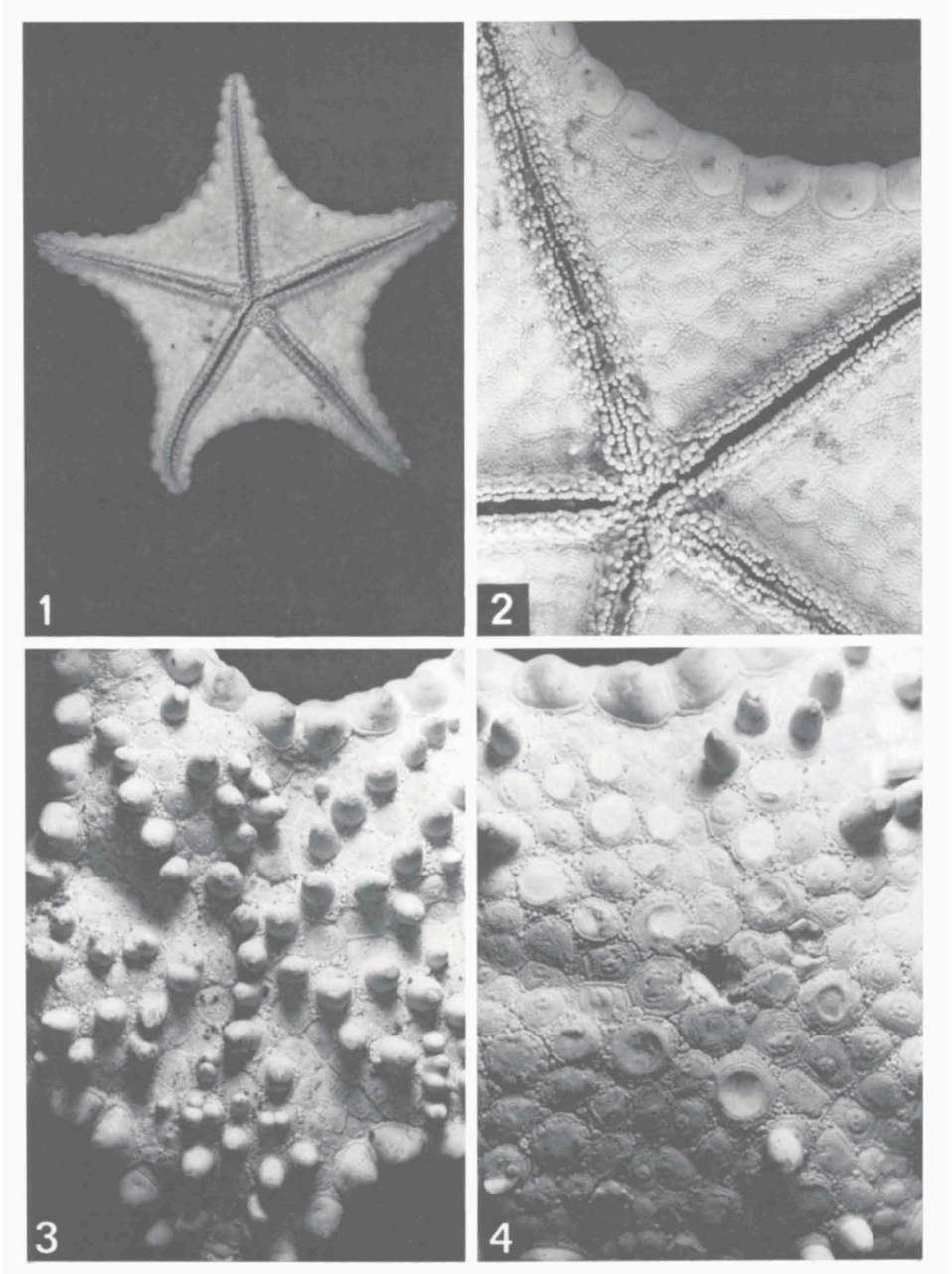
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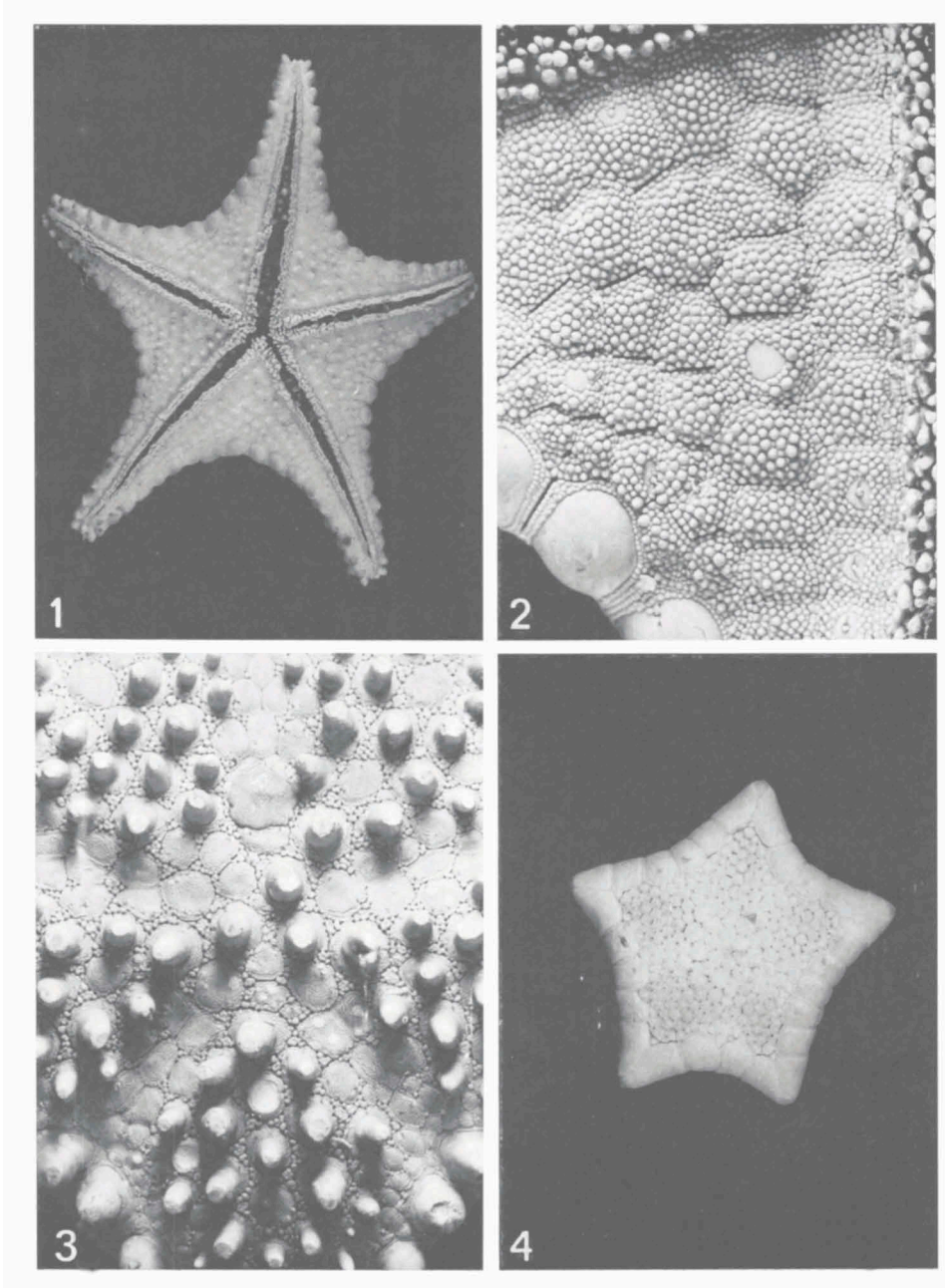
