ASTEROIDEA (ECHINODERMATA) FROM THE GUYANA SHELF

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With 31 text-figures and 20 plates

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INTRODUCTION

In a previous paper (Walenkamp, 1976) a revision was given of the Asteroidea of the coastal waters of Surinam. Since the preparation of that paper new material, collected in 1970 by the "Luymes" Guyana Shelf Expedition, became available. The present report is based on this new material. The 1970 expedition not only explored the waters off Surinam, but also the continental shelf off Guyana and French Guyana, and, moreover, investigated deeper waters than the O.C.P.S. expeditions dealt with in my 1976 paper. As a result fourteen species were taken, which were not represented in the collections of the previous expeditions.

The present report, which can be considered a supplement to the 1976 report, has the same set-up. Of the newly found species synonymy and full descriptions are given. For the other species I may refer to the 1976 descriptions.

In addition to the material mentioned above, a small collection of Asteroidea, property of the Surinaams Museum, Paramaribo, is included. These starfishes, apart from one sample taken on 8 March 1972 by Mr. P. A. Teunissen off the mouth of Krofajapasi Creek, Surinam, were all collected in 1957 during cruises of the trawler "Coquette" (cf. Altena, 1969).

Two types of maps are given: one indicating the stations where starfishes were collected in the seas of the Guyanas during the expeditions of our Museum (cf. stationslists, and Vervoort, 1967, 1971), and one giving the

general distribution patterns as these could be composed from references in the literature.

Under "Material examined" the number of the specimens collected at one station is placed between brackets; the numbers (no.) refer to the numbers under which the samples are stored in the echinoderm collections of the Rijksmuseum van Natuurlijke Historie, Leiden.

All specimens investigated are preserved in alcohol 70%.

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I am indebted to Miss J. A. Pool for her help in typing the manuscript.

List of the stations where Asteroidea were collected

"Luymes" Guyana Shelf Expedition, 1970:

Sta 1, 07°10'N 53°35'W, off Surinam, 24.viii.1970. Van Veen grab and Agassiz-trawl, depth 130-104 m. Sandy calcarenite. — *Goniaster tessellatus* (Lamarck, 1816).

Sta. 2, 07°07'N 53°36'W, off Surinam, 24.viii.1970. Van Veen grab and triangular dredge, depth 93 m. Sandy calcarenite. — *Tosia parva* (Perrier, 1881).

Sta. 3, 07°02'N 53°35'W, off Surinam, 24.viii.1970. Van Veen grab and Agassiz-trawl, depth 80 m. Calcareous sand. — *Astropecten comptus* Verrill, 1915.

Sta. 5, 06°36'N 53°35'W, off French Guyana, 24.viii.1970. Van Veen grab and Agassiz-trawl, depth 44 m. Calcareous sand. — *Luidia clathrata* (Say, 1825); *Astropecten riensis* Doderlein, 1917.

Sta. 7, 06°21'N 53°40'W, off French Guyana, 24.viii.1970. Van Veen grab and Agassiz-trawl, depth 33 m. Coarse calcareous sand. — *Echinaster brasiliensis* Müller & Troschel, 1842.

Sta. 11, 06°03'N 53°41'W, off French Guyana, 25.viii.1970. Van Veen grab and Agassiz-trawl, depth 27 m. Mud. — *Luidia clathrata* (Say, 1825).

Sta. 13, 06°43'N 52°46'W, off French Guyana, 25.viii.1970. Van Veen grab and Agassiz-trawl, depth 132 m. Fine sand and mud. — *Luidia ludwigi* Fisher, 1906; *Astropecten nitidus* Verrill, 1915; *Anthenoides peircei* Perrier, 1881.

Sta. 14, 06°44'N 52°45'W, off French Guyana, 26.viii.1970. Van Veen grab and Agassiz-trawl, depth 76 m. Muddy calcareous sand. — *Goniaster tessellatus* (Lamarck, 1816); *Linckia guildingii* Gray, 1840; *Linckia nodosa* Perier, 1875; *Narcissia trigonaria* Sladen, 1889; *Echinaster modestus* Perrier, 1881.

Sta. 16, 06°18'N 52°57'W, off French Guyana, 26.viii.1970. Van Veen grab and Agassiz-trawl, depth 56 m. Muddy calcareous sand. — *Luidia clathrata* (Say, 1825); *Tethyaster vestitus* (Say, 1825).

Sta. 19, 06°15'N 53°06'W, off French Guyana, 26.viii.1970. Van Veen grab and Agassiz-trawl, depth 42 m. Muddy calcareous sand. — *Luidia clathrata* (Say, 1825); *Tethyaster vestitus* (Say, 1825).

Sta. 21, 06°03'N 53°12'W, off French Guyana, 26.viii.1970. Van Veen grab and Agassiz-trawl, depth 42 m. Sandy mud. — *Luidia senegalensis* (Lamarck, 1816); *Luidia clathrata* (Say, 1825).

Sta. 34, 07°40'N 53°53'W, off Surinam, 27.viii.1970. Agassiz-trawl, depth 500 m. Muddy bottom. — *Nymphaster arenatus* (Perrier, 1881); *Doraster constellatus* Downey, 1970.

Sta. 38, 07°17'N 53°57'W, off Surinam, 28.viii.1970. Agassiz-trawl, depth 100 m. Shell gravel. — *Luidia ludwigi* Fisher, 1906; *Goniaster tessellatus* (Lamarck, 1816); *Echinaster brasiliensis* Müller & Troschel, 1842.

Sta. 43, 06°31'N 53°56'W, off Surinam, 28.viii.1970. Van Veen grab and Agassiz-trawl, depth 35 m. Shell gravel. — *Luidia clathrata* (Say, 1825); *Astropecten riensis* Döderlein, 1917.

Sta. 48, 07°45'N 57°1'W, off Guyana, 30.viii.1970. Agassiz-trawl, depth 500 m. Muddy bottom. — *Cheiraster mirabilis* (Perrier, 1881); *Pectinaster gracilis* Verrill, 1915.

Sta. 49, 07°44'N 57°3'W, off Guyana, 30.viii.1970. Van Veen grab and Agassiz-trawl, depth 200-120 m. Sandy mud. — *Anthenoides peircei* Perrier, 1881.

Sta. 50, 07°43'N 57°5'W, off Guyana, 30.viii.1970. Van Veen grab and triangular dredge, depth 96 m. Sandy mud. — *Anthenoides peircei* Perrier, 1881; *Tosia parva* (Perrier, 1881); *Echinaster modestus* Perrier, 1881.

Sta. 51, 07°41'N 57°01'W, off Guyana, 30.viii.1970. Van Veen grab and triangular dredge, depth 98 m. Muddy sand. — *Anthenoides peircei* Perrier, 1881.

Sta. 56, 07°34'N 56°58'W, off Guyana, 30.viii.1970. Van Veen grab, depth 86 m. Muddy sand, shells. — *Astropecten riensis* Döderlein, 1917.

Sta. 57, 07°36'N 56°57'W, off Guyana, 30.viii.1970. Van Veen grab, depth 90 m. Sandy mud, shells. — *Astropecten marginatus* Gray, 1840.

Sta. 63, 07°35'N 57°04'W, off Guyana, 31.viii.1970. Van Veen grab and triangular dredge, depth 71 m. Sandy bottom. — *Luidia ludwigi* Fisher, 1906; *Tethyaster vestitus* (Say, 1825); *Echinaster brasiliensis* Müller & Troschel, 1842.

Sta. 65, 07°33'N 57°05'W, off Guyana, 31.viii.1970. Van Veen grab and triangular dredge, depth 63 m. Sandy bottom. — *Astropecten riensis* Döderlein, 1917; *Narcissia trigonaria* Sladen, 1889; *Echinaster brasiliensis* Müller & Troschel, 1842.

Sta. 68, 07°25'N 57°08'W, off Guyana, 31.viii.1970. Van Veen grab and Agassiz-trawl, depth 51 m. Muddy sand. — *Echinaster brasiliensis* Müller & Troschel, 1842.

Sta. 69, 07°20'N 57°10'W, off Guyana, 31.viii.1970. Van Veen grab and triangular dredge, depth 46 m. Muddy sand. — *Echinaster brasiliensis* Müller & Troschel, 1842.

Sta. 72, 07°05'N 57°14'W, off Guyana, 31.viii.1970. Van Veen grab and Agassiz-trawl, depth 31 m. Sand, shells. — *Luidia senegalensis* (Lamarck, 1816); *Echinaster brasiliensis* Müller & Troschel, 1842.

Sta. 73, 06°55'N 57°15'W, off Guyana, 31.viii.1970. Van Veen grab, depth 29 m. Muddy fine sand, shells. — *Astropecten riensis* Döderlein, 1917.

Sta. 75, 06°43'N 57°17'W, off Guyana, 31.viii.1970. Van Veen grab and Agassiz-trawl, depth 25 m. Sand, Bryozoa. — *Luidia clathrata* (Say, 1825); *Astropecten riensis* Döderlein, 1917.

Sta. 80, 07°56'N 57°12'W, off Guyana, 1.ix.1970. Van Veen grab and Agassiz-trawl,

depth 618 m. Muddy bottom. — *Circeaster americanus* (A. H. Clark, 1916); *Pseudarchaster gracilis* (Sladen, 1889); *Henricia antillarum* (Perrier, 1881); *Mediaster bairdii* (Verrill, 1882); *Calyptraster coa* Sladen, 1882.

Sta. 85, 07°39'N 57°15'W, off Guyana, 2.ix.1970. Van Veen grab and triangular dredge, depth 69 m. Sand, shells. — *Echinaster brasiliensis* Müller & Troschel, 1842.

Sta. 87, 07°34'N 57°16'W, off Guyana, 2.ix.1970. Van Veen grab and triangular dredge, depth 59 m. Sand, shells. — *Luidia ludwigi* Fisher, 1906; *Narcissia trigonaria* Sladen, 1889; *Echinaster brasiliensis* Müller & Troschel, 1842.

Sta. 91, 07°15'N 57°17'W, off Guyana, 2.ix.1970. Van Veen grab and triangular dredge, depth 39 m. Muddy sand, shells. — *Astropecten riensis* Döderlein, 1917.

Sta. 92, 07°10'N 57°17'W, off Guyana, 2.ix.1970. Van Veen grab and triangular dredge, depth 31 m. Muddy sand, shells. — *Astropecten riensis* Döderlein, 1917.

Sta. 96, 06°52'N 57°31'W, off Guyana, 3.ix.1970. Van Veen grab and triangular dredge, depth 23 m. Muddy sand, shells. — *Astropecten marginatus* Gray, 1840; *Echinaster brasiliensis* Müller & Troschel, 1842; *Echinaster echinophorus* (Lamarck, 1816).

Sta. 97, 06°48'N 57°31'W, off Guyana, 3.ix.1970. Van Veen grab and triangular dredge, depth 21 m. Mud, shells. — *Luidia senegalensis* (Lamarck, 1816); *Astropecten riensis* Döderlein, 1917.

Sta. 98, 06°44'N 57°32'W, off Guyana, 3.ix.1970. Van Veen grab and triangular dredge, depth 19 m. Muddy fine sand. — *Luidia senegalensis* (Lamarck, 1816); *Astropecten marginatus* Gray, 1840.

Sta. 100, 08°N 57°26'W, off Guyana, 4.ix.1970. Agassiz-trawl, depth 500 m. Muddy bottom. — *Pectinaster gracilis* Verrill, 1915.

Sta. 103, 07°54'N 57°31'W, off Guyana, 4.ix.1970. Van Veen grab and triangular dredge, depth 85 m. Muddy sand, gravel. — *Astropecten riensis* Döderlein, 1917; *Echinaster brasiliensis* Müller & Troschel, 1842.

Sta. 107, 07°42'N 57°30'W, off Guyana, 5.ix.1970. Van Veen grab and triangular dredge, depth 65 m. Muddy sand, shells. — *Echinaster brasiliensis* Müller & Troschel, 1842.

Sta. 112, 07°24'N 57°36'W, off Guyana, 5.ix.1970. Van Veen grab, triangular dredge and detritus sledge, depth 39 m. Muddy sand. — *Luidia senegalensis* (Lamarck, 1816); *Luidia clathrata* (Say, 1825); *Astropecten riensis* Döderlein, 1917.

Sta. 113, 07°22'N 57°37'W, off Guyana, 5.ix.1970. Van Veen grab and triangular dredge, depth 32 m. Muddy bottom. — *Luidia senegalensis* (Lamarck, 1816); *Astropecten riensis* Döderlein, 1917; *Echinaster brasiliensis* Müller & Troschel, 1842.

Sta. 119, 07°01'N 57°47'W, off Guyana, 7.ix.1970. Van Veen grab and triangular dredge, depth 22 m. Sandy mud, shells. — *Luidia senegalensis* (Lamarck, 1816); *Luidia clathrata* (Say, 1825); *Astropecten marginatus* Gray, 1840.

Sta. 120, 07°06'N 57°43'W, off Guyana, 7.ix.1970. Van Veen grab and triangular dredge, depth 24 m. Muddy sand, shells. — *Luidia senegalensis* (Lamarck, 1816); *Luidia clathrata* (Say, 1825); *Astropecten marginatus* Gray, 1840; *Echinaster brasiliensis* Müller & Troschel, 1842.

Sta. 123, 07°23'N 57°39'W, off Guyana, 7.ix.1970. Van Veen grab and triangular dredge, depth 26 m. Sand, shells. — *Luidia senegalensis* (Lamarck, 1816); *Astropecten marginatus* Gray, 1840; *Astropecten riensis* Döderlein, 1917; *Echinaster brasiliensis* Müller & Troschel, 1842.

Cruises of the "Coquette" in 1957:

Cruise 1, Sta. A2, Off Coronie District, NNW Coppename, 20 miles off the coast, 1-4.iv.1957, 15 fms depth. — *Luidia senegalensis* (Lamarck, 1816); *Astropecten marginatus* Gray, 1840; *Astropecten brasiliensis* Müller & Troschel, 1842.

Cruise 2, Sta. B1, Off Marowijne District, NW of mouth Marowijne River, 8-12.iv. 1957, 20 fms depth. — *Luidia senegalensis* (Lamarck, 1816); *Astropecten marginatus* Gray, 1840.

Cruise 3, Sta. C3, Off Coronie and Nickerie Districts, N of Coppename-Nickerie, 20 miles off the coast, 16-19.iv.1957, 15 fms depth. — *Echinaster brasiliensis* Müller & Troschel, 1842.

Cruise?, Sta. D1, Off Commewijne District, NE of Lightship, iv.1957, 28 fms depth. — *Astropecten marginatus* Gray, 1840.

Cruise 5a, Sta. E5, Off Suriname District, 15 miles N of Lightship, 3.v.1957, 10 fms depth. — *Luidia senegalensis* (Lamarck, 1816); *Astropecten marginatus* Gray, 1840.

Cruise 15, Sta. 283, Off Saramacca District, 06°47'N 55°40'W, 26.vi.1957, 25 fms depth, Mud, fine shells. — *Echinaster brasiliensis* Müller & Troschel, 1842.

Taxonomic report

The following list contains all species known from Guyana waters. Those collected during the expeditions O.C.P.S. I and II are reported upon in my paper on the Asteroidea of Surinam (Walenkamp, 1976) and indicated by the letters OCPS. Those collected during the "Luymes" Guyana Shelf Expedition of 1970 are indicated by the letters GSE. The specimens from the Surinaams Museum (cf. Introduction) are indicated by the letters SM.

Subclassis Asteroidea de Blainville, 1830

Ordo Platyasterida Spencer, 1951

Familia Luidiidae Verrill, 1899

Genus *Luidia* Forbes, 1839

L. barimae John & A. M. Clark, 1954: OCPS

L. barbadensis Perrier, 1881: OCPS

L. clathrata (Say, 1825): OCPS, GSE, SM

L. senegalensis (Lamarck, 1816): OCPS, GSE, SM

L. alternata (Say, 1825): OCPS

L. ludwigi Fisher, 1906b: OCPS, GSE, SM

Ordo Paxillosida Perrier, 1884

Subordo Diplozonina Spencer & Wright, 1966

Familia Astropectinidae Gray, 1840

Subfamilia Astropectininae Gray, 1840

Genus *Astropecten* Gray, 1840

A. riensis Döderlein, 1917: OCPS, GSE

A. brasiliensis Müller & Troschel, 1842: OCPS, SM

A. marginatus Gray, 1840: OCPS, GSE, SM

A. americanus Verrill, 1880: OCPS

A. nitidus Verrill, 1915: GSE

A. comptus Verrill, 1915: GSE

Genus *Tethyaster* Sladen, 1889

T. vestitus (Say, 1825): OCPS, GSE

Subordo Notomyotina Ludwig, 1910
  Familia Benthopectinidae Verrill, 1894
    Genus *Cheiraster* Studer, 1883
    C. mirabilis (Perrier, 1881): GSE
    Genus *Pectinaster* Perrier, 1885a
    P. gracilis Verrill, 1915: GSE
Ordo Valvatida Perrier, 1884
Subordo Granulosina Perrier, 1894
  Familia Goniasteridae Forbes, 1841
    Genus *Goniaster* Agassiz, 1835
    G. tessellatus (Lamarck, 1816): OCPS, GSE
    Genus *Tosia* Gray, 1840
    T. parva (Perrier, 1881): GSE
    T. clugreta Walenkamp, 1976: OCPS
    Genus *Anthenoides* Perrier, 1881
    A. peircei Perrier, 1881: OCPS, GSE
    Genus *Rosaster* Perrier, 1894
    R. alexandri (Perrier, 1881): OCPS
    Genus *Nymphaster* Sladen, 1889
    N. subspinosus (Perrier, 1881): OCPS
    N. arenatus (Perrier, 1881): GSE
    Genus *Pseudarchaster* Sladen, 1889
    P. gracilis (Sladen, 1889): GSE
    Genus *Mediaster* Stimpson, 1857
    M. bairdii (Verrill, 1882a): GSE
    Genus *Circeaster* Koehler, 1909a
    C. americanus (A. H. Clark, 1916): GSE
  Familia Oreasteridae Fisher, 1911
    Genus *Oreaster* Müller & Troschel, 1842
    O. reticulatus (Linnaeus, 1758): OCPS
  Familia Ophidiasteridae Verrill, 1867
    Genus *Linckia* Nardo, 1834
    L. guildingii Gray, 1840: OCPS, GSE
    L. nodosa Perrier, 1875: GSE
    Genus *Narcissia* Gray, 1840
    N. trigonaria Sladen, 1889: OCPS, GSE
Ordo Spinulosida Perrier, 1884
Subordo Eugnathina Spencer & Wright, 1966
  Familia Pterasteridae Perrier, 1875
    Genus *Calyptraster* Sladen, 1882

C. coa Sladen, 1882: GSE
Subordo Leptognathina Spencer & Wright, 1966
Familia Echinasteridae Verrill, 1867
Genus *Echinaster* Müller & Troschel, 1840
E. brasiliensis Müller & Troschel, 1842: OCPS, GSE, SM
E. modestus Perrier, 1881: OCPS, GSE
E. echinophorus (Lamarck, 1816): GSE
Genus *Henricia* Gray, 1840
H. antillarum (Perrier, 1881): GSE
Ordo Forcipulatida Perrier, 1884
Subordo Zorocallina Downey, 1970
Familia Zoroasteridae Sladen, 1889
Genus *Doraster* Downey, 1970
D. constellatus Downey, 1970: GSE

Identification

As it is unnecessary to reprint here all identification keys of my previous paper on the Asteroidea of Surinam (Walenkamp, 1976), I shall limit myself to the diagnostic characters of the taxa newly found in Guyana waters. The key to the orders, however, proved, with the additional species, unsatisfactory, so a new one follows here.

Key to the orders of Asteroidea represented in Guyana waters:

1. Marginal plates usually large and conspicuous. Pedicellariae never pedunculate. Dorsal skeleton paxillate, tessellate or imbricate; never reticulate or absent 2
— Marginal plates not conspicuous. Pedicellariae pedunculate, fasciculate or absent. Dorsal skeleton reticulate, imbricate or absent, never tessellate or paxillate 4
2. Supero-marginal plates replaced by paxillae. Ossicles in transverse growth gradients, emerging from axial ossicles . . . . . Platyasterida
— Supero-marginal plates distinctly present as such. No transverse gradients 3
3. Oral plates prominent, usually with keel and median furrow. Pedicellariae sessile . . . . . Paxillosida
— Oral plates relatively inconspicuous, very similar to adambulacral plates. Pedicellariae, if present, alveolar, generally valvate . . . . Valvatida
4. Pedicellariae, if present, generally fasciculate, but usually absent . . . . . Spinulosida
— Pedicellariae pedunculate, straight or crossed . . . . Forcipulatida

Diagnostic characters of the taxa newly found in Guyana waters:

— *Astropecten nitidus* differs from the other species of *Astropecten* concerned by its large, convex supero-marginal plates without a trace of spines, and the ventral surface of the infero-marginal plates, which is set with a few sharp spines and a number of scattered, small, broad-based and sharply pointed spinelets.
— *Astropecten comptus* is characterized by its long arms and numerous (45 or more) supero-marginal plates. The adambulacral spines are flattened and chisel-like.
— The family Benthopectinidae contains the Paxillosida with paired dorsal muscle bands, alternating and imbricating marginal plates with long spines, tube feet with a sucking disk and double ampullae, and pectinate pedicellariae.
— The genus *Cheiraster* can be distinguished from *Pectinaster* by its U- or V-shaped papularia, which are not swollen, as is usually the case in *Pectinaster.*
— The main differences between *Tosia parva* and *Tosia clugreta* are: the ratio supero-/infero-marginal plates is considerably smaller in *Tosia clugreta* than in *Tosia parva*; the terminal pair of supero-marginal plates is not enlarged in *Tosia parva*, as is the case with that of *Tosia clugreta.*
— The genus *Mediaster* is remarkable for its tabulate dorsal plates, which are internally connected by radiating ossicles, the fact that the supero-marginal plates are dorsally not contiguous throughout the arm and the lack of an unpaired median spine on the oral plates.
— *Nymphaster arenatus* has ventral plates, which are covered by rounded granules in contrast to the short, stout, conical spines of *Nymphaster subspinosus*, and its infero-marginal plates lack the prominent spines, which some of these plates show in *Nymphaster subspinosus.*
— The dorsal arm plates of the genus *Circeaster* are conspicuously larger than those of the disk. The disk is large and the arms are long. The ventral plates bear bivalved, excavate or spatulate pedicellariae.
— *Linckia nodosa* stands apart for its large swollen plates, which occur at random on the disk and the arms, the minute spines on some lateral plates and the lack of granules on the ocular plates.
— The family Pterasteridae comprises the Spinulosida, the cross-shaped or lobed dorsal plates of which bear groups of spinelets, which support a membrane, which is distinct from the dorsal surface and forms a cavity for developing brood, which can escape by a central, valved aperture, called the osculum. The lateral spines on the adambulacral plates either support the oral web or merge in the oral surface.