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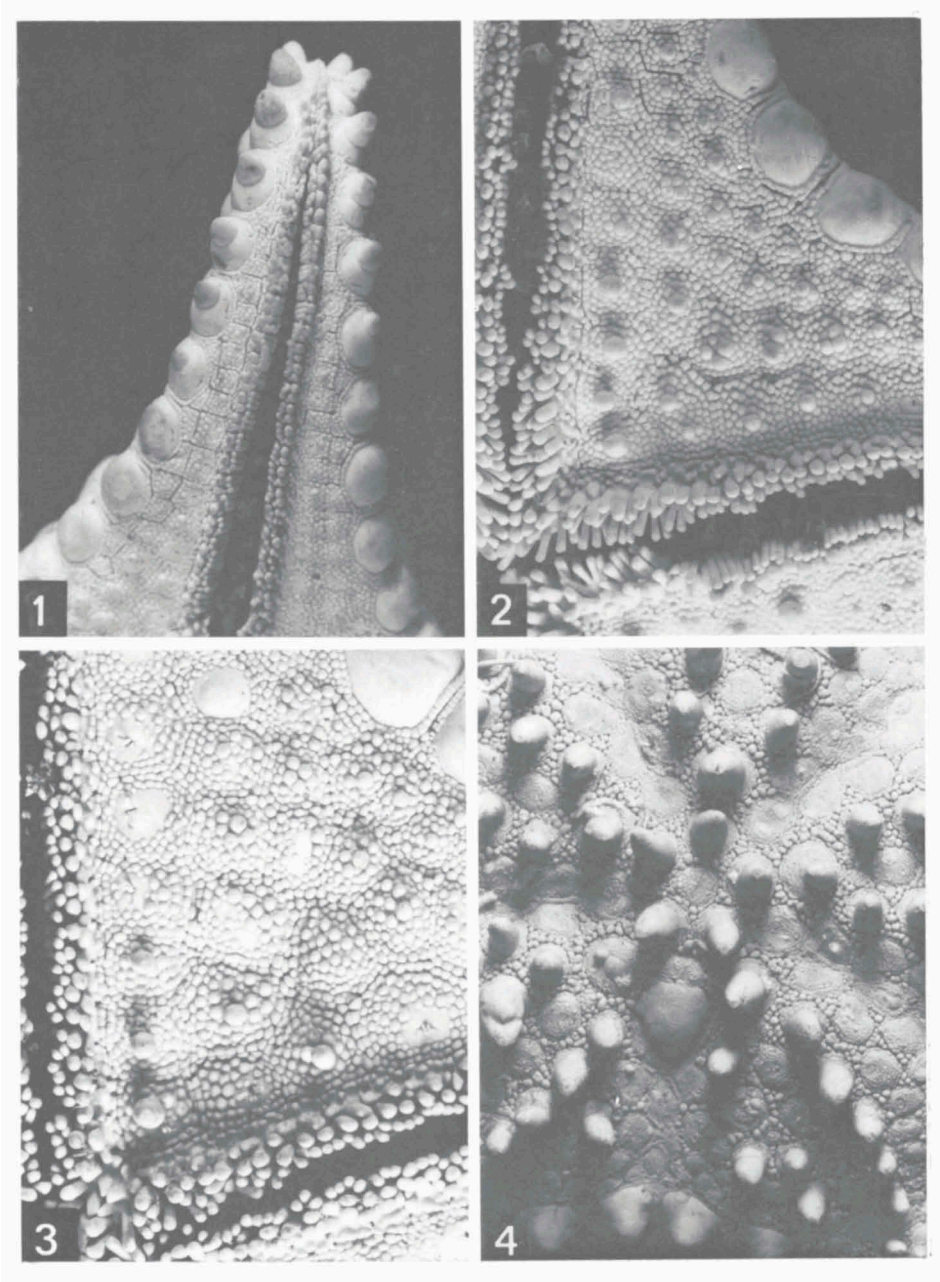
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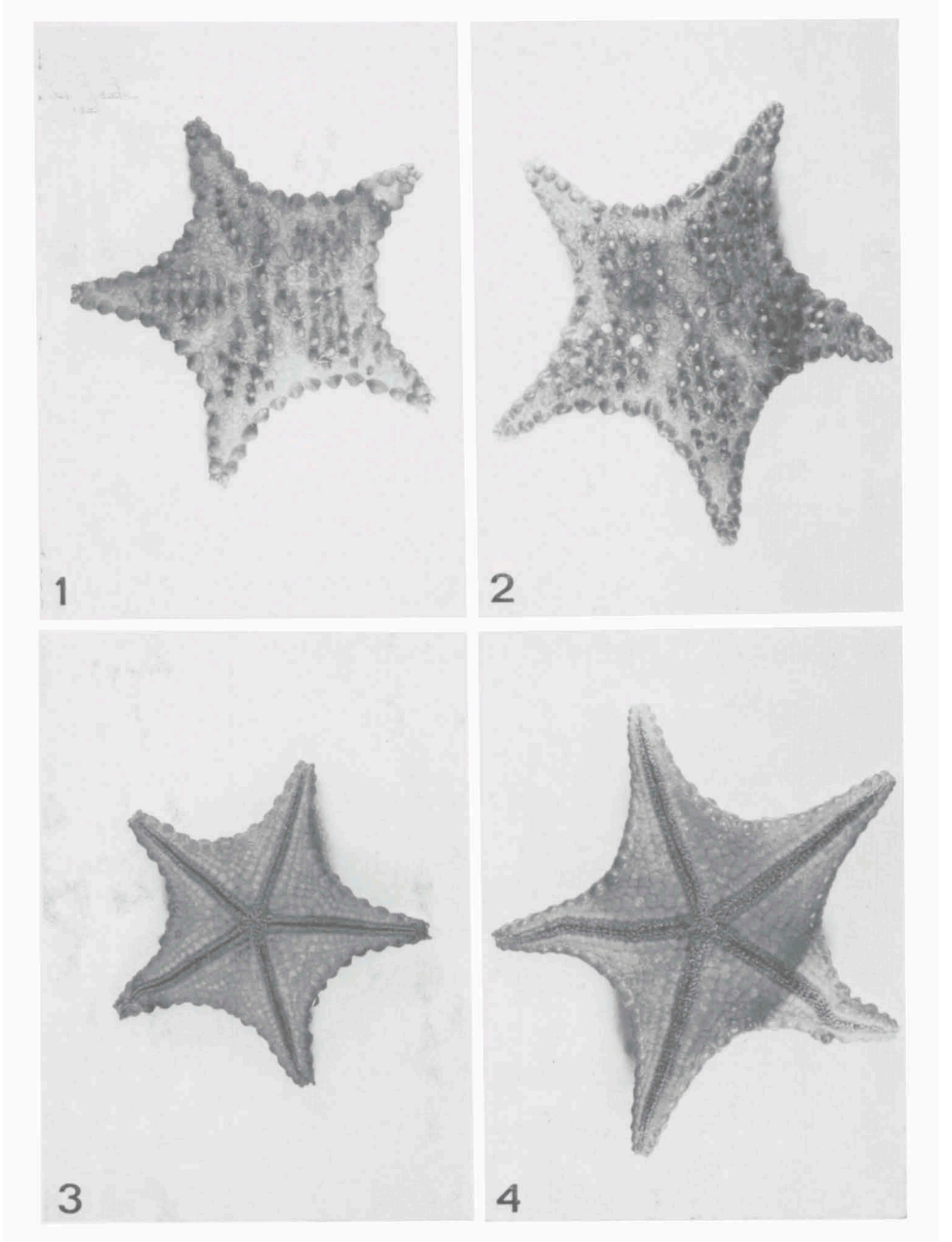
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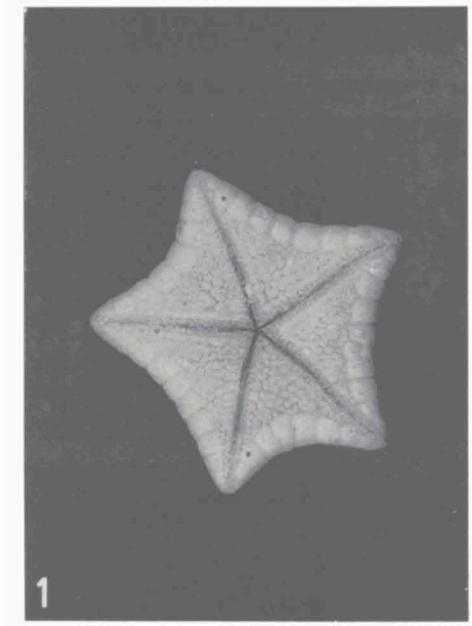
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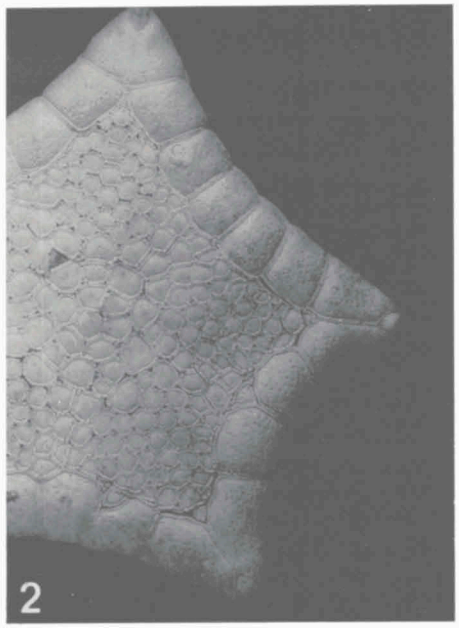
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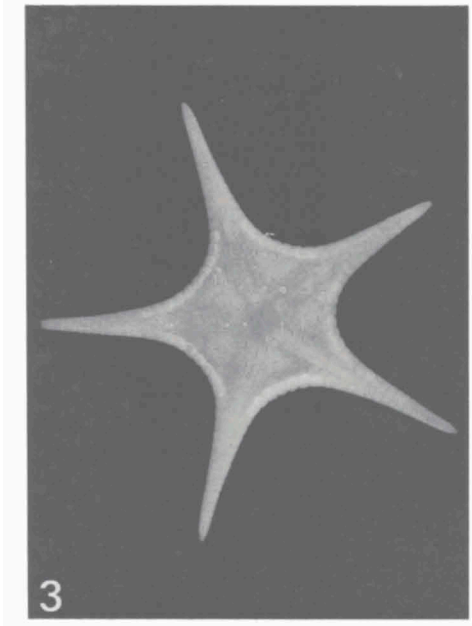