— *Echinaster echinophorus* is diagnosed by its seven to nine longitudinal series of seven to twenty dorsal and marginal spines, its plates with a patch of fine glassy granules and a smooth swollen area, which bears a single, stout, pointed spine, and by its adambulacral plates, which bear one or two slender spines deep in the furrow and one or two stouter spines on the ventral surface.

— The plates of *Henricia* bear a bundle or group of small spinelets, whereas the plates of *Echinaster* have isolated spines.

— *Doraster constellatus* is easily recognised by its large, duck-billed pedicellariae, which are unique to the family Zoroasteridae, and the large, flat, smooth, skin-covered dorsal plates of the disk.

Survey of the species

In this survey only the species, with are new to the Guyana waters are treated extensively. For identification keys, descriptions, synonymies, distribution patterns, variabilities, discussions on taxonomy, drawings and photographs of the species taken off Surinam and indicated by the letters OCPS in the Taxonomic Report above, I refer to Walenkamp (1976).

Luidia clathrata (Say, 1825) (fig. 1)

Material examined: 28 specimens from ten different stations. Sta. 5: (1), R/r = 83/13 mm, no. 5145; Sta. 11: (1), R/r = 66/13 mm, no. 5146; Sta. 16: (2), R/r = 133/18 and 22/6 mm, nos. 5139 and 5149; Sta. 19: (4), R/r = 89/14, 67/11, 13/3 and

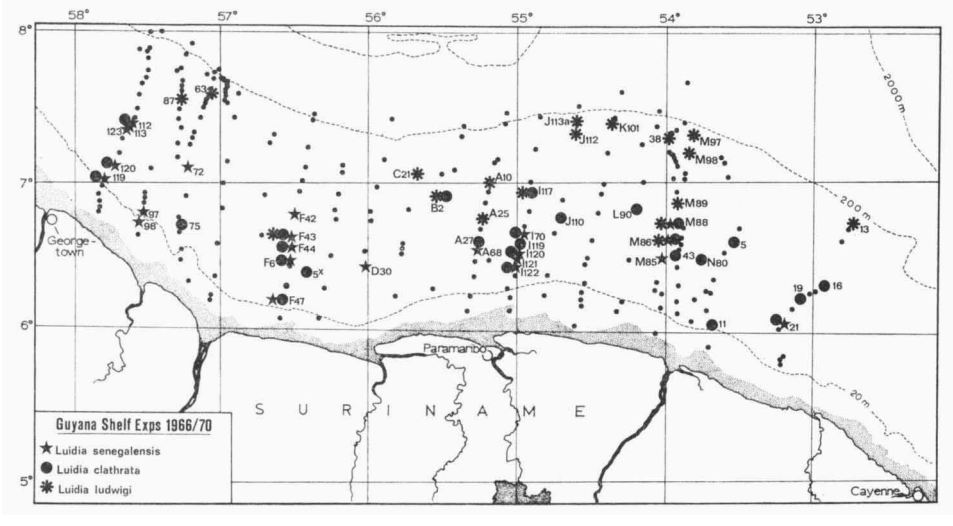

Fig. 1. Records of *Luidia senegalensis*, *Luidia clathrata* and *Luidia ludwigi* in Guyana waters; cf. stationlist and Walenkamp, 1976.

12/3 mm, no. 5147; Sta. 21: (4), R/r = 80/12, 23/6, 10/3 and 9/3 mm, no. 5143; Sta. 43: (8), R/r = 76/13, 72/13, 67/11, 55/10, 21/5, 20/5, 15/4 and 10/3.5 mm, no. 5141; Sta. 75: (4), R/r = 74/14, 54/9, 53/9 and 52/9 mm, no. 5140; Sta. 112: (2), R/r = 87/13 and 87/13 mm, no. 5142; Sta. 119: (1), R/r = 97/17 mm, no. 5144; Sta. 120: (1), R/r = 37/12 mm, no. 5148.

Luidia senegalensis (Lamarck, 1816) (fig. 1; pl. 1 figs. 1-3)

Material examined: a. "Luymes" Guyana Shelf Expedition, 1970: thirteen specimens from nine different stations. Sta. 21: (1), R/r = 189/23 mm, no. 5135; Sta. 72: (1), R/r = 109/16 mm, no. 5138; Sta. 97: (2), R/r = 121/21 and 75/14 mm, nos. 5133 and 5136; Sta. 112: (1), R/r = 104/16 mm, no. 5137; Sta. 113: (2), R/r = 99/14 and 83/11 mm, no. 5194; Sta. 119: (1), R/r = 77/13 mm, no. 5134; Sta. 120: (2), R/r = 80/13 and 72/14 mm, no. 5130; Sta. 123: (1), R/r = 78/12 mm, no. 5132.

b. "Coquette" Cruise, 1957 (material in the Surinaams Museum): Cruise 1, Sta. A2: (4), of which two so damaged that none of the arms could be measured, R/r = 114/16 and 62/10 mm, r = 17 and 16 mm; Cruise 2, Sta. B1: (2), R/r = 115/15 and 61/12 mm; Cruise 5a, Sta. E5: 2, R/r = 118/14 and 97/15 mm.

Remarks. — All specimens of *Luidia senegalensis*, caught during the "Luymes" Guyana Shelf Expedition of 1970, have nine arms, except for one specimen (Sta. 113, R/r = 83/11 mm), which has only six rays.

Luidia ludwigi Fisher, 1906 (fig. 1)

Material examined: Seven specimens from four different stations. Sta. 13: (1), R/r = 12/3 mm, no. 5170; Sta. 38: (4), R/r = 18/4, 16/3, 11/3 and 10/3 mm, no. 5163; Sta. 63: (1), R/r = 51/7 mm, no. 5150; Sta. 87: (1), R/r = 24/5 mm, no. 5176. "Coquette" Cruise "6", 140'-147' (cf. Altena, 1969: 41-42), (19-vi-1957): (1), R/r = 35/6 mm (Surinaams Museum).

Remarks. — During the Guyana Shelf Expedition a number of very small *Luidia* specimens has also been collected, which could not with certainty be identified, but possibly represent *Luidia ludwigi*.

Habitat of the *Luidia* species from Guyana waters

Luidia clathrata and *Luidia senegalensis* appear to have much the same preferences for depth and bottom consistency. Both species are often found together at depths between 19 and 56 m, the bottom being a mixture of mud and sand in variable proportions. Quite often shells and/or shell fragments are part of the bottom material.

Luidia ludwigi has been taken in deeper waters (34-132 m), but on a similar bottom.

To give here a complete picture of the known distribution of the genus in Guyana waters, I have included two maps showing the distribution of all *Luidia* species collected, including those caught during the O.C.P.S. expeditions I and II (cf. figs. 1-2).

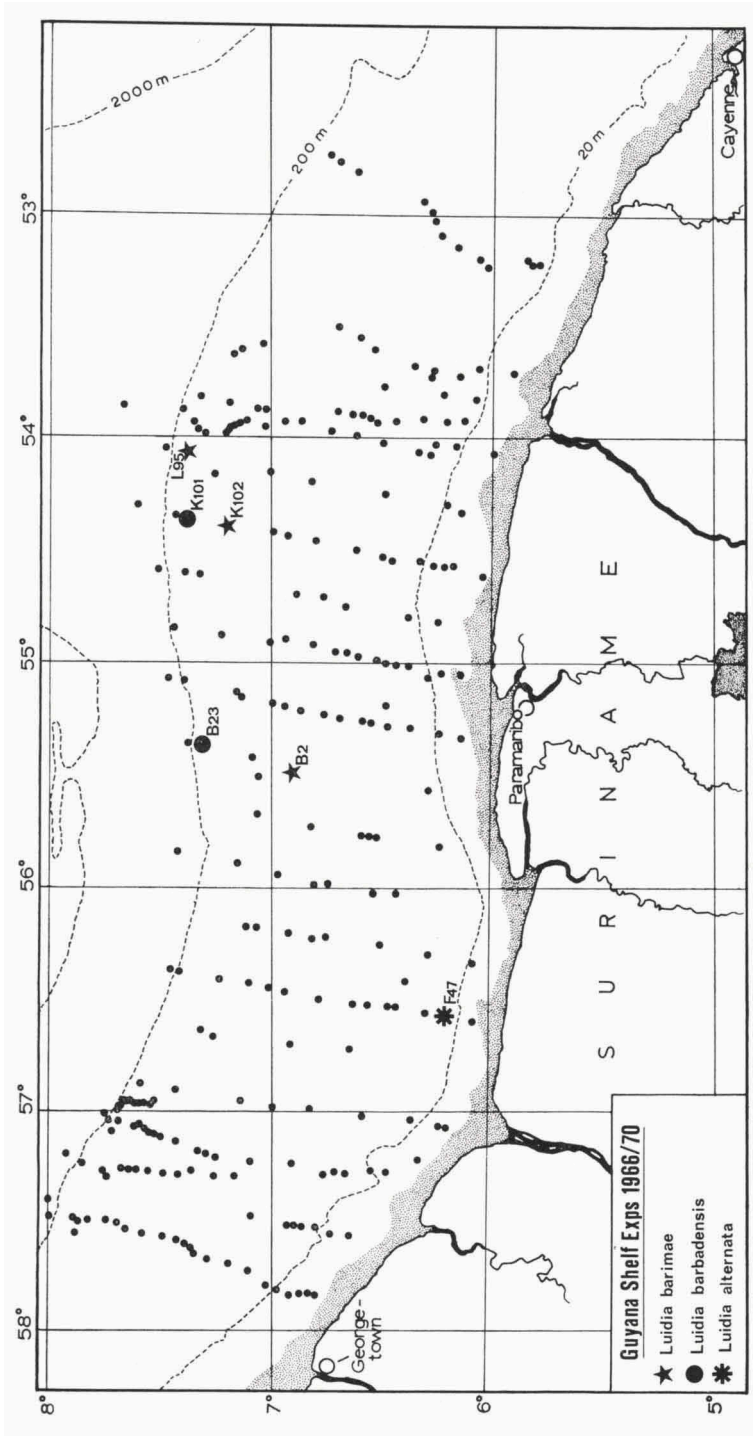

Fig. 2. Records of *Luidia barimae*, *Luidia barbadensis* and *Luidia alternata* in Guyana waters; cf. Walenkamp, 1976.

Astropecten riensis Döderlein, 1917 (fig. 5)

Material examined: 16 specimens from 13 different stations. Sta. 5: (1), R/r = 22/6 mm, no. 5161; Sta. 56: (1), R/r = 10/4 mm, no. 5165; Sta. 65: (1), R/r = 14/4 mm, no. 5166; Sta. 73: (1), R/r = 6/2 mm, no. 5171; Sta. 75: (2), R/r = 15/4 and 9/3 mm, no. 5168; Sta. 91: (2), R/r = 25/7 and 18/5 mm, no. 5157; Sta. 92: (1), R/r = 6/2 mm, no. 5172; Sta. 97: (1), R/r = 24/8 mm, no. 5162; Sta. 103: (1), R/r = 13/3 mm, no. 5167; Sta. 112: (1), R/r = 10/3 mm, no. 5169; Sta. 113: (1), R/r = 26/6 mm, no. 5164.

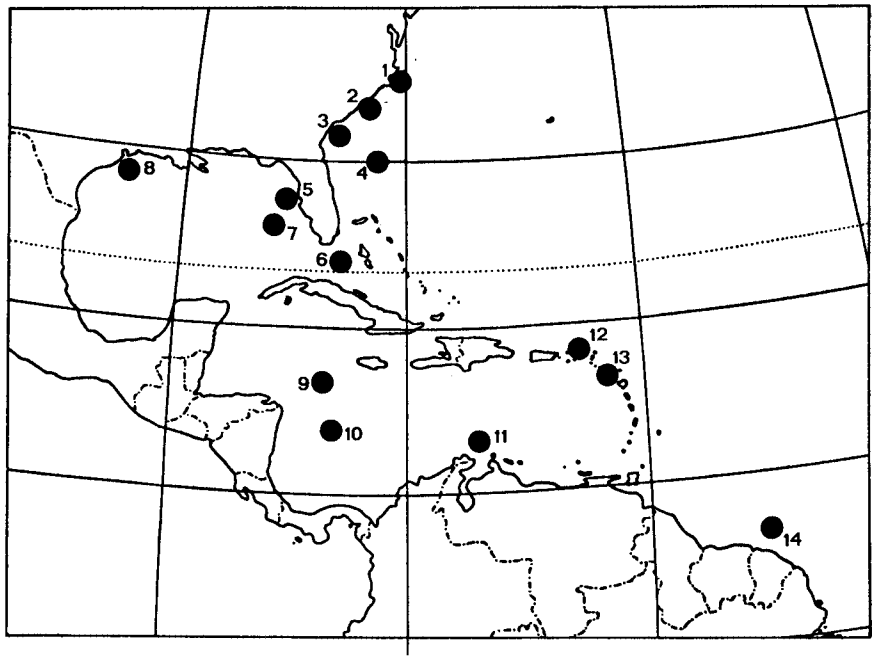

Fig. 3. Distribution in the western Atlantic of *Astropecten nitidus* Verrill, 1915. Explanation of the numbers used: 1, Cape Hatteras, North Carolina; 2, South Carolina; 3, Georgia; 4, off Jacksonville, Florida; 5, West Florida; 6, Cay Sal Bank, Bahama Islands; 7, West of Dry Tortugas; 8, off Galveston, Texas; 9, Caribbean Sea, between Honduras and Jamaica; 10, off Puerto Cabezas, Nicaragua; 11, off Gulf of Venezuela; 12, Virgin Islands; 13, St. Kitts Islands; 14, off French Guyana.

Astropecten marginatus Gray, 1840 (fig. 5)

Material examined: a. "Luymes" Guyana Shelf Expedition, 1970: 43 specimens from six different stations. Sta. 57: (1), R/r = 15/4 mm, no. 5173; Sta. 96: (1), R/r = 53/13 mm, no. 5158; Sta. 98: (7), R/r = 77/18, 70/15, 69/15, 57/15, 50/13, 43/15 and 26/8 mm, no. 5151; Sta. 119: (16), R/r = 71/17, 67/15, 65/14, 64/14, 59/14, 58/14, 57/15, 56/14, 54/13, 50/12, 42/12, 39/12, 37/12, 20/6 and 19/6 mm, no. 5152; Sta. 120: (17), R/r = 59/13, 57/14, 54/13, 53/14, 53/14, 53/13, 50/13, 50/13, 49/13, 48/13, 48/12, 45/12, 40/11, 38/11, 36/10, 31/9 and 30/9 mm, no. 5153; Sta. 123: (1), R/r = 52/13 mm, no. 5154.

b. "Coquette" Cruise, 1957 (material in the Surinaams Museum): Cruise 1, Sta. A2: (2), R/r = 47/11 and 46/11 mm; Cruise 2, Sta. B1: (1), R/r = 44/13 mm; Cruise?, Sta. D1: (5), R/r = 41/15, 31/14, 15/5, 14/5 and 12/5 mm; Cruise 5a, Sta. E5: (7), R/r = 52/11, 49/13, 47/11, 44/12, 38/11, 33/10 and 21/11 mm.

c. Eleven specimens, all with incomplete arms, collected by P. A. Teunissen on 8-iii-1972 in the estuary of the Krofajapasi Creek, Surinam, r = 11, 11, 12, 13, 14, 14, 15, 15, 16 and 16 mm (material in the Surinaams Museum).

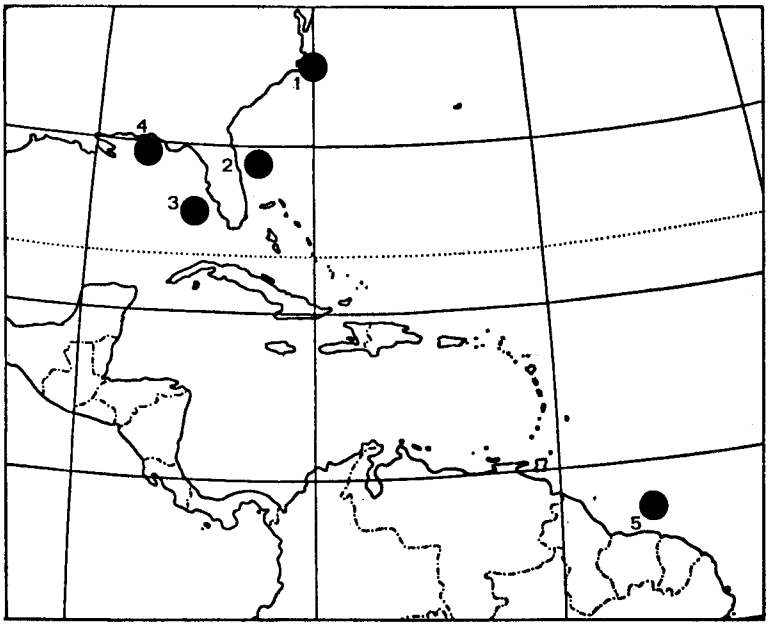

Fig. 4. *Astropecten comptus* Verrill, 1915; distribution in the western Atlantic. Explanation of the numbers used: 1, Cape Hatteras, North Carolina; 2, Daytona Beach, Florida; 3, West Florida; 4, off Santa Rosa Island, Florida; 5, Surinam.

Astropecten brasiliensis Müller & Troschel, 1842 (fig. 6)

Material examined: One specimen, collected during the "Coquette" Cruise, 1957. Cruise 1, Sta. A2, R/r = 100/19 mm (material in the Surinaams Museum).

Astropecten nitidus Verrill, 1915 (figs. 3, 6; pl. 3 figs. 1-2)

Astropecten nitidus Verrill, 1915: 179, pl. 20 fig. 2. — Gray, Downey & Cerame-Vivas, 1968: 145, fig. 17. — Downey, 1973: 30, pl. 7 figs. A, B.
Astropecten nitidus forcipatus Verrill, 1915: 180, pl. 16 fig. 3, pl. 20 fig. 1.

Material examined: One juvenile specimen from station 13, off French Guyana. R/r = 12/4 mm, no. 5174.

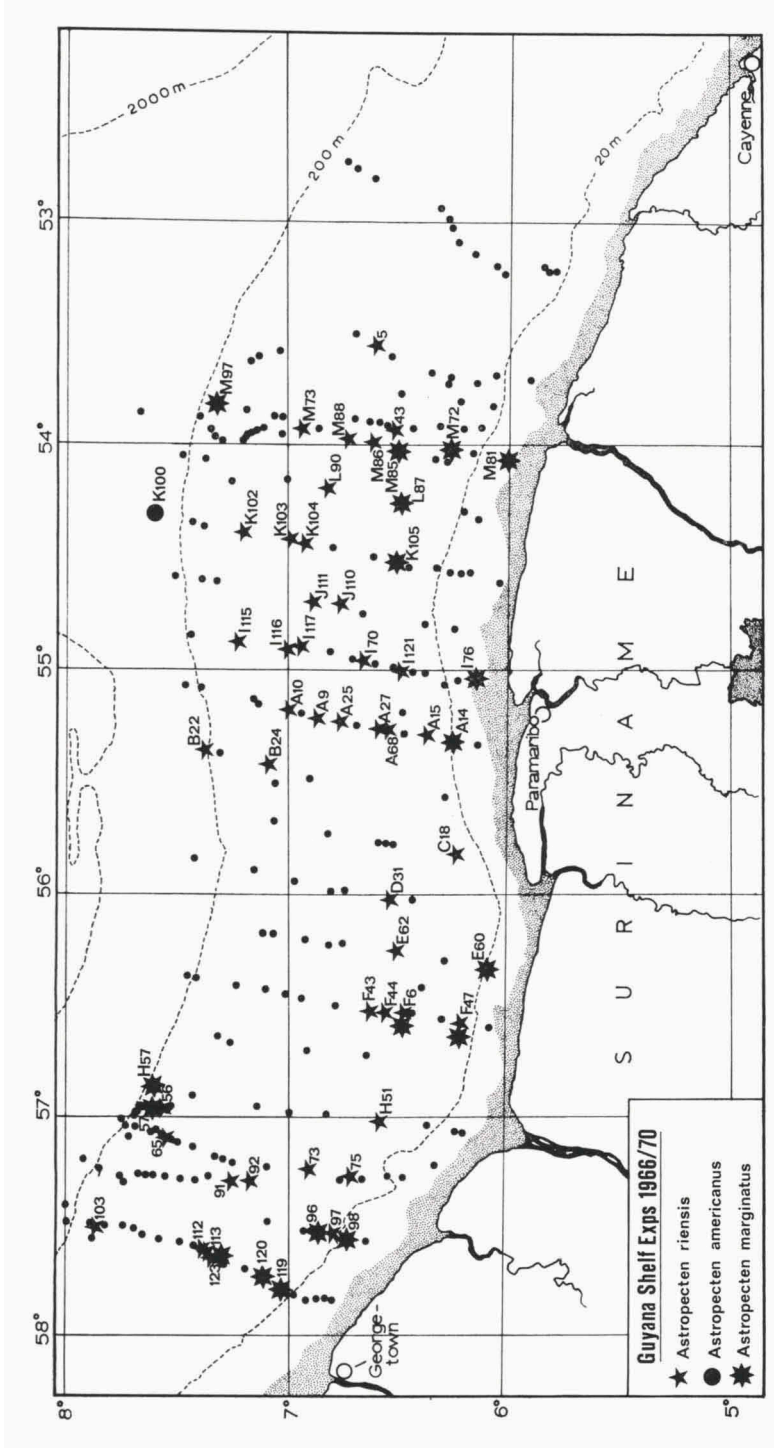

Fig. 5. Records of *Astropecten riensis*, *Astropecten americanus* and *Astropecten marginatus* in Guyana waters; cf. stationlist and Walenkamp, 1976.

Diagnosis. — Large, convex supero-marginal plates, without enlarged granules or spines. Paxillar area in the rays slightly wider than width of one series of supero-marginal plates. Infero-marginal plates with two, subequal lateral spines and a few smaller sharp spines and small, sharply pointed, broad-based spinelets.

Description. — The flat body has short, pointed arms (R/r ratio 12/4 = 3) with relatively large supero-marginal plates. At their bases the arms are about four mm wide. The paxillar area between the first two supero-marginal plates is about two mm wide; between the second supero-marginal plates its width is 1.5 mm. Between the terminal supero-marginal plates the paxillar area is still 0.5 mm wide. The paxillae form rather irregular transverse and longitudinal series. On the elevated central area they are small and crowned with more slender spinelets than on the arms. The dorsal paxillae have a crown of five to six marginal spinelets. There usually is one central spinelet, sometimes there are two or three or none.

Ten or eleven supero-marginal plates are present on each side of the ray. They are relatively large, evenly rounded, all wider than long, and all rectangular with rounded corners, except for the first ones, which are wedge-shaped. Towards the edges the granules of the central surface gradually become slender spinelets. In the grooves between the plates are many glassy, very thin spinelets. The second supero-marginal plate, which has the largest width/length ratio of all, is half again as wide as long.

The infero-marginal plates slightly protrude beyond the supero-marginal plates and bear two large lateral spines; the aboral of these is about as long as the plate is wide, i.e. 1.2 mm long and the adoral one about 0.8 mm. On the ventral surface there are a few smaller, sharply pointed spines interiorly to the lateral spines. Along the aboral margin of the plate there are one or two of these spines. The rest of the ventral surface of the plates bears some scattered spinelets. The grooves between the plates are overlapped by very slender spinelets and deeper down have many glassy spinules. Distally the marginal plates no longer stand at right angles to the axes of the rays, but at a sharper angle, directed towards the tip of the arm; the infero-marginal plates more so than the supero-marginal plates.

The terminal plate is strongly turned upwards, bilobed, each lobe bearing three short, stout spines (the central being the strongest) and a number of spinelets along the ambulacral groove. The rest of its surface is granulated.

In each arm-corner there are eight ventro-lateral plates, not reaching beyond the first infero-marginal plates, and increasing in size towards the oral plates. This increase in size is accompanied by an increase in the number of slender spinelets, which are placed on the plates, and on the proximal plates are often grouped together so as to form a fasciculate pedicellaria.

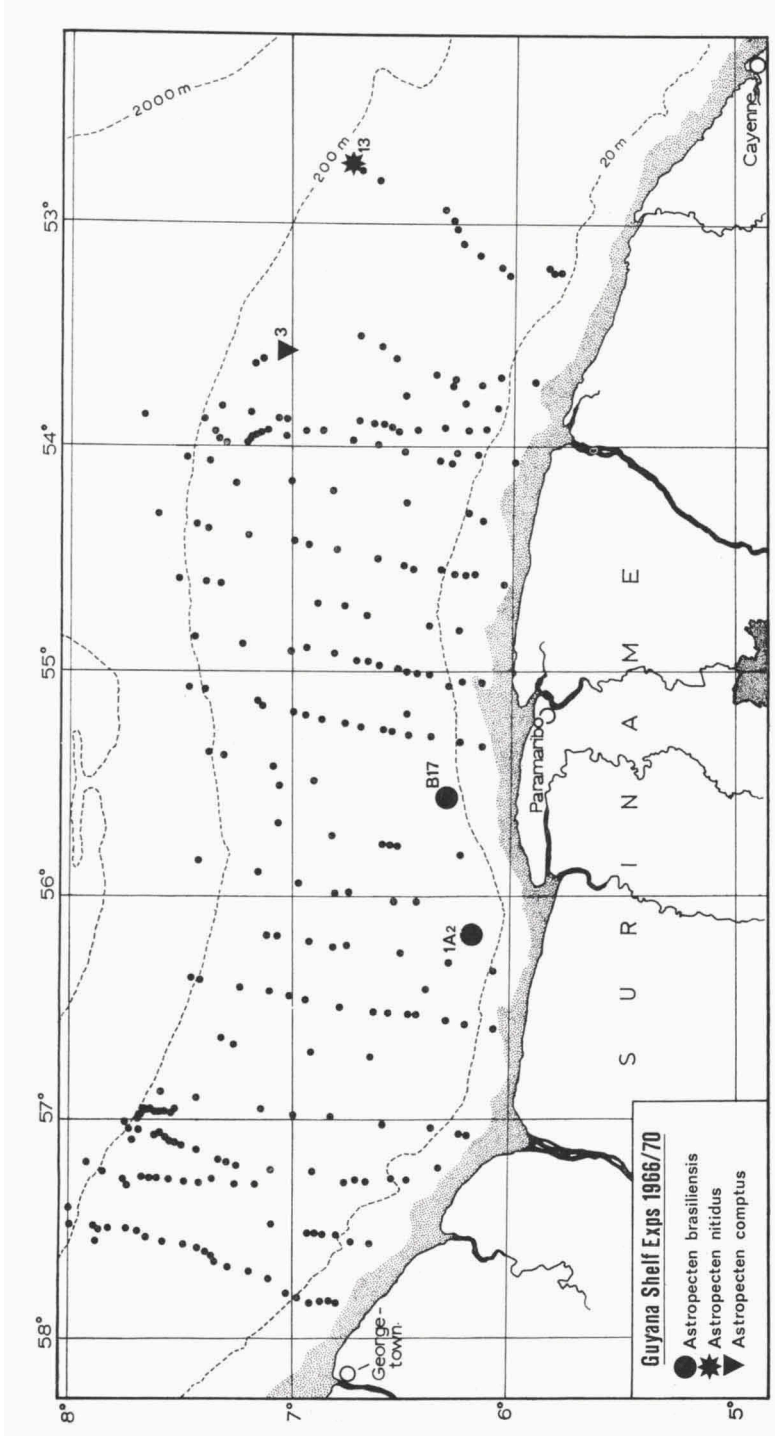

Fig. 6. Records of *Astropecten brasiliensis*, *Astropecten nitidus* and *Astropecten comptus* in Guyana waters; cf. stationlist and Walenkamp, 1976

There are about two adambulacral plates to each infero-marginal plate. The interior margin of the plates bears three furrow spines; on the proximal adambulacral plates, which are not placed at right angles to the ambulacral groove, but parallel to the grooves between the inferno-marginal plates, there are often four furrow spines. The spines are not fully developed, being not as smooth and flattened as in adult *Astropecten* specimens. The central furrow spine is the largest and both adorally and aborally flattened; the longest axes of the spines on either side in transverse section make an angle with that of the central spine. The second series of spines also consists of three spines, but smaller and less flattened than the furrow spines. None of these spines is particularly larger than the others. Interior to this second series there are often some additional spinelets. The furrow spines are placed on a triangular apophysis of the plates, protruding into the ambulacral furrow.

The spines of the oral plates are arranged in two series. The exterior series starts adorally at each side of the plate with two large spines, and rather abruptly continues as a series of about six, slender, rod-shaped spines. The aboral edge of the plates, along the first adambulacral plates, bears some small spinelets. The inner series of spines consists of about eight spines on either side of the central groove, which spines are very similar to those of the second series of adambulacral spines.

The madreporite is very inconspicuous, separated by one paxilla from the supero-marginal plates, strongly overlapped by the adjacent paxillae and having coarse gyri, so that the ridges on its surface strongly resemble the adjacent paxillar spinelets.

The colour in alcohol 70% is whitish.

Discussion. — The single specimen in our collection is young and not in good condition; particularly the armature of the ventral surface is damaged. In general this specimen appears more stubby, with relatively stouter marginals and shorter rays than those previously described; the ventral surface of the adambulacral plates has fewer spines and no pedicellariae. On the ventral surface of the infero-marginal plates the only series of spines, which one could call transverse series, are composed of a few spines along the aboral margin of the plate.

According to Downey (1973) *Astropecten nitidus forcipatus* Verrill, 1915, is merely a variety and not a distinct subspecies.

Distribution. — Off North and South Carolina. Georgia (type locality: "Albatross" station 2762). Florida. Cay Sal Bank, Bahama Islands. Gulf of Mexico. Caribbean Sea. Leeward Islands. French Guyana.

Bathymetrical range. — 36-333 m, mostly in the deeper part of this range.

Astropecten comptus Verrill, 1915 (figs. 4, 6; pl. 1 fig. 4; pl. 2 figs. 1-4)

Astropecten comptus Verrill, 1915: 176, pl. 12 figs. 3-3c, pl. 22 fig. 1. — Downey, 1973: 29, pl. 5 figs. C, D.

Material examined: One specimen from station 3, off Surinam. R/r = 84/12 mm, no. 5223.

Diagnosis. — Supero-marginal plates numerous, over 45 on each side of the ray, and granulated; spineless except for a short blunt spine or enlarged tubercle on the interior margin of the first supero-marginal plates. Interior and middle adambulacral spines flattened and chisel-like.

Description. — The body is flat and has five long tapering arms, slightly constricted at the base. The R/r ratio is seven. The width of the arm at the second supero-marginal plate is thirteen mm, of which the paxillar area occupies seven mm and the second supero-marginal plates each three mm. The paxillae are high and slender and bear a crown of six to twenty marginal and one to ten central spinelets, which are, on the central elevated part of the disk, distinctly more slender than on the surrounding part of the disk or on the proximal part of the arms. At the level of the first supero-marginal plates there are about nine paxillae in an irregular transverse row. Towards the tip of the arm the paxillae decrease in size and have fewer and more slender spinelets. Between the last two supero-marginal plates there still are five to six paxillae.

The supero-marginal plates are all wider than long, proximally more so than distally. They are all set with short, granular spinelets, rounded in the centre and gradually passing into the very thin and sharp spinelets between the plates. Only the first supero-marginal plates have one interior granule greatly enlarged to form a short, blunt spine, which is hardly noticeable with the naked eye. All other supero-marginal plates lack such an enlarged granule or spine. In the longest arm there are 45 supero-marginal plates on each side of the ray.

The terminal plate is quadrangular with rounded corners and dorsally as well as ventrally divided in two lobes by wide grooves.

The infero-marginal plates protrude beyond the supero-marginal plates, but as the ambulacral groove is extremely wide this feature is probably less distinct in better preserved specimens. The plates bear two large lateral spines, with adorally often a third, much smaller one. The largest, most aboral lateral spine is over four mm long. The first infero-marginal plates lack such lateral spines and the second ones only have one large lateral spine. The third and fourth infero-marginal plates often lack the smaller adoral spine. The ventral surface of the plates has two or three fairly long, often slightly curved, sharp spines, parallel to the lateral spines; often,

however, and especially distally, this series aborally turns to the interior side of the plates. Under these spines there are, aborally, two smaller spines. The rest of the aboral side of the plate bears about four slender spines, about two mm long. The oral side of the plates usually has three such spines, often slightly shorter. On the interior side of the plates there usually are one or two such spines. Between the above mentioned larger spines there is a number of small, slender spinelets. The grooves between the plates are set with fine spinules, as is the case with the supero-marginal plates.

The ventro-lateral area is very small and consists of ten small, irregularly rounded plates, not reaching beyond the proximal part of the second infero-marginal plate. The plates are set with long ,very slender spinelets, of which a few are sometimes grouped together so as to form a simple pedicellaria. The middle ventro-lateral plates usually bear a larger central spine, about 1.5 mm long.

There are fewer than two adambulacral plates to one infero-marginal plate. They bear three furrow spines: one keel-shaped central spine, which is flattened on its ad- and aboral sides and the longest of the three, and two others, which are flattened too, but stand obliquely ,the longest axis of their transverse sections making an angle of about 40° with the axis of the central furrow spine. Exterior to the furrow spines there are three to four, in- and exteriorly flattened spines. If there are four, the most adoral stands between the adoral furrow spine and the second spine of the second series. All these spines, and usually those of the third series too, have their flattened tips blunt and broadened like a chisel. Exterior to the second series there is a third series of more slender and rod-like spines. Exterior to these there are often some slender spinelets.

The madreporite is situated at a distance of three paxillae from the groove between the first supero-marginal plates. The edge is overlapped by paxillae, but it appears circular and with a diameter of about two mm. It has undulating grooves and is light brown.

Discussion. — *Astropecten comptus* appears to be a rare species. Verrill, 1915, mentioned two specimens, and the next author to report newly caught specimens of this species, Downey, 1973, six. In Guyana waters only one specimen has been taken. Due to this small number our knowledge of the variability is very limited. R ranges from sixteen to ninety-five mm; r from five to eighteen mm. The R/r ratio from three in the smallest to seven in the larger specimens. My specimen is unique for having a short, blunt spine on the interior margin of the first supero-marginal plates. Supero-marginal spines tend to be a rather variable character in *Astropecten* and this specimen might be a representative of an undescribed species with more supero-

marginal spines. As long as so few specimens of *Astropecten comptus* have been examined, however, and as long as the whole taxonomy of the genus *Astropecten* has not yet been revised, as it badly needs to be, I prefer not to add a new specific name to the ones already existing.

Distribution. — Off Cape Hatteras ("Albatross" station 2286, type locality). Off the east and west coasts of Florida. Surinam.

Bathymetrical range. — 20 to 80 m. The Surinam specimen was taken about 24 m deeper than previously published material.

Habitat of the *Astropecten* species from Guyana waters

The map in fig. 5 gives all stations in Guyana waters, where *Astropecten riensis, Astropecten marginatus* and *Astropecten americanus* have been collected during the O.C.P.S. expeditions I and II and the "Luymes" Guyana Shelf Expedition of 1970.

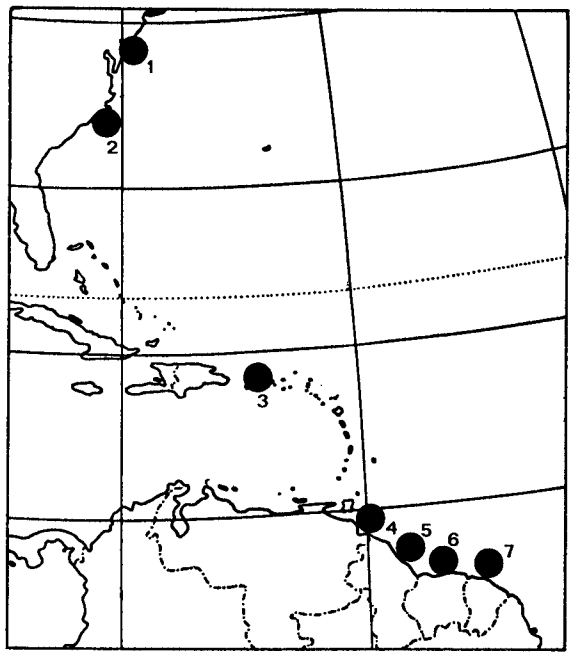

Fig. 7. Distribution of *Tethyaster vestitus* (Say, 1825). Explanation of the numbers used: 1, Cape May, New Jersey; 2, Diamond Shoal, North Carolina; 3, Puerto Rico; 4, off Rio Orinoco, Venezuela; 5, Guyana; 6, Surinam; 7, French Guyana. The species is also mentioned from Brazil without, however, an exact locality is given.

Astropecten marginatus has been collected at fewer stations than *Astropecten riensis*, but often in larger numbers. The two species appear to exclude each other more or less; at only three stations they have been taken together. This separate occurrence of the two species does not seem related to bottom consistency or depth, although *Astropecten marginatus* generally occurs in shallower water. The bathymetrical range of the two species in Guyana waters it for *Astropecten marginatus* 6-130 m, and for *Astropecten riensis* 25-400 m.

Astropecten americanus has been found at only one station (depth 300 m), so litle can be said about is distribution in the area, except that it appears to be a deeper water species, which impression is supported by the existing literature.

Astropecten comptus and *Astropecten nitidus* have both been caught at one station each, in deeper water (cf. fig. 6).

Tethyaster vestitus (Say, 1825) (figs. 7, 10; pl. 4 fig. 1)

Material examined: Three specimens of three different stations. Sta. 16: (1), R/r = 72/19 mm, no. 5187; Sta. 19: (1), R/r = 46/13 mm, no. 5189; Sta. 63: (1), R/r = 39/11 mm, no. 5186.

Remarks. — The smallest specimen (Sta. 63) was found to contain a whole, intact sea-urchin, *Eucidaris tribuloides* (Lamarck, 1816), the spines of which stuck through the skin of the starfish. The diameter of the test of the sea-urchin is six mm and it has strong spines, up to nine mm long.

Cheiraster mirabilis (Perrier, 1881) (figs. 8, 10; pl. 4 figs. 2-4)

Archaster mirabilis Perrier, 1881: 27; 1884: 256, pl. 8 figs. 7, 8, pl. 9 fig. 4, pl. 10 figs. 2, 3.
Archaster coronatus Perrier, 1884: 262.
Cheiraster coronatus — Perrier, 1894: 271. — Ludwig, 1910: 455.
Cheiraster mirabilis — Perrier, 1894: 276-278. — Verrill, 1915: 124, pl. 14 figs. 5, 5a. — Downey, 1973: 41, pl. 13 figs. A, B.
Cheiraster mirabilis coronatus Verrill, 1915: 127.
Cheiraster planus Verrill, 1915: 133, pl. 18 fig. 2.

Material examined: One specimen from station 48 off Guyana. R/r = 53/8, no. 5195.

Diagnosis. — R/r ratio about 8. Less than 50 papulae in each U-shaped papularium.

Description. — The body is flat and has five long, pointed arms. The R/r ratio is 6.6. The dorsal plates may be divided in primary and secondary ones: the primary dorsal plates are up to 0.5 mm in diameter; the secondary plates are much smaller. The primary plates usually bear a relatively large, slender, pointed spine, surrounded by a series of small marginal spinelets.

The secondary plates bear a few similar spinelets, but lack the spine. On the arms there are fewer secondary plates and fewer primary plates with a central spine. The dorsal plates are numerous: there are over twenty plates between the first supero-marginal plates. The (about twenty) papulae of each radius are arranged in two concentric U's between the first two supero-marginal plates. The papular area is slightly swollen.

In the longest arm there are 30 supero-marginal plates on each side of the ray. They bear a large central spine, which is proximally almost four mm long. The spine of the first supero-marginal plates is only about two mm long. The rest of the plates is sparingly covered with slender, pointed spinelets. Denuded plates show small, well separated glassy tubercles. The dorsal plates continue in such a way, that they cover the interior margin of the supero-marginal plates. The plates are not placed at right angles to the axes of the radii, but stand obliquely, their interior distal angle closer to the tip of the arm than the exterior distal angle.

Distally the terminal plates bear five long, slender spines on each side; these spines are very similar to the supero-marginal spines. The dorsal and lateral surfaces of the plates are set with spinelets, similar to those of the supero-marginal plates.

The slightly tumid infero-marginal plates do not correspond completely with the supero-marginal plates, because the first infero-marginal plates are longer than the first supero-marginal plates. They bear one large spine, similar to, but smaller than that on the supero-marginal plates. On most plates there are one or two additional, smaller spines. The ventral surface of the plates shows short, pointed spinelets, which are larger on the proximal plates. Denuded infero-marginal plates also show small, well separated glassy tubercles.

The small ventro-lateral areas do not reach beyond the second infero-marginal plates. They consist of twelve plates along the adambulacral and oral plates, and of about four plates between this series and the first infero-marginal plates. The two large proximal ventro-lateral plates bear one to three larger spines; the rest of their surface and the other ventro-lateral plates are set with pointed spinelets.

The adambulacral plates protrude in the ambulacral groove on a triangular apophysis. The furrow series of spines consist of seven to ten, usually eight, slender, rod-shaped, slightly flattened spines, over one mm long. On the ventral surface stands a very conspicuous, pointed spine, similar to, but slightly smaller than the large infero-marginal spine. On the interior and ab- and adoral margins of the plates about ten slender spinelets are situated.

The interior margin of the rounded, swollen oral plates bears four spines:

the interior two about two mm long, the exterior two slightly shorter. Along the ambulacral groove there are five to six spines on either side, slightly stouter than the adambulacral furrow spines. The tumid ventral surface is set with about fourteen short, slender spines, exteriorly decreasing in size. The two parts of the oral plates are separated by a broad groove.

The madreporite is almost two mm long and less wide. It is situated less than one mm from the supero-marginal plates and has coarse gyri.

The colour, in alcohol 70%, is white.

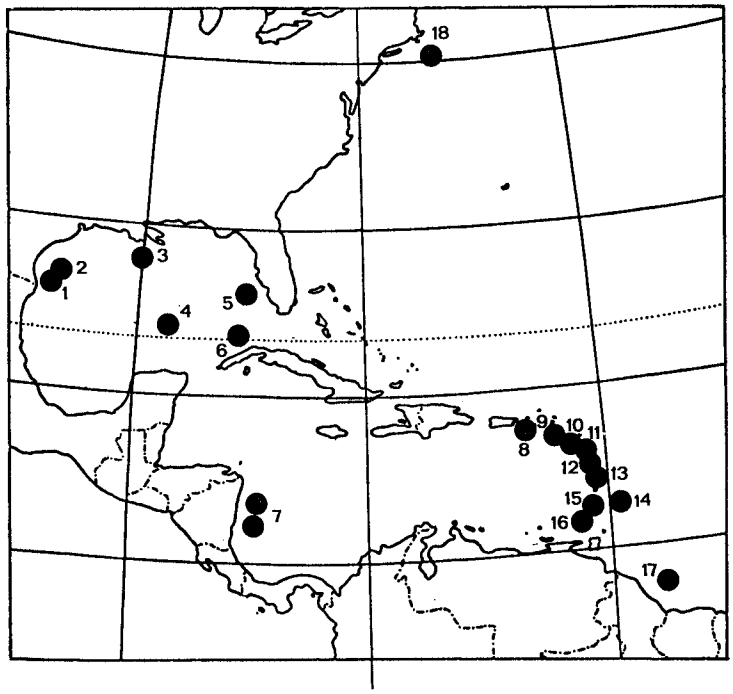

Fig. 8. Distribution of *Cheiraster mirabilis* (Perrier, 1881). Explanation of the numbers used: 1, Brownsville, Texas; 2, Corpus Christi, Texas; 3, New Orleans, Louisiana; 4, Gulf of Mexico; 5, West Florida; 6, Havana; 7, Nicaragua; 8, Santa Cruz; 9, Saba; St. Kitts; 10, Montserrat; 11, Guadeloupe; 12, Dominica; 13, Martinique; 14, Barbados; 15, St. Vincent; The Grenadines; Carriacou; 16, Grenada; 17, Guyana; 18, George's Bank, U.S.A.