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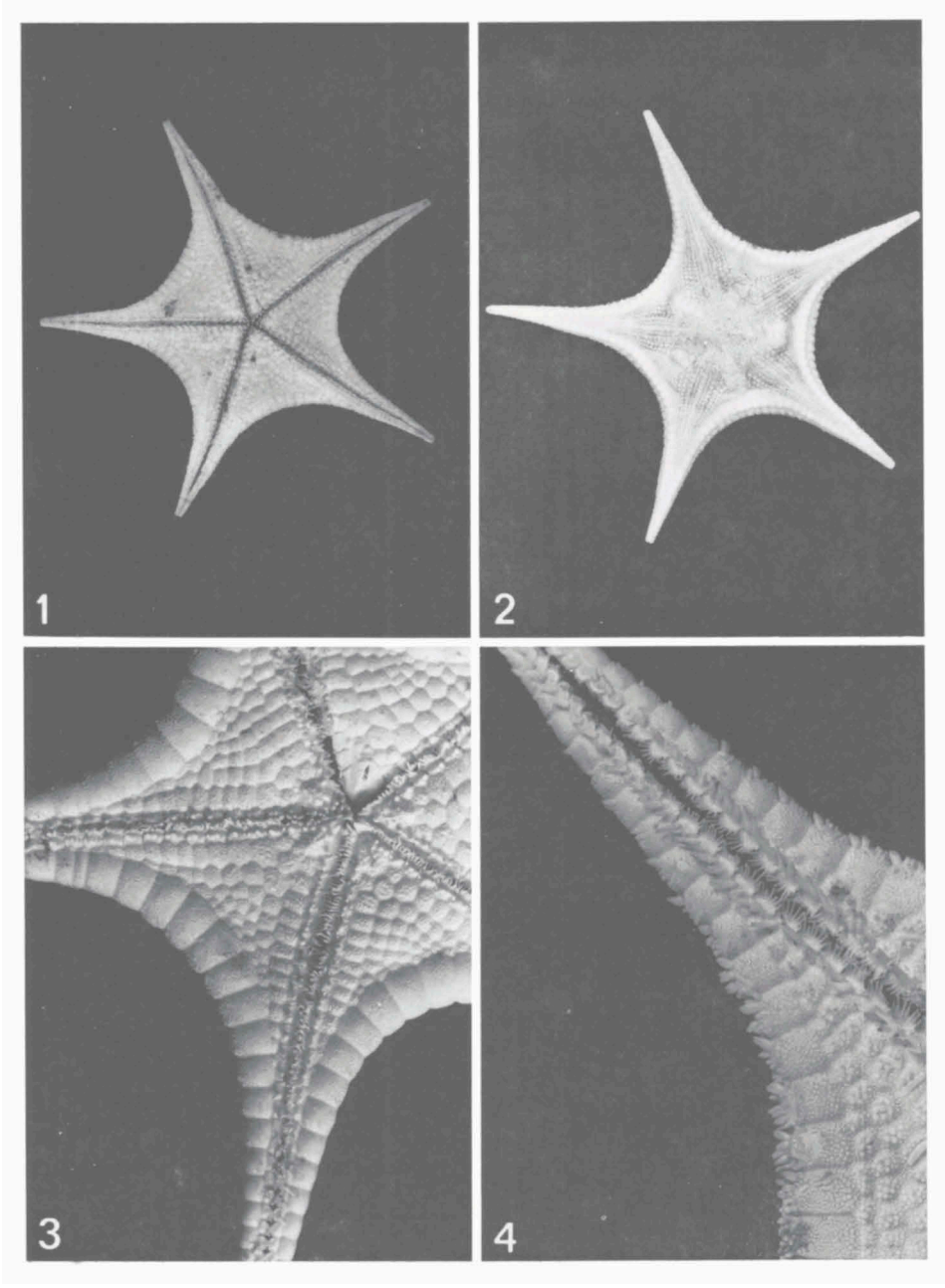
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