Remarks. — Ludwig (1910), Verrill (1915) and Downey (1973) considered *Cheiraster coronatus* (Perrier, 1884: 262) to be conspecific with *Cheiraster mirabilis*. Ludwig (1910: 455) considered *Cheiraster mirabilis* a juvenile form of *Cheiraster coronatus*, but incorrectly used the junior of the two names for the species. Verrill (1915: 127-128) made *Cheiraster*

coronatus a subspecies of *Cheiraster mirabilis*, but he added, that as far as Perrier's description of 1884 goes, "... there is no character by which this form is distinguishable from typical *C. mirabilis*...".

Basing herself on Verrill's descriptions, Downey (1973: 41) thought *Cheiraster planus* Verrill, 1915, to be a large *Cheiraster mirabilis*, the differences between the two forms being merely due to normal growth. This opinion, however, is not shared by Jangoux (1978: 96).

Distribution. — George's Bank, northeastern coast of the United States of America. Gulf of Mexico. West Florida. Havana. Nicaragua. Lesser Antilles. Guyana.

Downey (1973: 41) reported the species from George's Bank to the West Indies. This record is based on four specimens in the Smithsonian Institution, Washington, taken by the "Albatross" in 1885 and identified by A. E. Verrill (Downey, in litt.).

Bathymetrical range. — 100-1854 m depth.

Pectinaster gracilis Verrill, 1915 (figs. 9-10; pl. 5 figs. 1-4; pl. 6 figs. 1-4)

Pectinaster gracilis Verrill, 1915: 145-147, pl. 6 fig. 1, pl. 14 fig. 4, pl. 15 figs. 1-1b. — Downey, 1973: 44, pl. 15 figs. A, B.

Material examined: Three small specimens. Sta. 48: (2), R/r = 26/5 and 11/2.5 mm, no. 5210; Sta. 100: (1), R/r = 15/3 mm, no. 5209.

Diagnosis. — Dorsal plates rounded. Oral plates very large and wide, with one large tooth spine and about six smaller, slender spines on either side. Papular area slightly raised. Large spine on the infero-marginal plates surrounded by small, sharply pointed spinelets only.

Description. — The flat body of the largest specimen has five rather long, pointed arms. The R/r ratio is 5.2. The dorsal plates are rounded and swollen, but have an angular outline. In each interradius there is one very large dorsal plate with a diameter of about 0.6 mm, which bears one large central spine, about 0.9 mm long, with a few smaller spines around it; the edge of the plate has a series of pointed spinelets. One of these primary plates bears only pointed spinelets. The five large, interradial dorsal plates form the corners of a pentagon, on the sides of which there are five large radial plates, one on the interior of each swollen papularium; they are, however, smaller than the interradial primary plates. Any spines, which these plates may well have had, have been rubbed off. Interior to these plates there are five additional large, radial plates; again one in each radius, but slightly smaller than the outer ones. They bear a large central spine, over one mm long and surrounded by marginal spinelets. The other dorsal plates bear a crown of about seven pointed spinelets. The swollen papularia

have about six, rather large, single papular pores. The dorsal plates partly cover the interior margin of the supero-marginal plates. There are about seventeen dorsal plates in a transverse row between the first supero-marginal plates.

In the only intact arm there are 22 rounded supero-marginal plates on each side of the ray. On denuded plates the tubercle of the large (about two mm long) central spine is surrounded by small glassy tubercles. Around the central spine the plates bear scattered, pointed spinelets. The grooves between the plates make an angle of about 45° with the axis of the ray.

The terminal plate is rectangular with rounded corners. Except for a few spinelets along the ambulacral groove, all spines have been rubbed off, leaving only indistinct tubercles.

Each of the rounded infero-marginal plates bears a large central spine of about 1.5 mm length, surrounded by pointed spinelets, which in the direct vicinity of the spine often are slightly enlarged. Denuded plates show the large tubercle of the central spine and scattered glassy tubercles. The first plates are larger than the first supero-marginal plates, so the marginal plates do not correspond and often even alternate.

The ventro-lateral area extends to about the middle of the second infero-marginal plates and consists of about fourteen irregularly shaped, imbricating plates, arranged in two series: one of about ten plates along the adambulacral and oral plates, and a second of about four plates between this series and the infero-marginal plates. The two most adoral ventro-lateral plates are distinctly the largest of all. The plates bear a few pointed spinelets, of which one or two are often slightly enlarged.

There are about three adambulacral plates to two infero-marginal plates. The triangular interior part of the plates bears about eight slender, rod-shaped, slightly compressed furrow spines. On the middle of the plates there is one large pointed spine, about 1.3 mm long. The rest of the plates is bare, except for an occasional thin, pointed spinelet.

The oral plates show a deep median furrow. They have four oral furrow spines, the two central spines larger than the exterior two. On either side of the oral plates there are about six furrow spines along the ambulacral groove, which distally decrease in size. The swollen central surface of the plates has several enlarged, pointed spinelets.

The madreporite is situated directly exterior to the interradial primary plate, is hardly visible and has deep, coarse gyri.

The colour in alcohol 70% is white.

Variability. — The small specimen from station 48 (R/r = 11/2.5 mm) has essentially the same characters as the larger one. The large spines on

some of the dorsal plates are, however, not as well developed. The swollen papularia appear to have only one large papular pore, surrounded by four to five large, dorsal plates. The ventro-lateral areas show only one or two small plates. The central adambulacral spine is hardly larger than the six to seven furrow spines or has the same size. The terminal plates bear a few, relatively large, pointed spines. The glassy tubercles on the marginal plates are relatively larger and more crowded.

The specimen from station 100 (R/r = 15/3 mm) is very similar to the small specimen from station 48. Its damaged dorsal side appears to lack any sign of enlarged spines on the dorsal plates. Papular pores are not discernible; this in contrast to Downey's specimens of similar sizes, which show three to seven pores in each papularium. The ventro-lateral area has six plates, of which the two distal are very small. The central adambulacral spine is decidedly longer than the furrow spines, but hardly thicker or of identical size. The terminal plates bear three, large, pointed spines on each side.

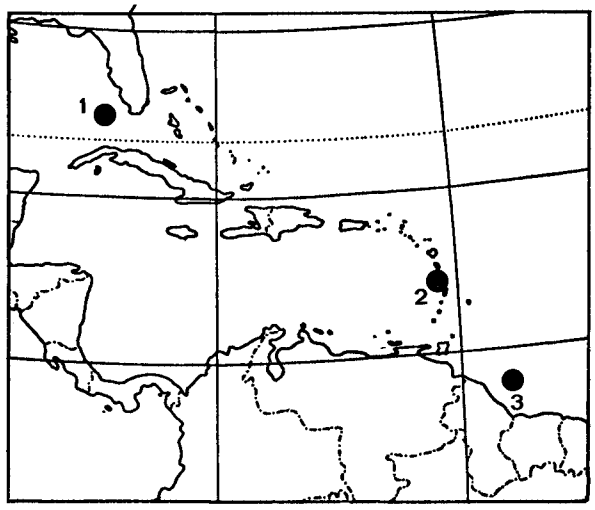

Fig. 9. Distribution of *Pectinaster gracilis* Verrill, 1915. Explanation of the numbers used: 1, Off Florida Keys; 2, Antilles; 3, Off Guyana.

Remarks. — I have hesitated to identify these specimens as *Pectinaster gracilis*, as Benthopectinidae of such small size cannot be identified with certainty, unless a good series of specimens of all ages is available. Crucial diagnostic characters like the papularia, the pectinate pedicellariae and spinulation are not or scarcely developed in so young specimens.

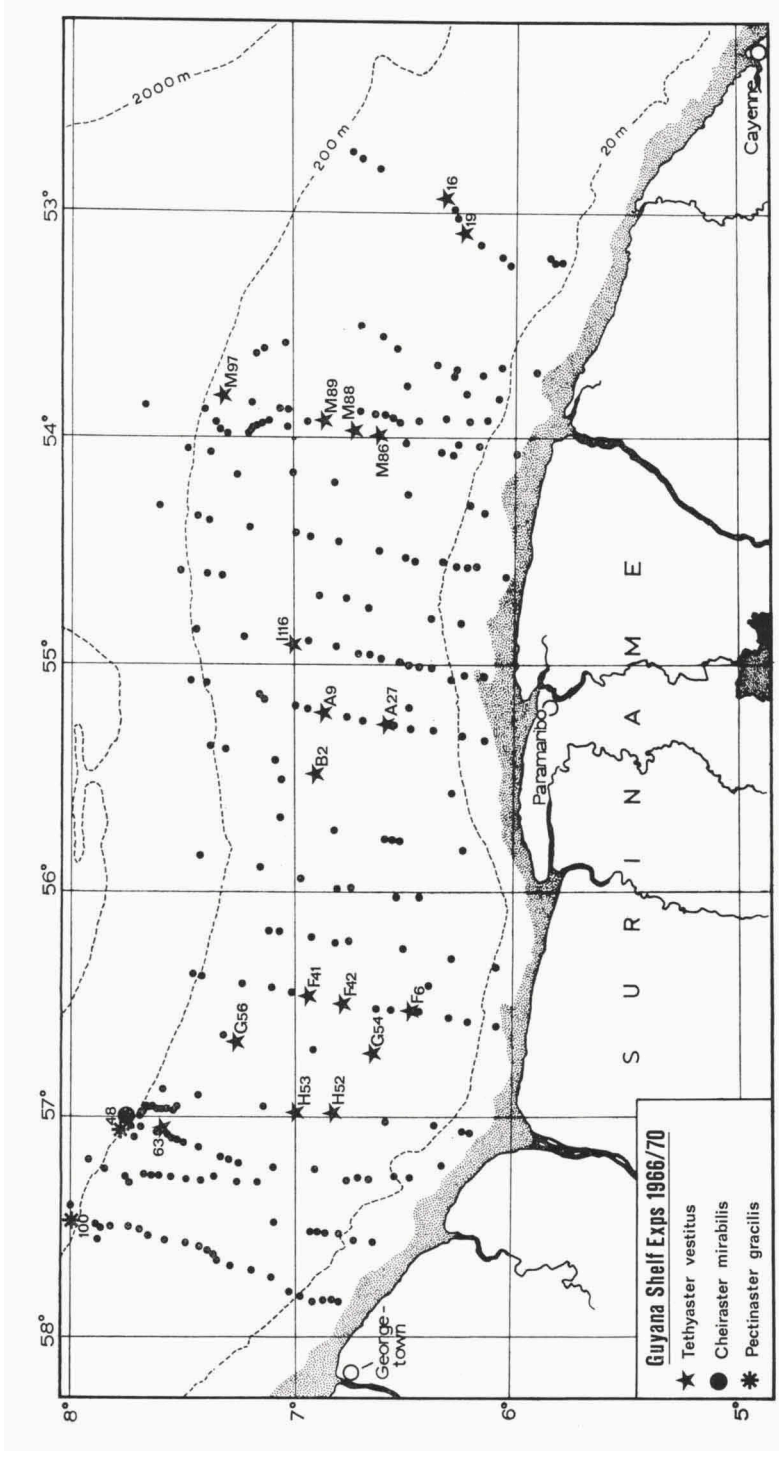

Fig. 10. Records of *Tethyaster vestitus*, *Cheiraster mirabilis* and *Pectinaster gracilis* in Guyana waters; cf. stationlist and Walenkamp, 1976

Distribution. — According to Verrill (1915: 147) the type and "cotypes" were taken by the "Albatross", but no station number is given. Verrill also reported having seen many specimens from the West Indies in the "Blake" collection, without giving further details. The specimen which Verrill depicted on plate 15 figs. 1-1b, is from the Antilles.

Downey (1973) reported the species from an unknown "Oregon" station, off Florida Keys.

The "Luymes" Guyana Shelf Expedition caught three specimens off Guyana in 1970.

It is remarkable that a species, which Verrill stated to be very common in the West Indies has only been mentioned once by another author.

Bathymetrical range. — 126-540 m.

Goniaster tessellatus (Lamarck, 1816) (fig. 11; pl. 7 fig. 1)

Material examined: Five specimens from three different stations. Sta. 1: (1), R/r = 16/9 mm, no. 5212; Sta. 14: (1), R/r = 28/13 mm, no. 5156; Sta. 38: (3), R/r = 56/28, 61/29 and 62/33 mm, no. 5155.

Remarks. — The number of supero- and infero-marginal plates of the present material is given in tab. I, as an addition to the 1976 records. Within a single specimen these numbers are remarkably constant.

TABLE I

R in mm	Supero-marginal plates	Infero-marginal plates
16	10	14
28	10	14
56	14	21
61	16	20
62	15	21

One specimen (Sta. 1, R/r = 16/9 mm) is peculiar for the complete absence of spines on the dorsal plates. Some dorsal plates of this specimen (three times the fourth carinal plate, once the interradial plate adjacent to the second and largest carinal plate, in the interradius ED, and once on the second and largest carinal plate in the radius A) have a rather tumid, bare area, usually separated by one row of central granules from the distal marginal granules and by several rows from the proximal margin. These bare areas bear a central, spatulate pedicellaria. The ten, bare supero-marginal plates on each side of the body are highly tumid, but not produced into a spine or tubercle; the distal two plates of each side of the ray are in

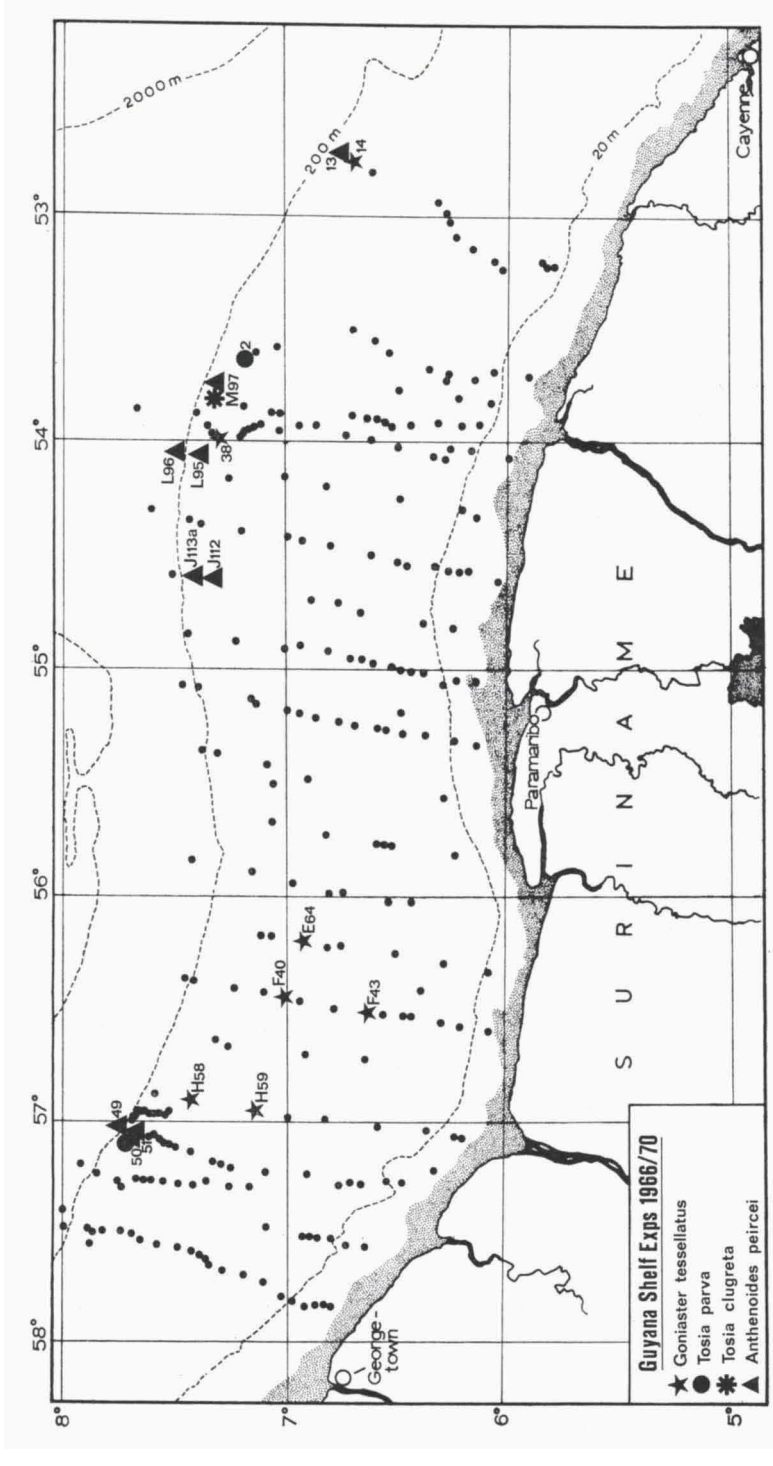

Fig. 11. Records of *Goniaster tessellatus*, *Tosia parva*, *Tosia clugreta* and *Anthenoides peircei* in Guyana waters; cf. stationslist and Walenkamp, 1976

contact along almost their whole length. There are fourteen infero-marginal plates on each side of the body, very similar to, but distinctly less swollen than the supero-marginal plates. The two or three distal infero-marginal plates (sometimes with the exception of the often very small ultimate ones) bear a thick, short, blunt spine. The marginal plates lack pedicellariae and there are no intermediate plates. The ventro-lateral areas are densely and evenly covered by rounded granules, and show only occasionally a pedicellaria on the plates adjoining the adambulacral plates.

Tosia parva (Perrier, 1881) (figs. 11-12; pl. 8 figs. 1-4)

Pentagonaster (Tosia) parvus Perrier, 1881: 19.
Pentagonaster parvus — Perrier, 1884: 231, pl. 7 figs. 7-8. — Sladen, 1889: 265, 266, 267, 746-747. — H. L. Clark, 1898: 5.
Goniaster americanus (pars) Verrill, 1899: 154-156, pl. 26 fig. 6.
Plinthaster dentatus (pars) — Gray, Downey & Cerame-Vivas, 1968: fig. 25, pag. 151.
Tosia parva — Halpern, 1969: 503-506, fig. 1. — Downey, 1973: 54, pl. 20 figs. A, B. — Walenkamp, 1976: 61, 63. — Tommasi & Oliveira, 1976: 84-86, fig. 7. — Carrera-Rodríguez & Tommasi, 1977: 96-97, figs. 20-23.

Material examined: Two specimens from different stations. Sta. 2: (1), R/r = 4/3 mm, no. 5180; Sta. 50: (1), R/r = 11/7 mm, no. 5181.

Diagnosis. — Marginal plates few, convex and decreasing in size towards the tip of the arm. Adambulacral plates with five furrow spines. Dorsal and marginal plates with rounded central granules, which on the marginal plates often stand together in small groups. Ventro-lateral plates with more than one row of marginal spinelets, particularly distally.

Description. — The thick body has five broad, short arms and wide interbrachial arcs. The R/r ratio is 11/7 = 1.6.

The apical plate is oblong; its greatest length is in the axis A-CD. The plate is tumid, with three small, round, central granules, otherwise the plate is bare, except for a marginal series of irregularly shaped, flat, angular granules. The apical plate is surrounded by six similar plates, with one to three similar central granules. The carinal series, of which five of the six surrounding plates form the first plates, consist of nine to ten plates: the first three rather irregularly shaped, the fourth to seventh regularly hexagonal and the terminal carinal plates more roundedly hexagonal. The third carinal plates are the largest of each series. The carinal plates have one or two (usually one) small round granules, which leave a hemispherical pit when rubbed off. The fourth to seventh carinal plates have about eight to ten flat, angular marginal spinelets, relatively larger than all other marginal granules. Interradially, between the second carinal plates, are the largest plates of the entire dorsal surface, distinctly larger than the third carinal

plates. From the large third carinal plate outwards there is on either side of the carinals an adradial series of five plates, similar to, but more rounded than the distal carinal plates. From the large interradial plate outwards there is a series of six plates along the adradial series and the third carinal plates. Between these two series of six plates there are in each interradius five other dorsal plates: one interior, and four along the supero-marginal plates. All dorsal plates have none to four small, round granules, which leave a hemispherical pit when rubbed off, and all plates are bordered by a single series of flat, angular marginal granules.

There are four swollen supero-marginal plates on each side of the ray. Except for the ultimate supero-marginal plates, the plates bear a marginal series of flat, angular granules, which are less angular on the sides of the body. The surface of the plates shows rounded granules, which leave a hemispherical pit when rubbed off. The granules are usually scattered, but in the centre of the plates they are often arranged in irregular groups of up to ten granules. Where the infero- and supero-marginal plates meet the granules are more frequent, often forming two or three rows. The ultimate supero-marginal plates have incomplete lateral series of marginal granules; the proximal and distal marginal granules are lacking.

The terminal plate is smooth and entirely without granules.

Where the first two supero- and infero-marginal plates meet there is a deep depression; deeper between the first than between the second marginal plates.

The supero- and infero-marginal plates correspond and show similar granulation. The ultimate infero-marginal plates are triangular.

The extensive ventro-lateral area reaches to the distal half of the second infero-marginal plates. There are about fifteen plates along the oral and adambulacral plates. Exterior to this series there is a second chevron of eight to nine plates. Between this series and the infero-marginal plates there are another two to three plates. The plates adjacent to the infero-marginal plates are usually completely granulated. The other ventro-lateral plates have a bare central area, except for the three small angular plates exterior to the single, median, proximal ventro-lateral plate. The plates with a bare central area often have a central granule and a second or even third series of distal marginal granules.