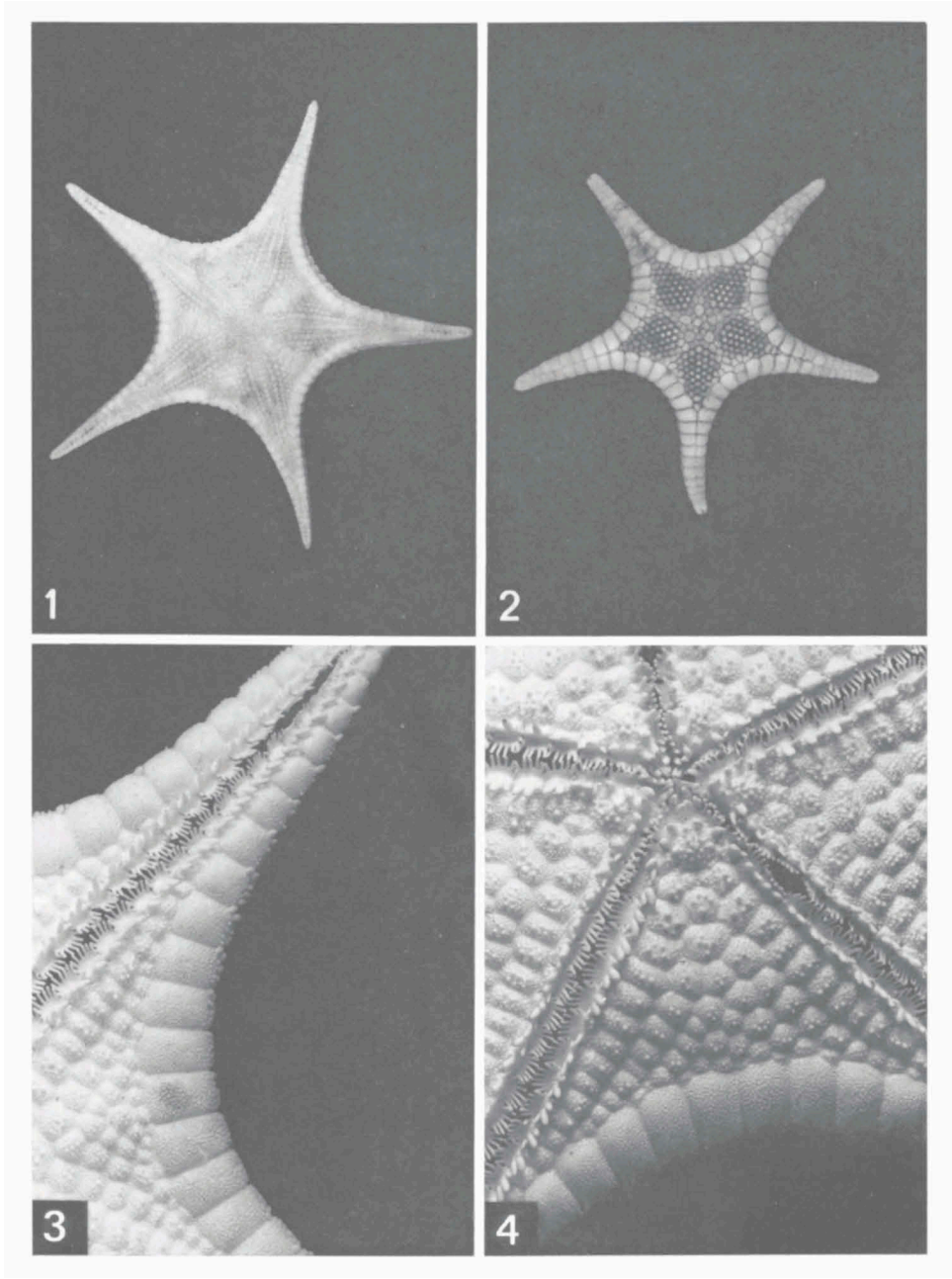
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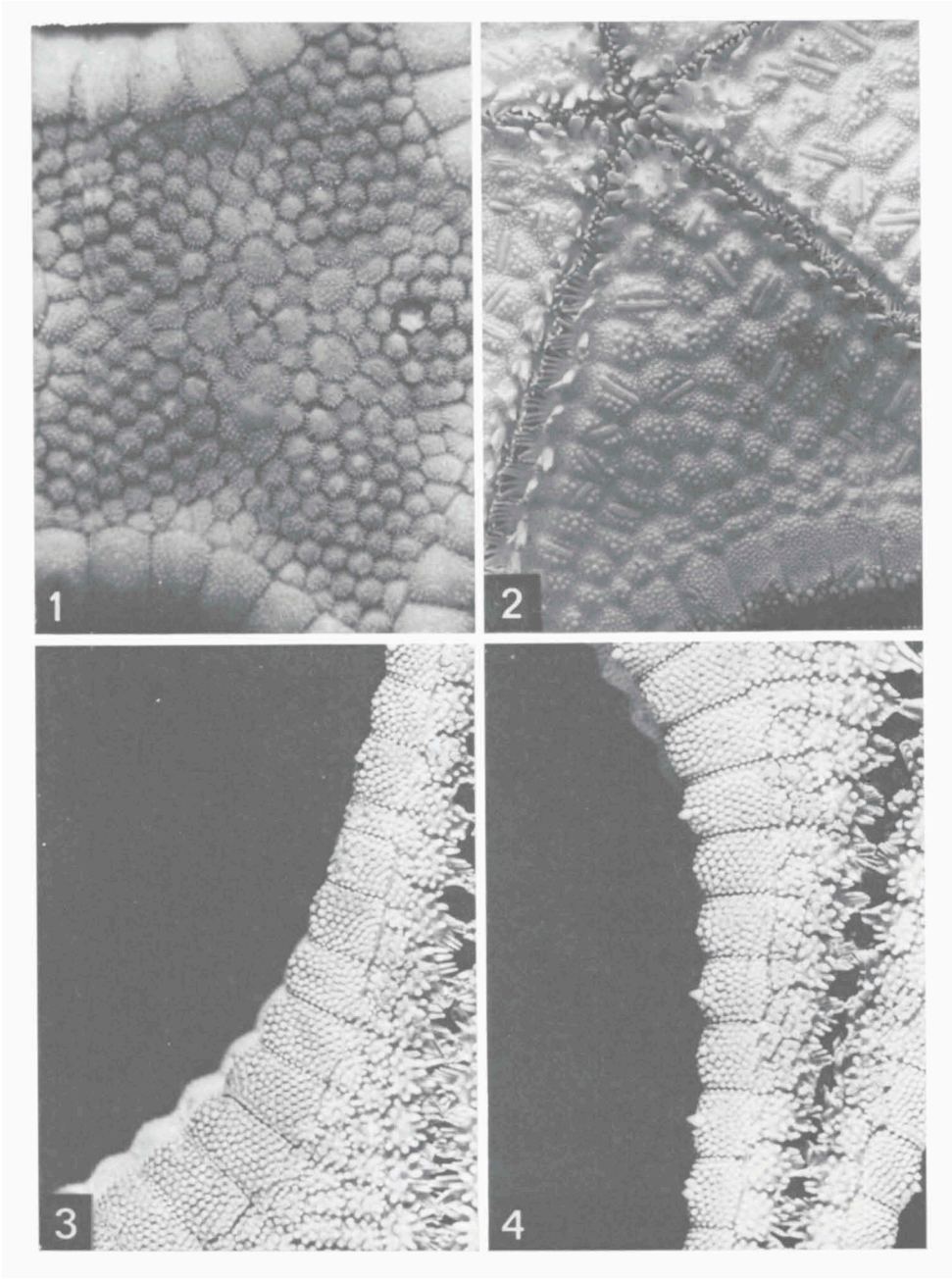
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