The adambulacral plates bear five compressed furrow spines, of which the proximal one is distinctly smaller than the others and often placed slightly more exteriorly. Exterior to the furrow series there are three transversely flattened, pointed spines, the most aboral one of which may, at the distal part of the arm grow to a considerable size. The exterior ventral surface

of the plates is set with about six or seven thick, very short spinelets, only slightly larger than the ventro-lateral granules.

The oral plates have about eight spines on either side, of which the oral four are distinctly larger than the others. Interior to the furrow series there are four thick, short spines on either side and interior to these spines there are six thick, even shorter spines on either side of the median furrow.

The madreporite lies between one large interradial plate and two reniform, more exterior, interradial plates. It is triangular with rounded sides and has rather deep and coarse gyri.

Variability. — In the smaller specimen (R/r = 4/3 mm) the five large interradial plates form a very conspicuous pentagon. The five plates are contiguous and enclose eight plates of different sizes. The carinal series outside this pentagon consist of three or four plates. In each interradius there is one series of six to eight plates, parallel to the supero-marginal plates and enclosed by a large interradial plate and two carinal series. In the interradius, where the madreporite is situated between the large interradial plate and the two middle plates of the series parallel to the supero-marginal plates, there is a very short plate between these two middle plates and the first supero-marginal plates. The tiny plate is completely covered by six granules.

On either side of the ray there are three supero- and three infero-marginal plates. The series of marginal granules of the marginal plates are rarely complete; the series are particularly deficient in the distal plates. Between the first and second marginal plates there is a wide and deep groove. The ventro-lateral area does not reach beyond the first infero-marginal plates.

There are about ten ventro-lateral plates in two series: the smaller plates are completely covered by granules, the two large plates distally to the small, median, proximal plates have a single series of marginal granules.

There are three to four (usually four) furrow spines on each of the adambulacral plates; these furrow spines are followed by two stouter, flattened spines. Exteriorly the plates show four or five very short spinelets. The distal adambulacral plates have one large central spine each.

The oral plates have five to six blunt spines on either side and about sixteen spines on their ventral surface, eight on either side of the median groove.

Remarks. — In discussing the taxonomy of *Goniaster tessellatus* (Lamarck, 1816) I stated that *Tosia parva* is definitely different from *Goniaster tessellatus*, (Walenkamp, 1976: 59, 61). Already in 1969 Halpern considered the two species distinct because *Goniaster tessellatus* has naked supero-marginal plates and the dorsal and ventral plates are completely covered by granules. He too observed that very small specimens (R = 11 mm) of

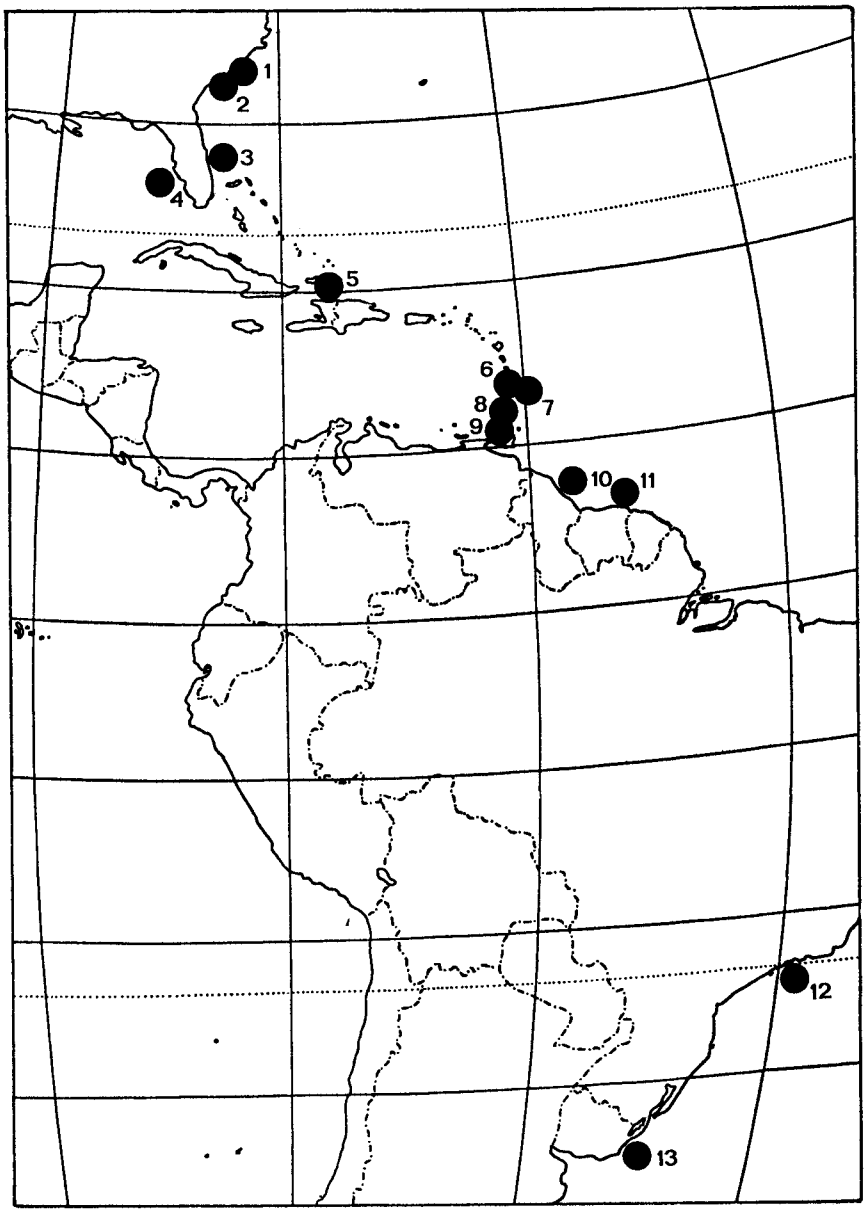

Fig. 12. Distribution of *Tosia parva* (Perrier, 1881). Explanation of the numbers used: 1, Fifty miles south of Cape Fear, North Carolina; 2, Charleston, South Carolina; 3, East Florida; 4, West Florida; 5, Great Inagua Island; 6, St. Lucia; 7, Barbados; 8, Grenada; 9, Los Testigos, Venezuela, and Trinidad; 10, Guyana; 11, Surinam; 12, Off Ilha de São Sebastião, Brazil; 13, Off Rocha, Uruguay.

Goniaster tessellatus already show dorsal spines; this in contrast to *Tosia parva*. Halpern (1969) designated a lectotype of *Tosia parva*.

Gray, Downey & Cerame-Vivas (1968) illustrated their description of *Plinthaster dentatus* (Perrier, 1884) with photographs of *Tosia parva*.

According to Halpern (1969: 505) this species has no pedicellariae. In the two specimens that I investigated I did not notice any either. Perrier (1884: 231) mentioned one specimen with pedicellariae on the plates adjacent to the adambulcral plates. Downey (1973: 54) who investigated eight specimens, stated that pedicellariae are rare; when present, they are small with two slender valves embedded in deep pits, and confined to the ventral surface.

Tommasi & Oliveira (1976) reported eight specimens from Brazil, from latitudes between 23°05'S and 24°38'S; the R's varying between two and three cm. Carrera-Rodríguez & Tommasi (1977) mention specimens from localities as far south as 34°25'S, 51°49'W.

Distribution. — Type locality: off Grenada ("Blake" station 253). Other localities: South of Cape fear, North Carolina. Charleston, South Carolina. East and west coasts of Florida. Great Inagua Island. St. Lucia. Barbados. Grenada. Los Testigos, Venezuela. Trinidad. Guyana. Surinam. Off Ilha de São Sebastião, Brazil. Off Rocha, Uruguay.

Anthenoides peircei Perrier, 1881 (figs. 11, 13; pl. 9 figs. 1-4)

Anthenoides peircei Perrier, 1881: 23-24; 1884: 168, 170, 184, 247-248, pl. 8 fig. 1; 1894: 38. — A. Agassiz, 1888: 103, fig. 379. — Sladen, 1889: 326, 756. — Verrill, 1915: 113-115, pl. 3 fig. 2, pl. 10 figs. 1-1b, 2-2f. — Fisher, 1919: 328, 331, 332. — H. L. Clark, 1941: 49. — John & A. M. Clark, 1954: 139. — A. H. Clark, 1954: 375. — Halpern, 1970a: 272-278, figs. 29, 30; 1970b: 195-201. — Flores & Martínez de Rodríguez, 1970: 5-7, fig. 3. — Downey, 1973: 48-49, pl. 17 figs. A, B. — Walenkamp, 1976: 63-68, figs. 8c, 21; pl .12 fig. 3, pl. 13 figs. 1-4, pl. 14 fig. 1, 3, 4, pl. 15 fig. 2.

Anthenoides brasiliensis Bernasconi, 1956a: 33-35, fig. 1; 1956b: 131; 1960: 24-25, pl. 2 figs. 1-2; 1963: 20, pl. 1 fig. 3, pl. 2 fig. 4, pl. 5 fig. 1; 1966b: 163; 1973: 296. — Tommasi, 1970: 11, fig. 33. Halpern, 1970b: 201-203. — Carrera-Rodríguez & Tommasi, 1977: 91-94.

Material examined: 14 specimens from ten different stations.

a. O.C.P.S. expeditions I and II (1966 and 1969). Sta. J 112: (1), r = 14 mm (all arms broken off and partly regenerated), no. 4349; Sta. J 113a: (2), R/r = 50/16 and 75/28 mm, no. 4346; Sta. L 95: (3), R/r = 17/13, 22/14 and 29/15 mm, no. 4350; Sta. L 96: (1), R/r = 107/39 mm, no. 4347; Sta. M 97: (1), R/r = 20/13 mm, no. 4351.

b. L.G.S.E. (1970). Sta. 13: (2), R/r = 63/24 and 83/32 mm, no. 5183; Sta. 49: (1), R/r = 28/11 mm, no. 5177; Sta. 50: (1), R/r = 12/5 mm, no. 5178; Sta. 51: (1), R/r = 17/7 mm, no. 5196.

c. Saba Bank Expedition (1972). Sta. 141 (17°13'N, 63°42'W; SW-slope Saba Bank; June 14th 1972; Agassiz-trawl, 300-600 m depth; soft bottom): (1), R/r = 102/38 mm, no. 5158.

Remarks. — At an earlier occasion (Walenkamp, 1976: 66-67) I expressed my doubts about the status of *Anthenoides brasiliensis* Bernasconi, 1956a: 33-35. The differences that Bernasconi gave to separate the species from *Anthenoides peircei* I attributed to the different ages (sizes) of the specimens. Bernasconi originally had only rather small specimens at her disposal (R up to 67 mm); in successive publications (1956a, 1956b, 1960, 1963, 1966 and 1973) she records an increasingly large variation of her species, which rather diminishes its differences with *Anthenoides peircei*. Downey (1973: 48) refers to the, unpublished, dissertation of Halpern (1970b) in which he points out that *Anthenoides brasiliensis* differs principally from *Anthenoides peircei* in lacking secondary dorsal plates, large central granules and bivalved pedicellariae on most ventro-lateral plates, and well developed infero-marginal spinelets. Halpern (1970b) adds: "Juvenile specimens of *Anthenoides peircei* (R less than 45 mm) also do not have these characters. Since the specimens I examined and the type of *Anthenoides brasiliensis* have R greater than 60 mm, I have kept the two species separate. It may be that *Anthenoides brasiliensis* represents an infraspecific, geografic variety of *Anthenoides peircei* in which these characters develop more slowly".

With six more specimens at my disposal (with R ranging from 12 to 102 mm), I stronger than ever believe *Anthenoides peircei* and *Anthenoides brasiliensis* to be conspecific, the latter merely representing an earlier phase of life. The fourteen specimens now at my disposal show the following changes with increasing size.

a. Specimens with R ranging from 12 to 29 mm lack secondary dorsal plates; at R = 31 and 50 mm there is a series of about ten small secondary plates on either side of the carinal series. In still larger specimens (R = 63-83 mm) the secundary plates are more numerous (up to 17) and more conspicuous. The two largest specimens (R = 102 and 107 mm) have three incomplete series of secondary plates, alternating with series of primary plates; the first, adradial series is double for a short distance, having some additional, smaller secondary plates; the third, exterior series consists of only four small plates.

b. The number and relative size of the enlarged central granules on the ventro-lateral plates increases with the size. It is remarkable, however, that in the two largest specimens only the proximal ventro-lateral plates show a few such granules, the other plates being fairly evenly granulated.

c. The first specimen to show an occasional pedicellaria on the proximal ventro-lateral plates has R = 28 mm. At R = 29 mm there are no pedicellariae. The specimens with R = 31 and 50 mm have one pedicellaria on the proximal one or two ventro-lateral plates. At R = 63 mm five of the ten

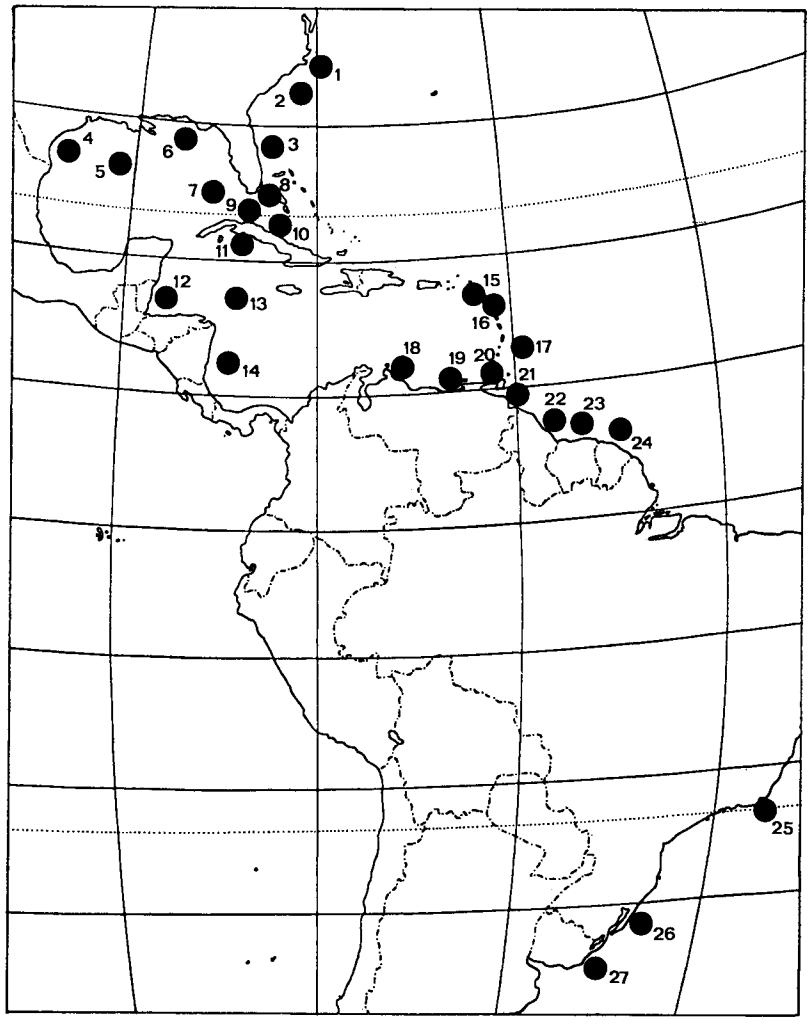

Fig. 13. Distribution of *Anthenoides peircei* Perrier, 1881. Explanation of the numbers used: 1, Off Cape Lookout, North Carolina; 2, Off Long Bay, South Carolina; 3, Eastern Florida; 4, 5, 6, Gulf of Mexico; 7, Dry Tortugas, Florida; 8, St. Lucie, Florida; 9, Matanzas, Cuba; 10, Cayo Romano, Camaguey, Cuba; 11, Bahia de Cochinos, Santa Clara, Cuba; 12, Belize; 13, Caribbean Sea between Jamaica and Honduras; 14, Isla de San Andrés, Nicaragua; 15, 16, Leeward Islands; 17, Barbados; 18, Dutch Antilles; 19, Off Cariaco Trench; 20, Los Testigos; 21, Off Rio Orinoco; 22, Guyana; 23, Surinam; 24, French Guyana; 25, Cabo Frio, Brazil; 26, Palmares do Sul, Brazil; 27, Cabo Polonio, Uruguay.

proximal ventro-lateral plates adjacent to the adambulacral plates have a large bivalved pedicellaria. At R = 75 mm only the proximal two ventro-lateral plates have a bivalved pedicellaria, which is, however, quite often absent. At R = 83 and 107 mm eight out of the ten proximal ventro-lateral plates adjacent to the adambulacral plates have a large bivalved pedicellaria; in the larger specimen this pedicellaria is up to four mm wide. The specimen with R = 102 mm (Saba Bank) has remarkably small and few pedicellariae (Cf. pl. 9 figs. 3-4).

d. In the specimens with R ranging from 12 to 28 mm the infero-marginal plates are evenly granulated. In the specimens with R ranging from 29 to 50 mm some granules are somewhat enlarged. In the specimen with R = 63 mm the marginal granules are distinctly enlarged on the first infero-marginal plates, and in the arm bases some are drawn out into a short spinelet in the aboral corner. At R = 83 mm the first infero-marginal plates have distinctly enlarged granules, and one to three aboral spines along half the armlength. At R = 102 mm the first seven infero-marginal plates have enlarged granules and aborally a group of about six short spines. A single aboral spine persists until about the fifteenth infero-marginal plate. The largest specimen (R = 107 mm) has in the interbrachial arc the entire exterior edge of the plates with short spines. From about the ninth infero-marginal plate to almost the tip of the arm there is one, aboral, fairly large spine on each plate.

e. The length/width ratio of the infero-marginal plates changes as follows:

R in mm	Width ventrally	Maximum length	Length/width ratio
12	2.0	2.1	0.95
17	2.3	3.0	0.77
17	2.1	2.7	0.78
20	2.5	3.2	0.78
22	2.5	3.0	0.83
28	2.7	3.5	0.77
29	2.7	3.3	0.82
31	3.0	3.9	0.77
50	3.0	4.3	0.70
63	3.5	6.2	0.56
75	4.2	6.3	0.67
83	3.5	6.0	0.58
102	4.3	5.3	0.81
107	4.0	6.2	0.64

Distribution. — North and South Carolina. Florida. Gulf of Mexico. Caribbean Sea. Venezuela. Antillean Islands from Yucatan to Venezuela. Guyanas. Brazil. Uruguay.

Bathymetrical range. — 20-844 m.

Nymphaster arenatus (Perrier, 1881) (figs. 14-15)

Pentagonaster arenatus Perrier, 1881: 21; 1884: 168, 176, 178, 179, 181, 182, 186, 236-238, pl. 7 figs. 3, 4; 1894: 39.
Pentagonaster ternalis Perrier, 1881: 20; 1884: 168, 180, 181, 186, 233-234, pl. 1 fig. 1. — A. Agassiz, 1888: fig. 377.
Dorigona arenata — Perrier, 1885a: 39, 40; 1885b: 884; 1894: 31, 32, 33, 34, 38, 39, 40, 379-382, pl. 21 fig. 5, pl. 22 fig. 6, pl. 24 figs. 5, 6. — Koehler, 1895: 451; 1896: 57-58, 124-125; 1909b: 83, 290-291, 294-295, pl. 3 fig. 7. — Grieg, 1921: 19-20, pl. 4 figs. 5-8.
Dorigona prehensilis Perrier, 1885a: 39-40; 1894: 31, 32, 33.
Dorigona ternalis — Perrier, 1885a: 39-40; 1894: 39, 371-375.
Non Dorigona ternalis — Koehler, 1909b: 54-58, pl. 8 figs. 5, 6.
Nymphaster protentus Sladen, 1889: 295, 296, 300, 303-306, 307, 309, 651, 693, 705, 752, pl. 50 figs. 3, 4, pl. 53 figs. 9, 10; 1891: 694. — Bell, 1889: 434-435. — Bourne, 1890: 326-327. — Verrill, 1899: 186. — Farran, 1913: 12.
Nymphaster albidus Sladen, 1889: 295, 296, 306-308, 309, 655, 694, 750, pl. 51 figs. 1, 2, pl. 53 figs. 5, 6. — Verrill, 1899: 186.
Nymphaster basilicus Sladen, 1889: 295, 296, 306, 308-310, 655, 693, 709, 752, pl. 57 figs. 8, 9. — Verrill, 1899: 186. — Tommasi, 1970: 12, fig. 35.
Nymphaster arenatus — Sladen, 1889: 752. — Verrill, 1899: 186. — Farran, 1913: 11-12. — Fisher, 1919: 277. — Koehler, 1924: 182. — Mortensen, 1927: 84-85, fig. 48. — H. L. Clark, 1941: 39-40. — A. H. Clark, 1954: 375. — John & A. M. Clark, 1954: 139. — Halpern, 1970a: 223-228, fig. 28, B. — Downey, 1973: 58-59, pl. 22 figs. C, D.
Nymphaster prehensilis — Sladen, 1889: 752.
Nymphaster ternalis — Sladen, 1889: 752. — Verrill, 1899: 185, pl. 26 fig. 7. — Fisher, 1919: 264, 266, 268, 276, 278, 282. — A. H. Clark, 1954: 375.
Pentagonaster subspinosus — Bourne, 1890: 327.
Nymphaster subspinosus — Bell, 1892: 75-76. — Nichols, 1903: 249. — Kemp, 1905: 189.
Dorigona jacqueti Perrier, 1894: 31, 383-386, pl. 21 fig. 4, pl. 22 fig. 5. — Koehler, 1895: 451.
Nymphaster jacqueti — Koehler, 1924: 182.

Material examined: One specimen from station 34, R/r = 58/15 mm, no. 5182. One specimen from station 154 of the "Onversaagd" Expedition, off Cap de Mazagan, Morocco, 570 m depth, R/r = 63/18 mm, no. 5224.

Diagnosis. — Dorsal, marginal and ventral plates covered by small, round granules, which are never enlarged to form a spine. Long, slender, tapering arms without dorsal plates. Dorsal plates in a straight-sided pentagon formed by the supero-marginal plates.

Description. — The large pentagonal disk has five long, slender and tapering arms. The dorsal plates are tabulate and covered by numerous small, round granules. Several plates have an inconspicuous excavate pedicellaria near their edge. The central plates are irregularly angular in outline. About halfway the centre of the disk and the angles of the dorsal pentagon the carinal and adradial series of plates consist of rather regularly rounded oblong plates, which are much wider than long and arranged in regular rows; each plate is surrounded by five papular pores. Near the sides of the pentagon the interradial dorsal plates are crowded, small and angular in outline. The

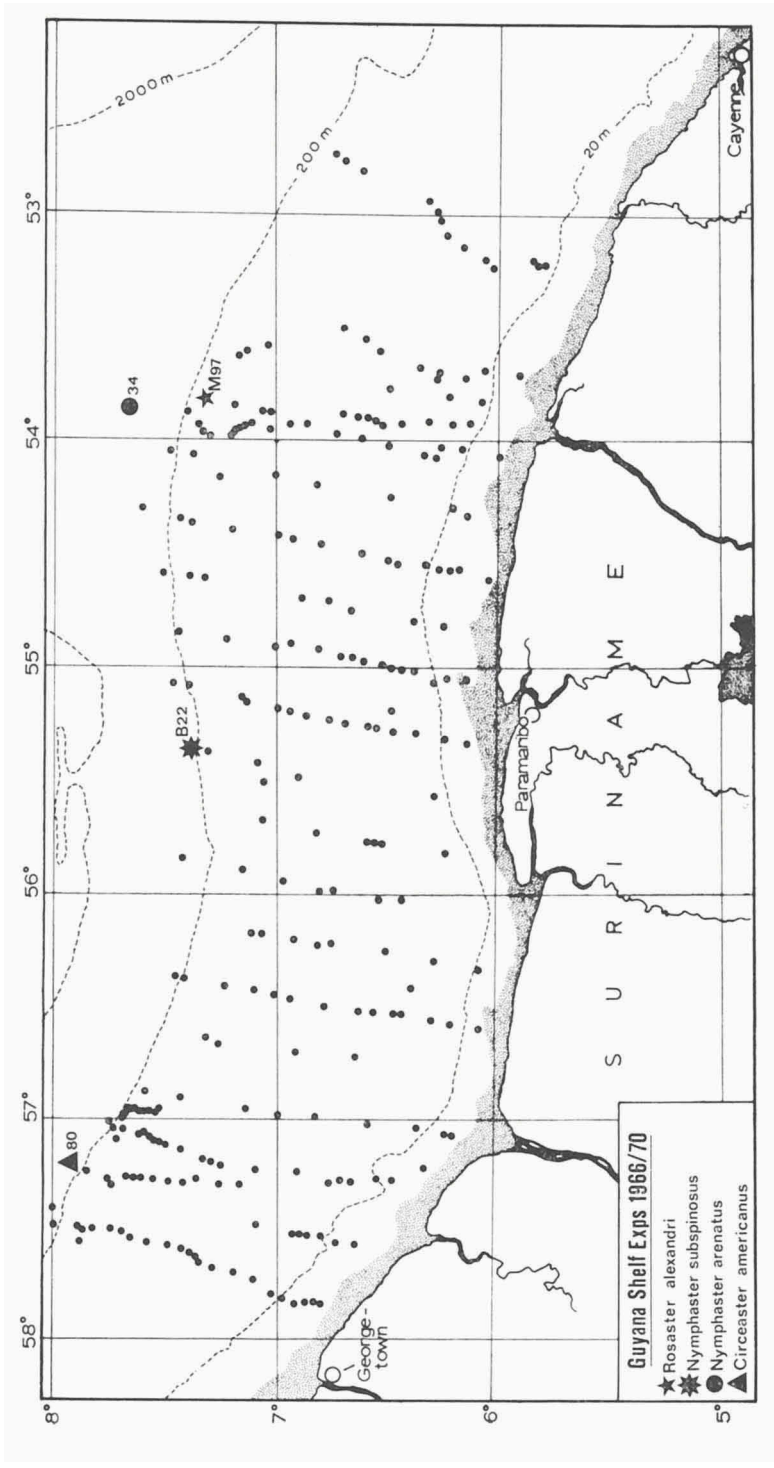

Fig. 14. Records of *Rosaster alexandri*, *Nymphaster subspinosus*, *Nymphaster arenatus* and *Circeaster americanus* in Gyana waters; cf. stationlist and Walenkamp, 1976.

area without papulae is a small triangle, of which the basis is formed by the first two and a half supero-marginal plates on either side and the top lies distal to the eighth mid-interradial plate from the basis. Denuded plates show very shallow pits, where the granules were removed and a small oblong hole, where the pedicellaria was present.

There are about 34 supero-marginal plates on each side of the ray. The first four plates increase in width in such a way, that their interior margins form a straight line and their exterior margins a broad interbrachial arc. The fourth and widest plate is about 4.5 mm wide; the fifth and following supero-marginal plates are contiguous, and correspond over the whole length of the arm, their length/width ratio gradually increasing to such a degree that the penultimate supero-marginal plates are longer than wide. The ultimate plates are very short. The supero-marginal plates are all densely covered by small, round granules, which leave a shallow pit when rubbed off. The proximal supero-marginal plates occasionally have one, small, excavate pedicellaria.

The infero-marginal plates correspond with the supero-marginal plates, but, in contrast, decrease in width from the very first plate onward. Like the supero-marginal plates the plates are evenly granulated and do not show any sign of enlarged granules or spines. I could not discern any pedicellariae either. Distally the infero-marginal plates are almost entirely confined to the sides of the arm.

The terminal plates are inconspicuous; the granules, if ever present, have been rubbed off without leaving pits.

The large ventro-lateral area extends to the fifth or sixth infero-marginal plates and has four chevrons of slightly imbricating plates, the exterior chevron consists of four plates enclosing a single exterior angular plate. The interior chevron consists of 31 plates, including a small triangular plate, which is squeezed between this series and the oral plate. The second chevron consists of seventeen plates; and the third of nine plates. The plates all are covered by granules, which are slightly larger than those of the infero-marginal plates. Some plates, mainly the middle plates of the interior chevron, have a bare central area. Only very rarely a ventro-lateral plate bears an excavate pedicellaria.

The first adambulacral plates are much wider than long, but the width/length ratio decreases quickly after a few plates. In the middle of the arms the plates are distinctly longer than wide and show, proximally, a triangular apophysis in the furrow. There are seven to eight compressed furrow spines along the whole interior edge of the plates, proximally, however, only four to five. Exterior to the furrow series there are four to five shorter and

thicker spines (proximally three). Exterior to this last series there are two longitudinal series of four to five short, thick spinelets, hardly larger than the ventro-lateral granules. Only very few adambulacral plates bear one excavate pedicellaria.

The long diamond-shaped oral plates have a very deep, but narrow median groove. On either side of the plate there are about eight thick spines along the ambulacral groove and in the mouth; the proximal and distal spines are slightly compressed, those in the centre almost quadrangular in cross section. The ventral surface has about five thick, short spines on either side of the median groove. On the exterior ventral surface there are about four short, thick spinelets.

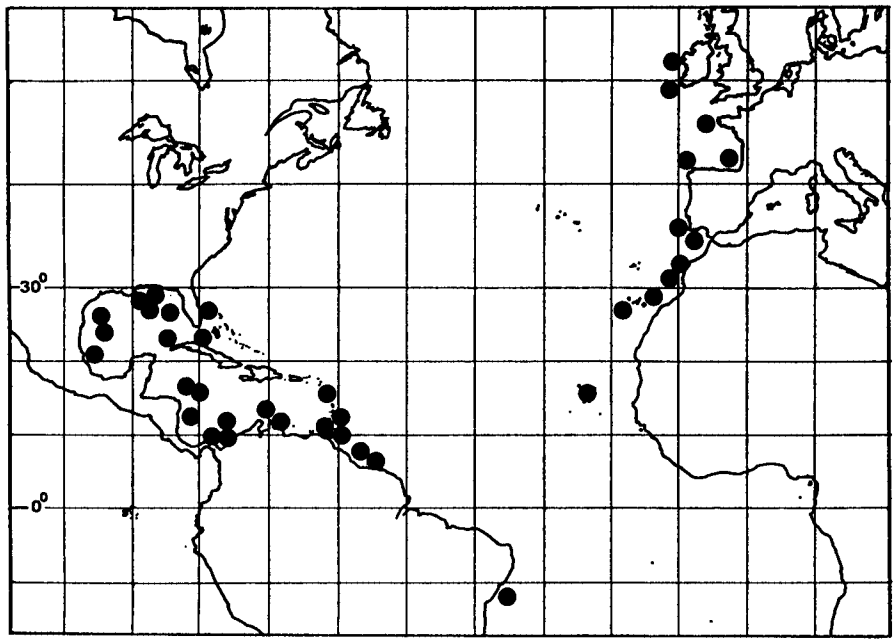

Fig. 15. Distribution of *Nymphaster arenatus* (Perrier, 1881). This map indicates the geographical range of the species without, however, giving a full record of all localities, where specimens have been collected.

The madreporite has a diameter of 2.5 mm and many fine gyri.

Discussion. — Halpern (1970a, b) synonymised *Nymphaster ternalis* with *Nymphaster arenatus*. Perrier (1881) had separated *Nymphaster ternalis* from *Nymphaster arenatus* mainly because the former has pedicellariae, which the latter lacks, but the presence of these organs proves to be a very variable character. Mortensen (1927) synonymised two other species of

Perrier (1885a and 1894), viz. *Dorigona jacqueti* and *Dorigona prehensilis*, with *Nymphaster arenatus*. *Dorigona jacqueti* is a junior synonym of *Dorigona prehensilis*.

Two of the three new species of *Nymphaster* that Sladen (1889) described, viz. *Nymphaster albidus* and *Nymphaster basilicus*, are separated on differences, which Halpern (1970a) found to fall well within the range of individual variation of *Nymphaster arenatus*.

Sladen's (1889) third species of *Nymphaster*, viz. *Nymphaster protentus*, has been synonymised with *Nymphaster arenatus* by Farran (1913). Farran refers to H. L. Clark and Koehler, who both identified his specimens of *Nymphaster* from Ireland as *Nymphaster arenatus*, while in Farran's opinion they are "undoubtedly" the *Nymphaster protentus* of Sladen.

Halpern (1970a) also mentions many specimens of *Nymphaster*, which are intermediate between *Nymphaster subspinosus* and *Nymphaster arenatus*. These intermediate forms occur in the bathymetrical range of *Nymphaster subspinosus*, viz. from 275 to 724 m. Halpern considers the two species to be distinct, as they are usually well separable on the basis of the armature of the ventral plates, and because all specimens below 750 m depth are "typical" *arenatus*. Halpern's explanation for these intermediate forms is a complete breakdown of isolating mechanisms between sympatric populations of *Nymphaster arenatus* and *Nymphaster subspinosus* in the uppermost part of the bathymetrical range of *Nymphaster arenatus*. As yet nothing is known about the genetics, fertility or viability of these intermediates, except that they appear to be quite common.

Distribution. — Both sides of the Atlantic Ocean in deeper waters.

a. Western Atlantic: Little Bahama Bank. Off eastern Florida. Gulf of Mexico. Caribbean Sea. Antilles. Off northeastern South America.

b. Eastern Atlantic: Off western Ireland. Bay of Biscay. Southwestern Spain. Morocco. Canary Islands. Cape Verde Islands.

Bathymetrical range. — 275-3000 m depth.

Pseudarchaster gracilis (Sladen, 1889) (figs. 16, 19; pl. 10 figs. 1-4)

Aphroditaster gracilis Sladen, 1889: 117-120, pl. 17. figs. 1-2, pl. 18 figs. 7-8. — Verrill, 1899: 195. — Fisher, 1919: 227-228.
Pseudarchaster concinnus Verrill, 1894: 250-255; 1895: 132; 1899: 193, pl. 30 figs. 3-3b. — H. L. Clark, 1941: 31-32. — Madsen, 1951: 89. — A. H. Clark, 1954: 375.
Astrogonium gracile — Perrier, 1894: 342, 354.
Astrogonium aphrodite Perrier, 1894: 342, 354, pl. 21 fig. 2, pl. 23 fig. 2.
Astrogonium necator Perrier, 1894: 350-355, pl. 23 fig. 1. — Koehler, 1909b: 74-75.
Pseudarchaster aphrodite — Verrill, 1899: 195.
Pseudarchaster necator — Verrill, 1899: 195.

Pseudarchaster ordinatus Verrill, 1899: 194-195, pl. 30 figs. 4-4b. — A. H. Clark, 1954: 375.
Astrogonium eminens Koehler, 1907: 34-37; 1909b: 68-71, pl. 16 figs. 3-6.
Astrogonium aequabile Koehler, 1907: 37-40; 1909b: 66-68, pl. 11 figs. 1-4.
Astrogonium marginatum Koehler, 1909b: 71-73, pl. 14 figs. 1-4.
Pseudarchaster gracilis — Mortensen, 1927: 86. — Macan, 1938: 355. — Halpern, 1972: 360, 363-366, figs. 1-2. — Downey, 1973: 59-60, pl. 23 figs. C, D.

Material examined: One juvenile specimen from station 80. R/r = 11/4 mm, no. 5279.

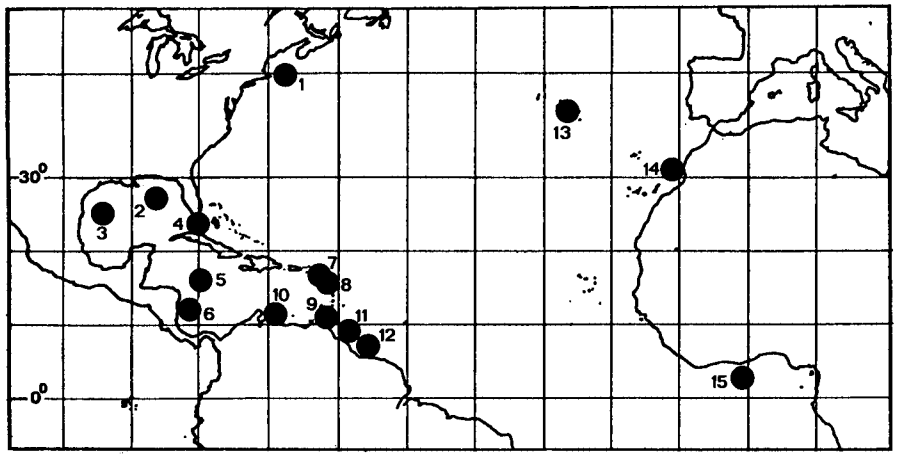

Fig. 16. Distribution of *Pseudarchaster gracilis* (Sladen, 1889). Explanation of the numbers used: 1, Cape Cod, Massachusetts; 2, 3, Gulf of Mexico; 4, Straits of Florida; 5, Caribbean Sea; 6, Nicaragua; 7, between Saba and St. Maarten; 8, Antigua; Guadeloupe; 9, between Grenada and Los Testigos, Venezuela; 10, South of Curaçao; 11, Guyana; 12, Surinam; 13, Azores; 14, Morocco; 15, Ivory Coast.

Diagnosis. — Bases of paxillae tessellate. Infero-marginal and ventro-lateral plates set with small, slender spinelets and rather long, conical spines. In adult specimens there is a pectinate pedicellaria between every two adjacent ventro-lateral plates in the series along the oral and adambulacral plates. There are five to ten adambulacral furrow spines and six to eleven oral furrow spines. The oral plates also bear one large, median tooth each.

Description. — The body is rather flat and has five narrow, tapering arms and wide interbrachial arcs. The R/r ratio is 11/4 = 2.75.

The carinal series of dorsal plates extends to the terminal plate. The adradial series reach to the sixth supero-marginal plates. The dorsal plates are rounded. The carinal plates of the arms have an angular outline: proximally hexagonal, distally quadrangular. In each interradius there is, at a distance of about six dorsal plates from the supero-marginal plates, one large primary plate. The fourth or fifth carinal plate is distinctly larger

than the others. Large, single papular pores are only to be found in the narrow region between the large carinal plate and the first two supero-marginal plates; the most exterior pores, however, are separated from the supero-marginal plates by about three series of dorsal plates. The plates are set with short, blunt spinelets with thickened tips. Ventrally the dorsal plates are irregularly rounded and tessellate; they are never connected by ossicles.

The supero-marginal plates are all wider than long; the first plates being about half again as wide as long and the last two being small and squeezed between the terminal plate and the third supero-marginal plates, counting from the tip of the arm. Denuded plates are completely smooth. There are about thirteen supero-marginal plates on each side of the ray. The plates are sparingly covered by short, thick, blunt spinelets, thicker and shorter than those of the dorsal plates and increasing in size to the exterior sides of the plates.

The terminal plates are about as long as the three supero-marginal plates preceding the ultimate one. They are slightly tapering distally. The dorsal side narrows proximally between the distal two pairs of supero-marginal plates. There is one large terminal spine; a few thickened and pointed spinelets are placed on the sides. Dorsal spines or granules, if ever present, are rubbed off, except for some rounded granules.

The supero- and infero-marginal plates correspond, except for the very distal part of the arm; the infero-marginal plates reaching further distally for about half an ultimate plate. The infero-marginal plates are set with a few, rather thick, short, tapering and pointed spines, surrounded by similar spinelets. On the ventral surface the spines are generally slightly smaller. Denuded plates are smooth.

The ventro-lateral area does not reach beyond the second infero-marginal plates and consists of two or three longitudinal series. The first series, along the oral and adambulacral plates, consists of eight to nine plates, of which the proximal ones are the largest. The second series consists of four to six smaller plates, and the third (between the second series and the infero-marginal plates) of maximally two, usually very small plates. The plates of the three series imbricate slightly and are set with several short, pointed spinelets, similar to those on the infero-marginal plates. There are no pedicellariae.

The adambulacral plates are almost twice as long as wide, shorter than the infero-marginal plates; they have a proximal triangular apophysis in the furrow. Along the whole interior length of the plate there are four to five pointed furrow spines. The ventral surface of the plates bears one

enlarged spine, surrounded by a few small, pointed spines, which are very similar to the infero-marginal spinelets.

Each oral plate has one very large and distinct median tooth, which is finely serrated and greyish in contrast to the white colour of the rest of the body. On either side this wide tooth is accompanied by one much smaller, also greyish spine. Along the ambulacral groove there are about six rod-shaped spines on either side of the plates. The tumid ventral surface shows a deep groove, on either side of which there are five spines, exterior to the large median tooth. On the exterior part of the plate there may be some additional small spines.

The madreporite lies exterior to the interradial primary plate. It is rounded, has a diameter of 0.5 mm and shows very deep and coarse gyri.

The colour in alcohol 70% is white; the colour in life is unknown.

Remarks. — The juvenile specimen in our collection is in poor shape and differs slightly from previously described specimens. However, I attribute these differences mainly to the small size. There are no pedicellariae. The shape of the adambulacral plates and the number of furrow spines appears to be size-related. Halpern (1972) who revised the Atlantic Pseudarchasterinae, investigated 80 specimens of this species, but even he does not mention the distinctly larger interradial and carinal plates, that I found in my specimen; these, however, are conspicuous only in denuded areas.

Distribution. — Type locality: Challenger station 78, 37°26'N 25°13'W. Both sides of the Atlantic Ocean. a. Western Atlantic: Along the coasts of the United States of America, south of Cape Cod, Massachusetts. Gulf of Mexico. Caribbean Sea. Lesser Antilles. Guyana. Surinam. b. Eastern Atlantic: West coast of Africa, from Morocco to the equator. Azores.

Bathymetrical range. — 320-3224 m.

Mediaster bairdii (Verrill, 1882) (figs. 17, 19; pl. 7 fig. 2; pl. 11 figs. 1-4)

Archaster bairdii Verrill, 1882a: 139-141; 1882b: 218. — Sladen, 1889: 122, 724.
Mediaster stellatus Perrier, 1891a: 268-269; 1891b: 1226; 1896: 46, pl. 4 figs. 1-1d. — Richard, 1900: 76, fig. 26.
Isaster bairdii — Verrill, 1894: 258-262; 1895: 136.
Mediaster bairdii — Verrill, 1899: 181, pl. 24 figs. 1-9, pl. 26 figs. 8-8a. — Gray, Downey & Cerame-Vivas, 1968: 150-151, fig. 24.

Material examined: One specimen from station 80; R/r = 69/28 mm, no. 5213.

Diagnosis. — Large disk with five, short, pointed arms and wide, rounded interbrachial arcs. Papulae single and large, and arranged in a star-shaped pattern. Dorsal plates often, ventro-lateral plates very rarely with a pedicellaria, which on the dorsal plates is slightly higher than the surrounding

granules and about twice as wide. Armature of the adambulacral plates in three or four longitudinal rows. Marginal plates all wider than long, gradually narrowing towards the arm-tips and uniformly set with small round granules.

Description. — The body has a large disk, which is rather flat, dorsally slightly convex in the centre and in the proximal half of the radii, and

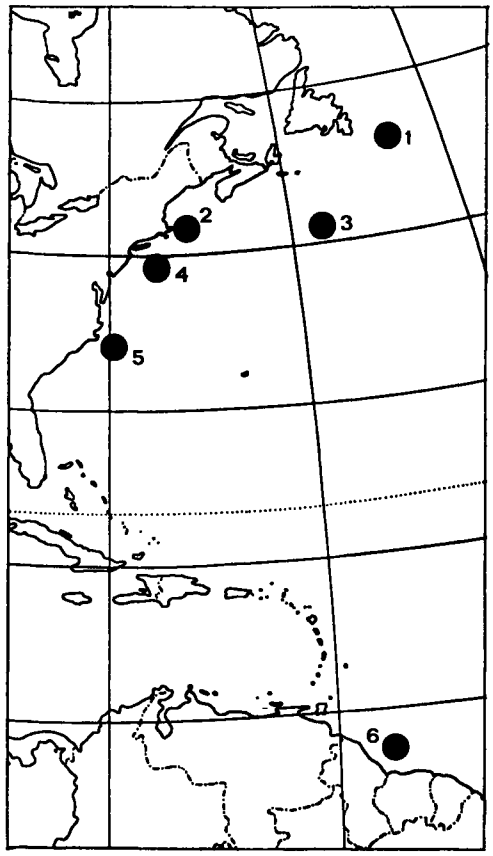

Fig. 17. Distribution of *Mediaster bairdii* (Verrill, 1882). Explanation of the numbers used: 1, Off Newfoundland, 46°04'40"N, 49°02'30"W; 2, Southern coast of New England; Martha's Vineyard; 3, 4, Five stations between 3 (42°55'30"N, 50°51'W) and 4 (39°47'07"N, 70°35'W); 5, Shelf off Cape Lookout; 6, Guyana.

ventrally slightly concave. The interbrachial arcs are very wide and evenly rounded. The marginal plates form a wide and distinct border. The R/r ratio is 69/28 = 2.5. The five arms taper rapidly to a slender tip.