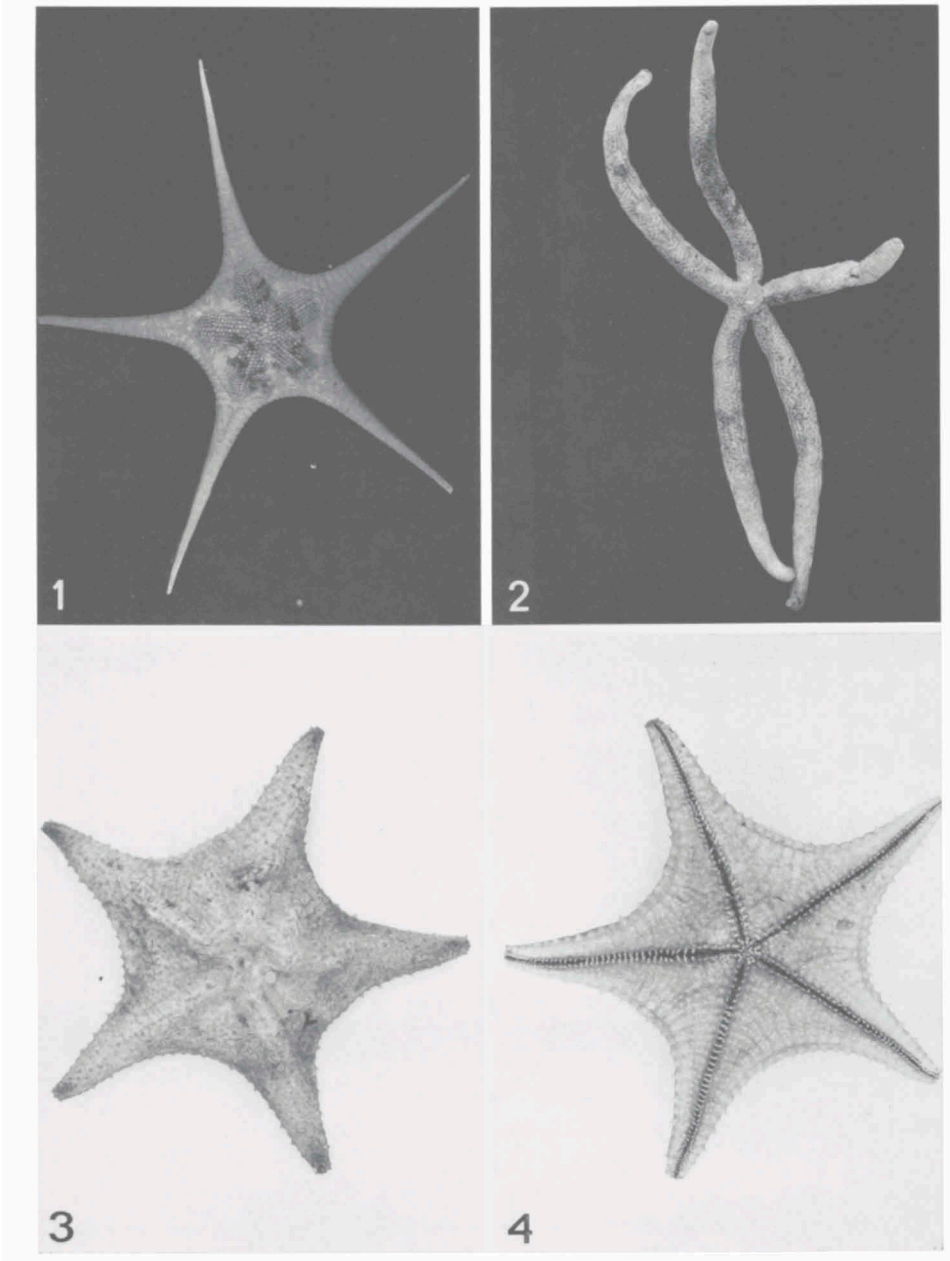
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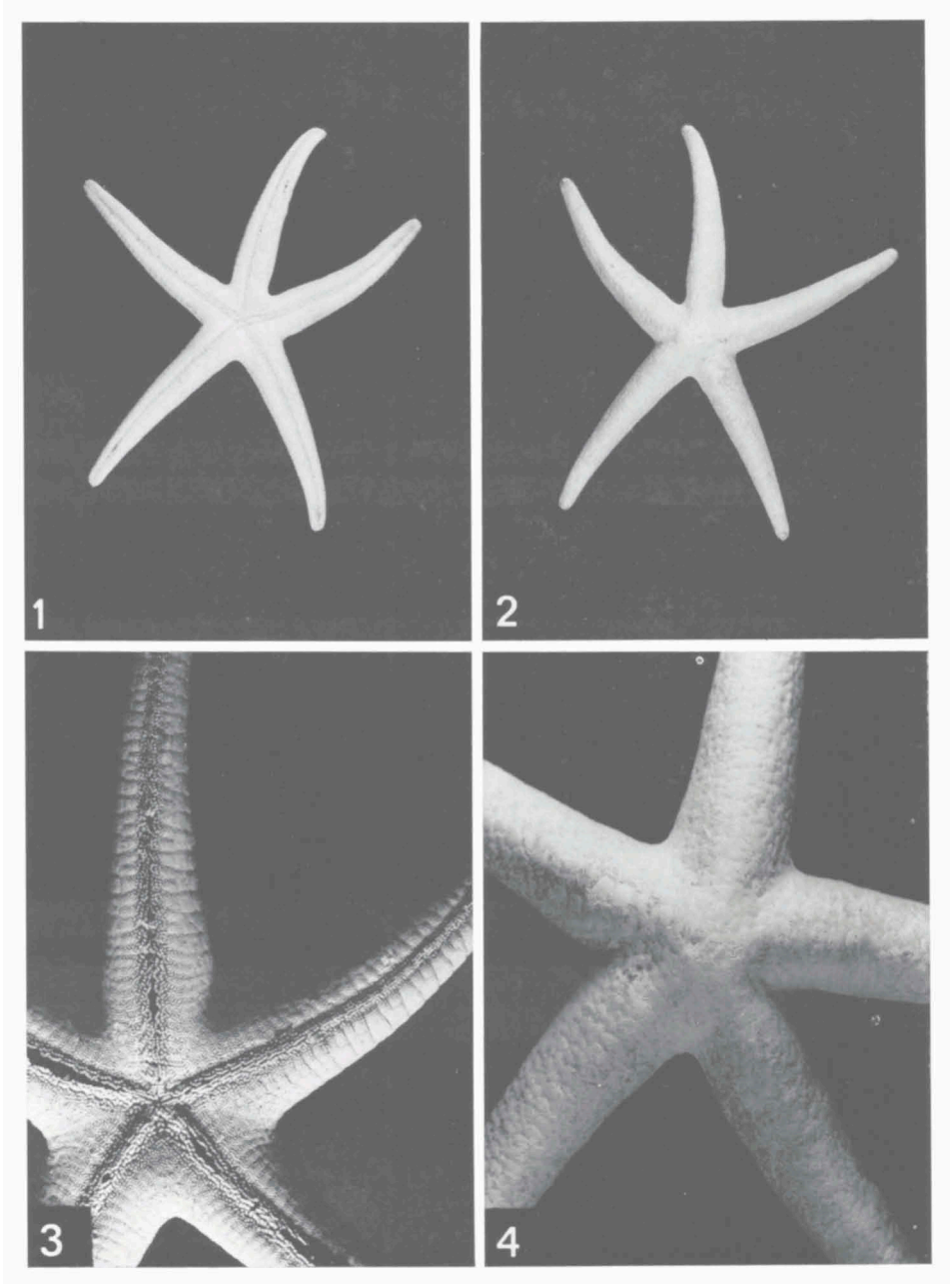