The dorsal surface is covered by fairly large paxillar plates, about fifteen

from the anus to the mid-interradial edge and about seventy from the anus to the terminal plate. In the centre of the disk the paxillae are about 0.5 mm high; in the middle of the radii they are about twice that height. The paxillae in the centre are the largest of all and have an irregular, rounded outline; only rarely there is a small secondary plate. Each disk-paxilla has from three to 24 granules on its surface, which are larger in height than in diameter, slightly angular in outline and surrounded by ten to twenty marginal granules, which are slightly stouter, more angular, slightly diverging and longer. The central area of the paxillae, therefore, is often very distinctly lower than the margin. The radial paxillae of the proximal half of the ray have a very similar armature, although the granules are less numerous. On almost all these paxillae a sometimes central, but usually marginal, valvulate pedicellaria occupies the space of two to four granules. The pedicellariae have the same height as the marginal granules and are about twice as wide; the two valves are rounded above and strongly widened, with dentate edges, which perfectly fit in two opposing valves. When removed the pedicellariae leave a deep radial slit. Not rarely two pedicellariae occur on one plate. The paxillae of the radii are, at least in the proximal half of the ray, ellipsoid, slightly less than twice as wide as long. The outline of the more lateral radial paxillae is more circular. All these above mentioned dorsal paxillae, viz. those of the centre of the disk and the proximal half of the radii, are usually surrounded by six, large and single papular pores, which are very conspicuous. The plates are internally connected by six radiating rods, between which the papulae are situated. In the distal half of the radial papular areas there are usually only four internal ossicles, two on either side; longitudinally the plates are directly connected. The dorsal paxillae, exterior to those that are surrounded by papulae, show some distinct differences: the plates are tessellate, without internal connecting ossicles or papulae and appear very crowded; pedicellariae are rare (if present they are usually smaller than those on the central plates) and completely absent in the distal third of the ray. This applies to the plates in the triangular interradii, the distal third of the rays and the two series adjacent to the supero-marginal plates. Between the first supero-marginal plates there are 20-25 dorsal paxillae in a transverse series. At about the seventh pair of supero-marginal plates there are about nine longitudinal series of dorsal plates and no more papulae. Between the distal eight pairs of supero-marginal plates there remains only one longitudinal series of more or less rectangular dorsal plates, which are wider than long. The granulation of the interradial and distal radial plates is also different, viz. the granules are gradually smaller, less angular, closer together and less numerous. Particularly in the distal part of the arms the distinction between

the marginal and central granules disappears, and the granules become very similar to those of the supero-marginal plates.

The terminal plates are about 1.5 mm long and less wide. Granulation, if ever present has become rubbed off, as is also the case with the terminal supero-marginal plates.

The anus is central and, when the granules of the surrounding paxillae are removed, clearly visible. It is surrounded by eleven small spines, which curve over it.

On each side of the ray there are 29 supero-marginal plates. The plates on both sides of the arms are always separated by one or more longitudinal series of dorsal plates. In some places the space of one supero-marginal plate is occupied by two smaller plates; this phenomenon occurs from one to three times on each side of the body. The first supero-marginal plates are about three times as wide as long. The length/width ratio gradually increases towards the armtips, but the plates are always wider than long; the distal plates are half again as wide as long. The plates are evenly and densely covered by small rounded granules; the space between the granules is less than half their diameter. The marginal granules are angular and, contrary to those of the dorsal plates, not raised above the level of the central granules. The marginal granules of adjacent plates touch each other over the narrow furrows. There are no papulae between or below the supero-marginal plates. Only in the interbrachial arcs there is an occasional, inconspicuous pedicellaria which is smaller than the marginal granule that it replaces, and leaves a deep pit when removed. Denuded marginal plates show shallow hollows, where the granules have been removed.

The infero-marginal plates are about 25 in number on each side of the ray and hardly ever correspond with the supero-marginal plates. They are very similar to the supero-marginal plates in form and granulation. The first plates, however, are narrower, being only twice as wide as long. The plates in the interbrachial arcs often have one or two marginal granules replaced by a small and inconspicuous pedicellaria, which leaves a deep pit when removed. Some infero-marginal plates too may be replaced by two or three smaller plates.

The large, roughly triangular ventro-lateral areas extend to about the fourteenth infero-marginal plates. The denuded plates imbricate slightly; the distal ones over the proximal ones. The two distal edges of the plates are straight and often meet under a right angle; the proximal side of the plates is more rounded, often almost semicircular. The two most proximal ventro-lateral plates bear a two- or three-valved, spatulate pedicellaria. The plates are set with about ten, thick, blunt, slightly angular, short spinelets

on the edge and two or three similar granules in the centre. Except for the two proximal plates only very few ventro-lateral plates bear a small valvulate pedicellaria; such plates are only found in the series adjacent to the adambulacral plates. The ventro-lateral plates correspond with the adjacent adambulacral plates and the grooves between the adambulacral plates continue in almost straight lines between the ventro-lateral plates, perpendicular to the ambulacral groove. The grooves of either side meet at the mid-interradial line; they are crossed, also in right angles, by grooves parallel to the ambulacral grooves. Near the infero-marginal plates the ventro-lateral plates are smaller and less regularly arranged. The distal plates are very small and squeezed between the infero-marginal and adambulacral plates.

The adambulacral plates are wider than long and, when denuded, faintly show three terraces, of which the most exterior one is the largest. The furrow terrace has six, sometimes seven, laterally compressed, rather long, bluntly pointed spines, which are about 1.5 mm long and somewhat constricted at their bases. On the middle terrace stands a longitudinal row of four or five shorter, thicker, similarly compressed spines, of which the proximal one or two are often shorter than the others and more exteriorly situated. The exterior terrace bears one or two (usually two) irregular series of short spinelets, which decrease in size towards the ventro-lateral plates, the most exterior spinelets being very similar to the ventro-lateral granules. In the distal fourth of the arms this exterior terrace relatively increases in size and shows, except for its interior margin, a spine pattern very similar to that of the disappearing ventro-lateral plates. The spines of the middle terrace and those of the interior row of the exterior terrace may form an elliptical group, but are usually parallel. Pedicellariae are lacking on the adambulacral plates.

The oral plates have a broad median groove, which at its widest part measures about one fourth of the maximum width of the whole plate. There are about twelve furrow spines on either side, gradually increasing in size towards the mouth. The adoral furrow spines are not conspicuously enlarged. Exterior to the furrow series, on either side of the median groove, there are six or seven much shorter and thicker spines. The ventral surface of the oral plates is covered by eight to twelve blunt spinelets on either side of the groove, of which six to eight stand in a quite straight line on the edge of the groove.

The madreporite is pentagonal, about as large as three dorsal plates; it has rather coarse gyri. It is situated at a distance of three dorsal plates from the anus and sixteen mm removed from the nearest supero-marginal plates.

The colour in alcohol 70% is beige; the colour in life of my specimen is unknown.

Discussion. — Verrill (1882a) described six small specimens of this species from the "Southern coast of New England", the larger radius of the largest specimens being 38 mm. The differences between Verrill's description and my specimen can be attributed to the smaller size of the former, viz. the smaller number of marginal plates and adambulacral and oral spines.

In his description of the new genus *Isaster*, erected to accomodate the species *Archaster bairdii*, Verrill (1894) writes that the supero-marginal plates are well developed, but do not form a wide margin on the disk. This feature indeed has been figured in later publications, viz. Perrier (1896), Verrill (1899), Richard (1900), Gray, Downey & Cerame-Vivas (1968). The first supero-marginal plates of my specimen, which otherwise fits the descriptions, are three times as wide as long, and do form a wide margin.

Perrier (1891a) described the species *Mediaster stellatus* from Newfoundland and figured it in 1896. Verrill (1899) judged this species to be synonymous with *Mediaster bairdii*. Richard (1900) merely mentions Perrier's findings and reproduces his figure of the dorsal surface.

The only two records in literature on the colour of this species are from Verrill (1882): light orange, and from Gray, Downey & Cerame-Vivas (1968): dorsally brilliant red and ventrally salmon orange.

Distribution. — This species has hitherto only been collected off the northeastern coast of North America. Type locality: "Fish Hawk" station 952, southern coast of New England, 39°55'N 70°28'W, off Martha's Vineyard, Massachusetts, 396 fms, yellow mud and sand (Verrill, 1882). Northeastern coast of the United States; Shelf off Cape Lookout, North Carolina (Gray, Downey & Cerame-Vivas, 1968). Off Martha's Vineyard, "Albatross" station 1122; five "Albatross" stations in 1885, amongst which the stations 2429 and 2552, localities between 42°55'30"N 50°51'W and 39°47'07"N 70°35'W (Verrill, 1894). Newfoundland, Campagne "l'Hirondelle", 1887-1888, station 161, 46°04'40"N 49°02'30"W (Perrier, 1891). The Guyana record therefore means an important southward extension of its known range.

Bathymetrical range. — 90-1300 m.

Circeaster americanus (A. H. Clark, 1916) (figs. 14, 18; pl. 12 figs. 1-2)

Lydiaster americanus A. H. Clark, 1916: 141-144; 1954: 376.
Circeaster occidentalis H. L. Clark, 1941: 46-49, pl. 4 fig. 2. — A. H. Clark, 1954: 376.
Circeaster americanus — Halpern, 1970a: 265-270, figs. 26, 27, 28, A; 1970b: 174-179. — Downey, 1973: 55, pl. 21 figs. A, B.

Material examined: One specimen from station 80. R/r = 94/34 mm, no. 5184.

Diagnosis. — Dorsal plates of the arms distinctly larger than those of the

disk. Disk large and arms long. Ventral plates with large, broad excavate pedicellariae.

Description. — The large pentagonal disk has five long arms. The R/r ratio is 94/34 = 2.8. The interbrachial arcs are wide and rounded.

The dorsal plates are rounded polygonal with convex edges and a flat or slightly convex dorsal surface. Each plate is surrounded by a single series of elevated, flat, angular granules. Many plates have one to four small and rounded granules on the dorsal surface. These granules are often larger on the smaller plates and leave a deep pit when rubbed off. On the disk many plates bear a broad excavate pedicellaria, fitting very neatly in the excavations in the surface when fully open. The single papulae are large, but absent in the broad-based interradial triangles and on the arms. In the interradii, near the edge of the disk, the dorsal plates are distinctly smaller and more crowded and angular. The dorsal plates are quite numerous: from the central anus to the first supero-marginal plates there are over twenty plates. There are no regular carinal or adradial series. The dorsal arm plates are larger and more angular than the dorsal plates of the disk, and entirely without pedicellariae. The supero-marginal plates are adjacent from the fifteenth pair on. Until the tenth pair there are about two longitudinal series of arm plates; in the arm bases there are usually three. The arm bases are dorsally covered by two large adradial plates, with one smaller plate in between. Many proximal dorsal arm plates are much wider than long, particularly the adradial ones. The distal dorsal arm plates are usually smooth, only occasionally showing one small, round central granule.

There are 21 to 24 supero-marginal plates on each side of the ray. They slightly increase in width toward the fifth plate, which is at the arm basis. In the arms the width of the supero-marginal plates decreases very irregularly. After the fifteenth pair the plates narrow and shorten more quickly and gradually. All supero-marginal plates have a single series of flat, angular, usually quadrangular granules. The surface is set with small, round and well spaced granules. Near the ventral border of the plates there is one (sometimes two) small, excavate, bivalved, sometimes trivalved pedicellaria, which is only lacking on the distal marginal plates. Occasionally a supero-marginal plate is replaced by two or three smaller plates.

In the middle of the rays the infero-marginal plates are slightly longer than the supero-marginal plates, so that distally these marginal plates do not correspond. The plates bear a series of rectangular marginal granules, which are often drawn out in a tiny, blunt, central point. The central granules are round and distinctly larger than those of the supero-marginal plates; they leave a deep pit when rubbed off. Near the supero-marginal plates the infero-

marginal plates each have one, small, usually trivalved, excavate pedicellaria. On the ventral surface there are usually one or two small, bivalved, excavate pedicellariae. Central granules and pedicellariae gradually disappear on the distal plates.

The terminal plates are smooth and bare; only proximally bearing some granules. Judging from the scars, the plates have three thick terminal spines, which are, however, not present on the examined specimen.

The extensive ventro-lateral area reaches to the eighth or ninth infero-marginal plates. Along the mid-radial line there are about eleven ventro-lateral plates from the oral to the infero-marginal plates; there are over 25 ventro-lateral plates from the oral plates to the distal corner of the area. All plates have a series of stout, thick marginal granules, which are often drawn out in a tiny point. Occasionally a few similar granules are found on the surface of the plates; particularly on the few smaller plates, which lack pedicellariae. Virtually all ventro-lateral plates have a large alveolar pedicellaria. On the proximal plates the valves of the pedicellariae are more than one mm wide and slightly over half as high; on the distal plates the valves are much less wide. The valves of all pedicellariae have serrated edges, which fit the edges of the opposite valves. Rarely a plate has a pedicellaria with three valves, or two pedicellariae.

The adambulacral plates are stout and have a series of five stout, thick, blunt, compressed furrow spines, which are often more or less triangular in cross section. The adoral spine of the series is usually somewhat smaller and placed slightly more interiorly. Exterior to the furrow series there are three to four much shorter, often very irregularly shaped spines. Exterior to these spines there is on each plate one large alveolar pedicellaria, very similar to those of the ventro-lateral area. Between such a pedicellaria and the marginal granules, which are very similar to those of the ventro-lateral plates, there are quite often one to three larger granules.

The oral plates have four strong, thick oral furrow spines, which are roughly triangular in cross section. Distally to these spines there is a second row on either side of the median groove. This series runs from the two median oral furrow spines, along the outer two to the ambulacral groove. The two distal and largest spines of this second series stand along the ambulacral groove, next to the outer oral spines. On the ventral surface of the plates there are about a dozen thick, angular granules on either side of the median groove: the distal and proximal granules being the largest of all.

The madreporite lies slightly closer to the central anus than to the supero-marginal plates. Its diameter is about three mm. In the margin are short gyri; the large central area has numerous small, short, fine slits.

The apical plates surrounding the anus have their proximal marginal granules greatly enlarged.

The colour in alcohol 70% is dark brown; the colour in life was not noted.

Variability. — References in the literature suggest that the interbrachial arc may vary from angular to rounded. The R/r ratio in the specimens so far investigated varies from 2 to 3.4. These two characters may make the general appearance of the species quite variable. Enlarged dorsal plates in the arm may be few or, rarely, lacking.

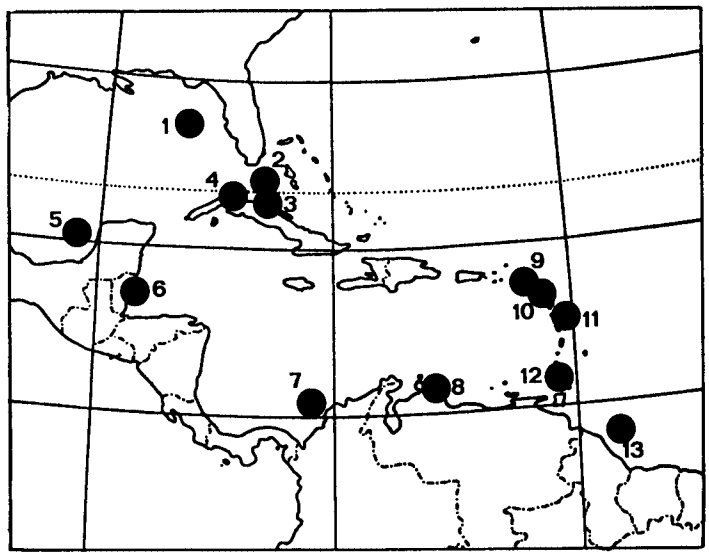

Fig. 18. *Circeaster americanus* (A. H. Clark, 1916), distribution in the western tropical Atlantic. Explanation of the numbers used: 1, Gulf of Mexico; 2, Straits of Florida; 3, Cuba: Puerto Sagua la Granda, Santa Clara, and Bahia Cardenas, Matanzas; 4, Playa Baracoa, Havanna, Cuba; 5, West of Yucatan; 6, Ambergris Cay, British Honduras; 7, Off Cartagena, Colombia; 8, South of Curaçao; 9, Leeward Islands, between Saba and St. Barthélemy; 10, Off Antigua; 11, East of Dominica; 12, North of Trinidad; 13, Off Guyana.

Remarks. — Halpern (1970a) synonymized the generic names *Circeaster* Koehler, 1909b and *Lydiaster* Koehler, 1909b. He also could not find any "major differences" between *Lydiaster americanus* A. H. Clark, 1916, and *Circeaster occidentalis* H. L. Clark, 1941.

Distribution. — Type locality: Gulf of Mexico ("Albatross" station 2395, March 1885, 28°36'15"N 86°50'W, 347 fms depth, grey mud). Straits of

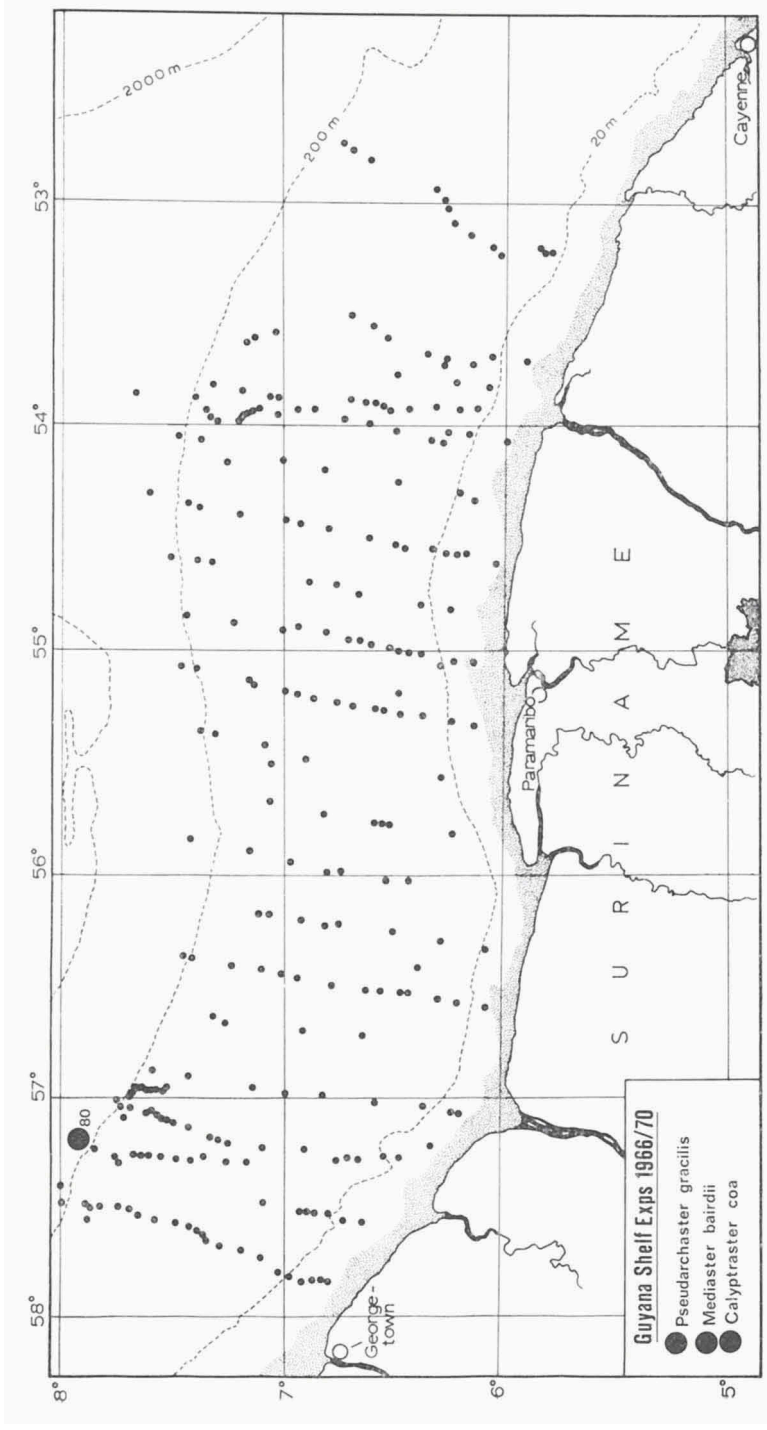

Fig. 19. Records of *Pseudarchaster gracilis*, *Mediaster bairdii* and *Calyptraster coa* in Guyana waters; cf. stationlist and Walenkamp, 1976.