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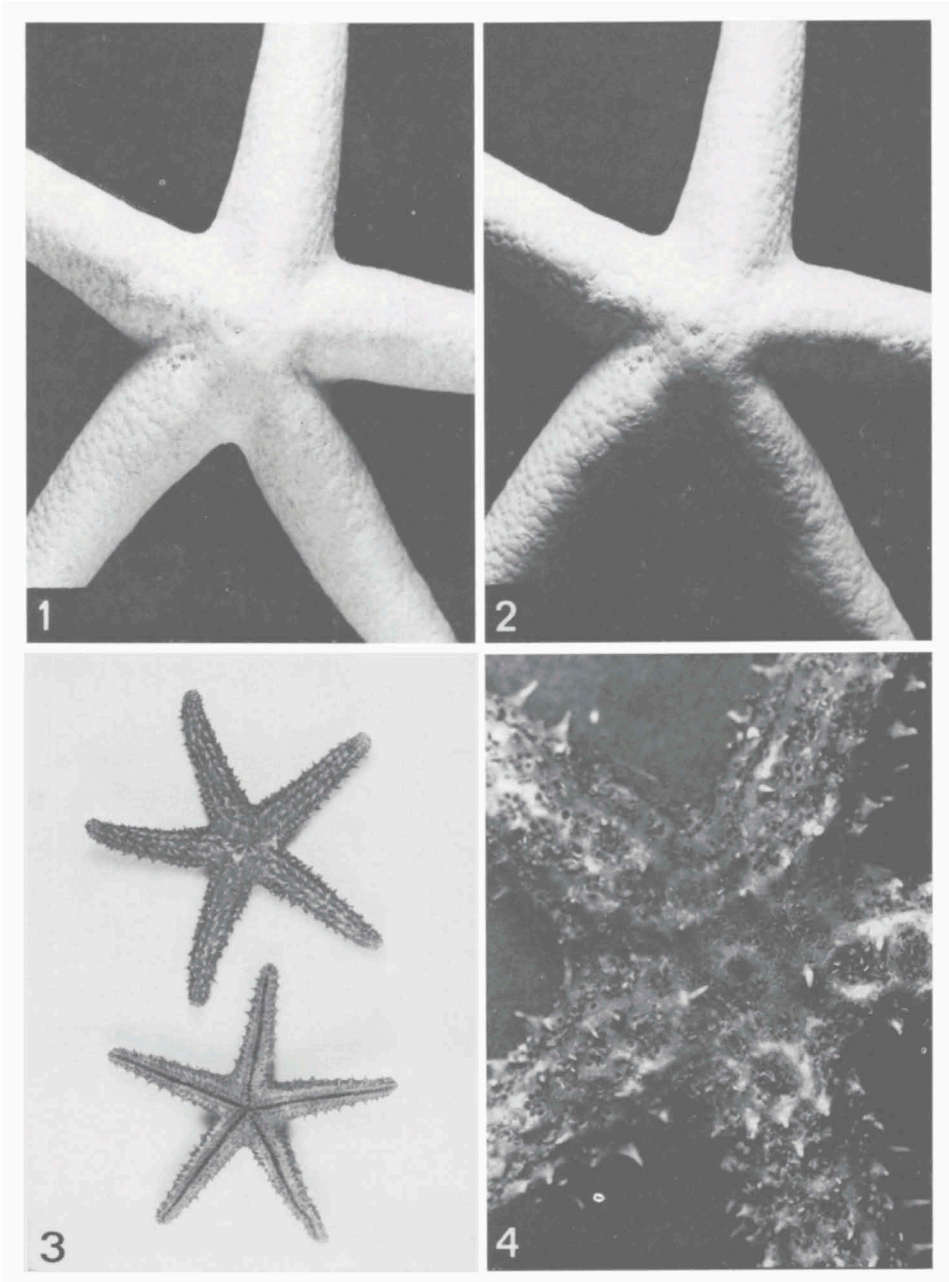
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