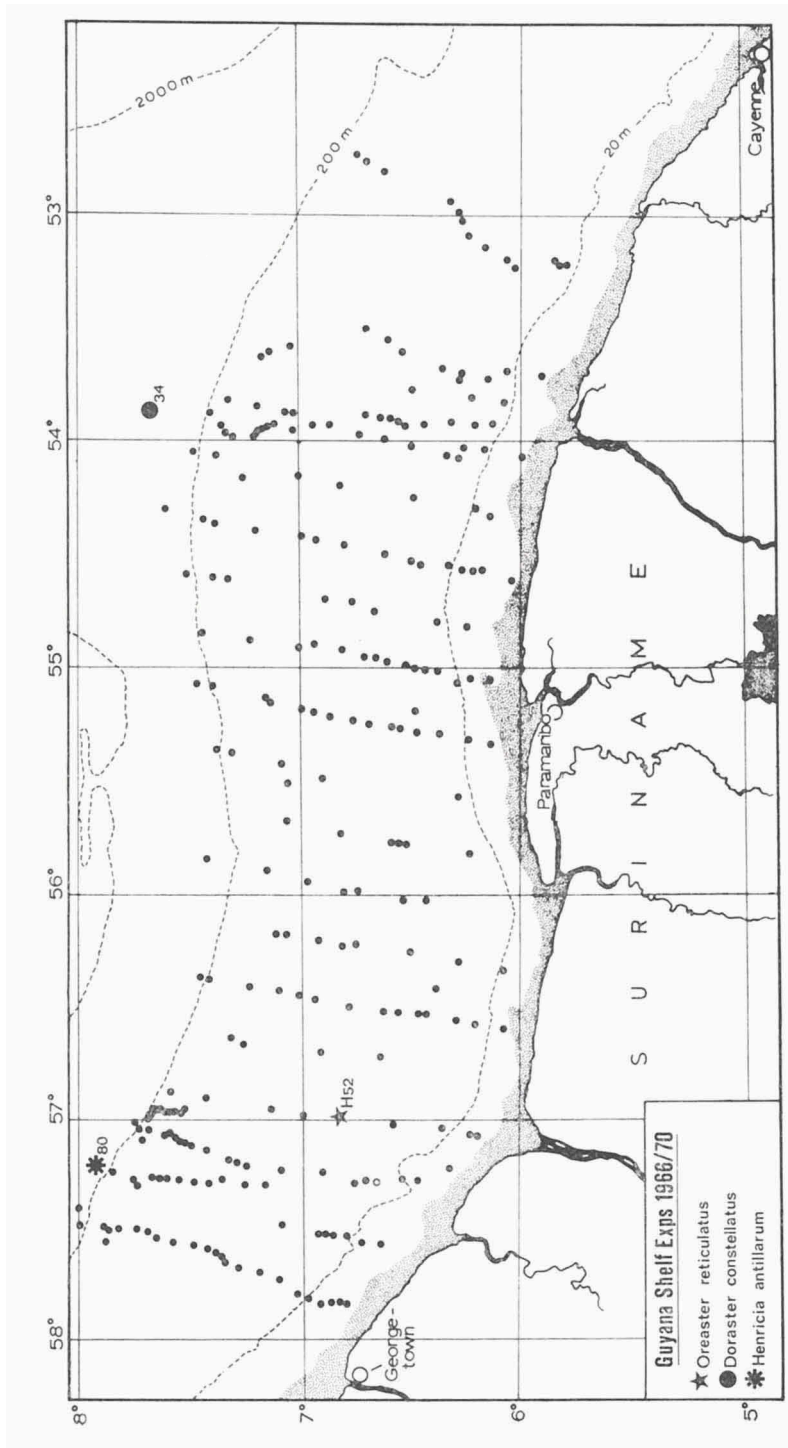

Fig. 20. Records of *Oreaster reticulatus*, *Doraster constellatus* and *Henricia antillarum* in Guyana waters; cf. stationlist and Walenkamp, 1976.

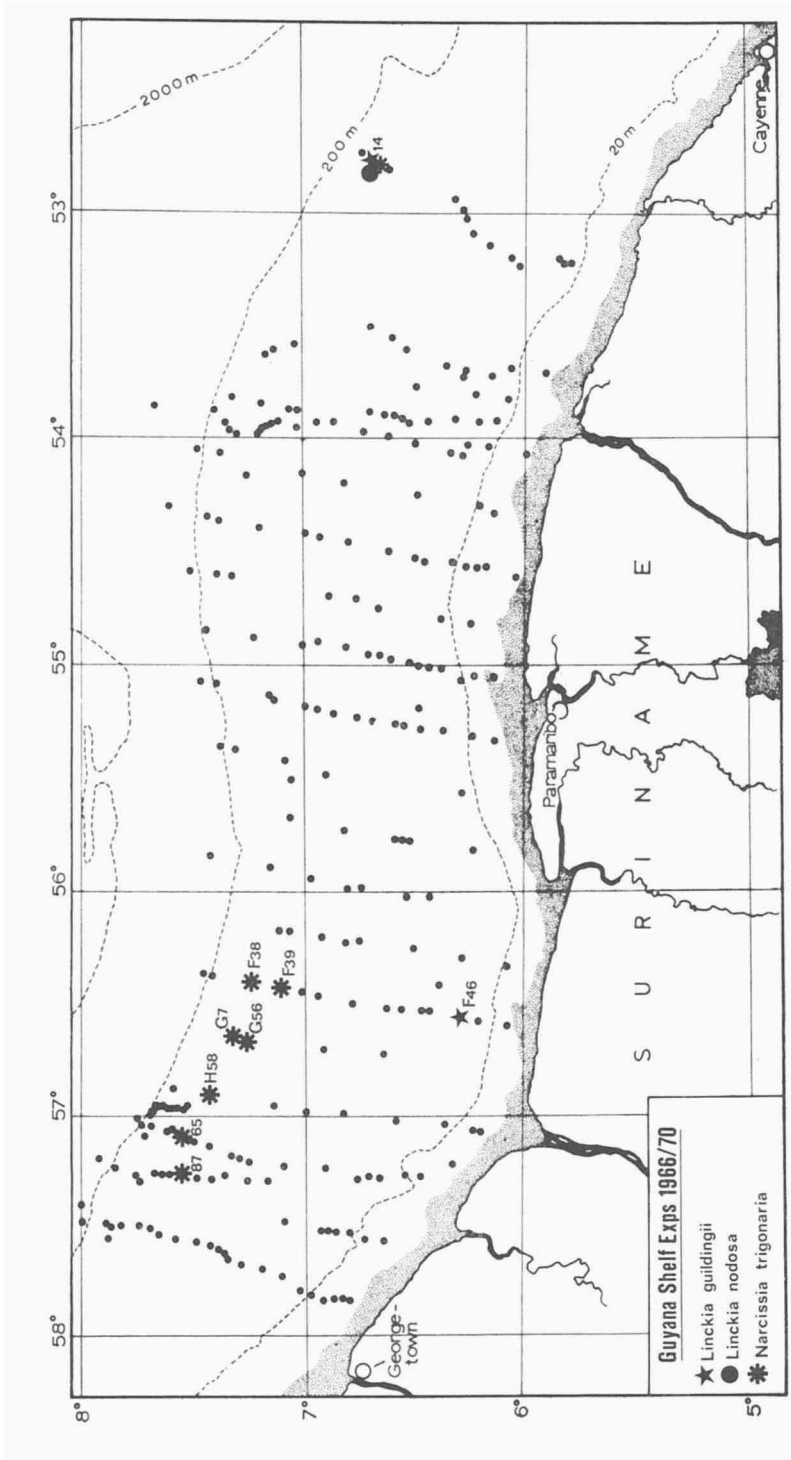

Fig. 21. Records of *Linckia guildingii*, *Linckia nodosa* and *Narcissia trigonaria* in Guyana waters; cf. stationlist and Walenkamp, 1976.

Florida. Coasts of Cuba. Gulf of Mexico. British Honduras. West of Yucatan. North coasts of Colombia. Curaçao. North of Trinidad. Leeward Islands: Antigua; between Saba and St. Barthélemy. Windward Islands: East of Dominica. Off Guyana.

Bathymetrical range. — 447-1446 m.

Linckia guildingii Gray, 1840 (fig. 21; pl. 19 fig. 1)

Material examined: Three specimens from station 14: R/r = 45/5, 46/4 and 66/5 mm, no. 5193. All three specimens have six arms of unequal lengths. The R's above indicate the length of the longest rays of each specimen.

Linckia nodosa Perrier, 1875 (figs. 21-22; pl. 12 figs. 3-4)

Linckia nodosa Perrier, 1875b: 417-418; 1884: 226. — Bell, 1884: 124, 509. — Sladen, 1889: 409, 786. — Fisher, 1906a: 1086. — Caso, 1961: 72-74, fig. 26. — Downey, 1968: 42; 1973: 67, pl. 27 figs. C, D. — Jangoux, 1978: 97.

Linckia bullisi Moore, 1960: 414-416, fig. 1.

Non *Linckia nodosa* — Verrill, 1915: 93. — Brito, 1971: 262-263, pl. 3 figs. 1-2.

Material examined: Seven specimens from station 14: R/r = 57/7, 56/7, 51/7, 48/7, 47/6, 42/6 and 40/5, no. 5192.

Diagnosis. — Many of the dorsal and lateral plates of the disk are swollen; in the arms the swollen plates occur randomly in the carinal, adradial and supero-marginal series. Some lateral plates have one or more short, central spinelets. Terminal plates with only a few granules or short spinelets.

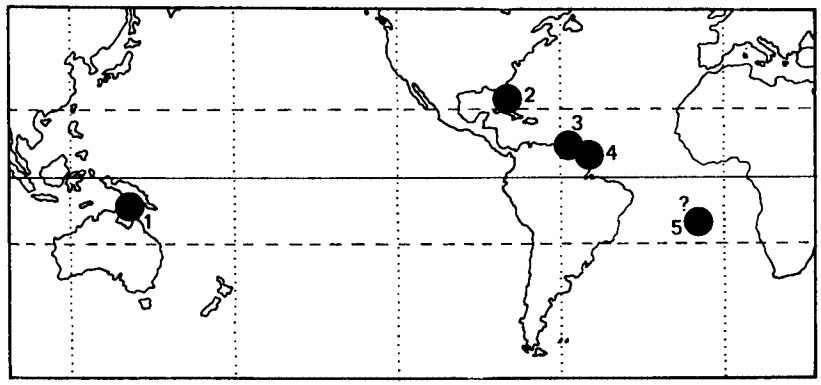

Fig. 22. Distribution of *Linckia nodosa* Perrier, 1875. Explanation of the numbers used: 1, Arafura Sea and Torres Strait; 2, Florida and Tortugas; 3, Guyana; 4, French Guyana; 5, St. Helena (Cf. *discussion* and *distribution* in text).

Description. — The body of this species has a very small disk with five, ventrally flattened, cylindrical arms, which are widest in the middle, proximally constricted and distally tapering to a blunt tip. Except for two

series of spines along the ambulacral groove and for the terminal plates, the whole surface of the species is densely covered by a tough skin with crowded, rounded granules, which are larger in the centre of the plates. On the centre of the swollen supero-marginal plates they even develop into a number of short, thick spinelets.

The dorsal skeleton is rather irregular. The pattern of the swollen dorsal plates is different in all specimens examined. The large, swollen plates are connected by one to several much smaller, flat, imbricating plates: the distal plates are imbricating over the proximal ones. The dorsal and lateral plates can be arranged in five main longitudinal series, which are transversely connected by small, flat ossicles. The series are: one carinal series and, on either side, one adradial and one supero-marginal series. The adradial series appears to branch off the carinal series after the proximal constriction of the arm. Dorsal to the infero-marginal plates there are numerous papular areas with about ten pores each.

The supero-marginal series is quite regular, except for the occurrence of the swollen plates. The proximal infero-marginal plates are wider than long. From about the sixth infero-marginal plate onwards they are longer than wide and imbricating, usually the distal over the proximal ones. Except for the tip of the arm there is one small, slender plate, wider than long, between each pair of supero- and infero-marginal plates. The marginal plates correspond along the whole length of the arm. In the small interradial area the marginal plates are separated by two to three very short series of small plates. There are no papulae in this area. In the distal part of the arms most infero-marginal plates bear one central, much enlarged granule.

The terminal plates are bare, except for a few central and/or terminal short, thick spinelets and/or granules. When rubbed off, the granules of these plates leave a small pit, in contrast to the granules of all other plates, which leave no pit.

The ventro-lateral areas extend to almost the tips of the arms with the series adjacent to the oral and adambulacral plates. For the larger part of the arm this series corresponds with the adambulacral plates. The second series reaches about three quarters of the arm length; the third series as far as the ninth or tenth infero-marginal plates. In the small interradial area there are two, short, rather irregular series squeezed between the three series of plates already mentioned. The ventro-lateral plates imbricate: usually the distal over the proximal and the exterior over the interior plates. The granules on the series of plates adjacent to the adambulacral plates are slightly larger than those on the other plates and more similar to the granules on the ventral surface of the adambulacral plates.

The adambulacral plates are ventrally about twice as wide as long, separated by deep, wide grooves filled with connective tissue, which grooves, however, can only been seen when the covering coat of granules is removed. Seen from the ambulacral groove the plates are L-shaped, with the lower bar making an angle of about 130° with the vertical one. The plates are interiorly and dorsally connected. There are two series of spines, consisting of two furrow spines and one broad, short, almost round and compressed spine exterior to these two. The furrow spines stand on the lower bar of the L: one broad, compressed, distally widening and rounded adoral spine, and one slightly shorter, much more slender, but also compressed aboral spine. The round and compressed spine of the second series stands at the very adoral side of the vertical bar of the L, so that at first sight it appears to belong to the two furrow spines of the adjacent adambulacral plate. The rest of the surface of the plates is densely covered by round granules, of which one is slightly larger than the others.

The oral plates have two slender spines in the mouth and two or three broad-tipped, compressed spines along the ambulacral furrow. Exterior to this series there is one very much broadened, short, compressed spine on either side of the median groove. The rest of the ventral surface is covered by granules, like the adambulacral plates. Between the furrow spines and the two large ventral spines there are often some small granules.

The anus is slightly out of centre and surrounded by slightly enlarged and flattened granules.

In the examined specimens the madreporite lies distally to one interradial or two radial, swollen dorsal plates. Its outline is sharply set off from the surrounding granules and it has sharply cut, radiating gyri. In the largest specimens its diameter is about 2.5 mm.

Remarks. — It is virtually impossible to say much about the shape of the smaller plates without removing the thick granular coat. I have done so in a portion of one specimen.

Variability. — The tumid dorsal and lateral plates are randomly distributed and in the various specimens occur in different numbers. Quite a number of proximal supero-marginal plates is often not swollen. In some specimens many infero-marginal plates are slightly swollen, although not to the same extend as the tumid dorsal plates. Only very rarely a really tumid infero-marginal plate occurs in the specimens examined. The size of the short, thick spinelets on the lateral plates appears to increase irregularly with the size of the specimens. In some specimens some adradial and even sometimes some carinal swollen plates also have such enlarged granules. The ornamentation of the terminal plates may vary from a few granules to several short, thick, bluntly pointed spinelets.

Discussion. — Downey (1973) synonymized *Linckia nodosa* with *Linckia formosa* Mortensen (1933: 430). I hesitate to share her opinion on this matter, because her reasoning that "Mortensen overlooked *Linckia nodosa* altogether" seems unlikely. Mortensen corresponded with H. L. Clark on the differences between *Linckia formosa* and *Linckia bouvieri*. H. L. Clark synonymized *Linckia nodosa* with *Linckia bouvieri* in 1921. It seems therefore more likely that Mortensen, knowing of this action, accepted H. L. Clark's point of view and limited himself to the question of possible differences between his new species, *Linckia formosa*, and *Linckia bouvieri*, the latter including specimens of *Linckia nodosa* as well as of *Linckia bouvieri*. Mortensen's photographs (pl. 22 figs. 2, 4) show his species to have tumid plates only in the adradial and carinal series, the supero-marginal plates forming a neat, flat row. Mortensen also mentions his specimens to have three to five papular pores in each area, whereas *Linckia nodosa* and *Linckia bouvieri* usually have about ten. The small size of Downey's specimens (R = 27 and 36 mm) probably accounts for them having only two to eight papular pores in each area.

I do, however, fully agree with Downey, where she synonymises *Linckia bullisi* with *Linckia nodosa*.

Distribution. — Type locality unknown. Florida. Tortugas. Guyana. French Guyana. According to Bell (1884: 124) the species also occurs in the Arafura Sea and the "Prince of Wales Channel", which later authors like Sladen (1839) and Fisher (1906a) interpret as Torres Strait, probably near Prince of Wales Island, North Australia. Downey (1968, 1973) says the species to range from Florida to Brazil and St. Helena; the St. Helena record is of Mortensen's *Linckia formosa*.

Bathymetrical range. — 13-855 m.

Narcissia trigonaria Sladen, 1889 (fig. 21; pl. 13 figs. 1-6)

Material examined: Four specimens of three different stations. Sta. 14: (2), R/r = 20/5 and 111/15 mm, nos. (respectively) 5206 and 5159; Sta. 65: (1), R/r = 68/11 mm, no. 5190; Sta. 87: (1), R/r = 48/9 mm, no. 5191.

Remarks. — Downey (1973: 69) gives a brief, but good description of the changes, which take place during growth. A very similar pattern can be observed in the specimens from Guyana waters. The figures 1-6 of plate 13 illustrate the changes in habitus accompanying an increase in size.

Calyptraster Sladen, 1882 (figs. 19, 23-25; pl. 14 figs. 1-4)

Calyptraster Sladen, 1882: 207-209; 1889: 489-491. — Madsen, 1947: 3-7. — Bernasconi, 1966a: 95-99, figs. 1-2; 1972: 9-14, pls. 1-2. — Tommasi, 1970: 13. — Cherbonnier & Sibuet, 1972: 1351. — Downey, 1973: 79. — Sibuet, 1975: 284, 294.
Non *Cryptaster* Perrier, 1894: 191.

Body pentagonal, or, particularly in larger specimens, with rather sharp interbrachial arcs. R/r ratio from 1.4 to 1.8. Supradorsal membrane thin and transparent or thick and fleshy. Spiracula present. No spicules. Paxillae with five to fourteen paxillar spinelets, which form a widely expanded crown, which may merely support the supradorsal membrane, or lift it in high tent-like peaks; the spinelets do not appear to pierce the membrane. Adambulacral spines in curved, oblique series, never longitudinal, with three to seven spines,

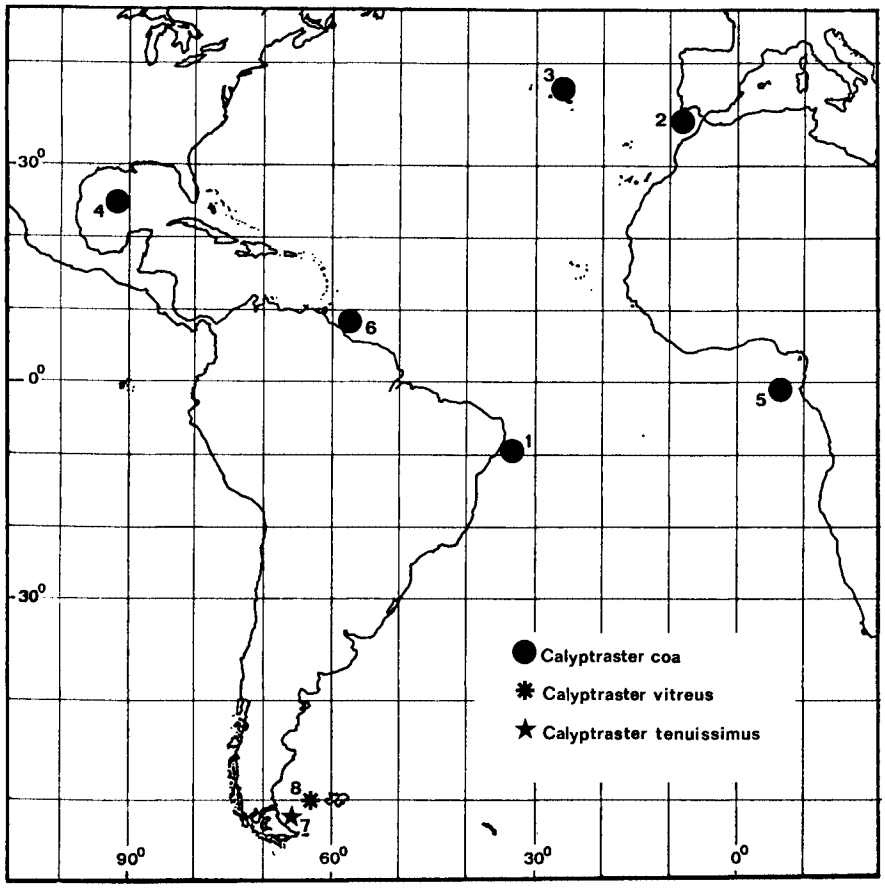

Fig. 23. Distribution of the genus *Calyptraster* Sladen, 1882. Explanation of the numbers used: 1, Type locality of *Calyptraster coa*, Southeast of Pernambuco, Brazil, 630 m depth; 2, 35°43'N, 8°16'W, 2150-2300 m depth (Madsen's specimens); 3, Azores, 36°58'02"N, 26°20'00"W, 2871 m depth; 4, Gulf of Mexico, 25°21'N, 91°02'W, 3105-3150 m depth; 5, Campagne Walda, 0°40.1'S, 6°48.8'E, 3034 m depth (Sibuet's specimen); 6, Off Guyana, LGSE, station 80, 618 m depth; 7, Type locality of *Calyptraster tenuissimus*, off Estrecho de Magallanes, Argentina, 52°22'S, 65°45'W, 116 m depth; 8, Type locality of *Calyptraster vitreus*, Meseta Malvinas, Argentina, 50°S, 62°50'W, 145 m depth.

which are always, at least partly, webbed. Oral plates with one to seven oral furrow spines, which may, or may not be webbed, and with two or three free suboral spines, which may be smooth and pointed or thickened and thorny. Ventro-lateral spines merged in the ventral floor. No independent lateral fringe.

Type species: *Calyptraster coa* Sladen, 1882.

Calyptraster coa Sladen, 1882 (figs. 19, 23-25; pl. 14)

Calyptraster coa Sladen, 1882: 207-209; 1889: 489-491, 655, 691, 709, 800, pl. 78 figs. 1-2, pl. 79 figs. 1-3. — Tommasi, 1970: 13, fig. 37.
Calyptraster personatus — Madsen, 1947: 3-7, figs. 1-2. — Cherbonnier & Sibuet, 1972: 1351, map no. 6. — Downey, 1973: 80, pl. 35 figs. C, D. — Sibuet, 1975: 284, 294.
Non *Cryptaster personatus* Perrier, 1894: 191, pl. 14 figs. 4a-c.

Material examined: a. "Challenger" Expedition, 1873-1876, station 122c, 09°05'S 09°10'S, 34°49'W to 34°53'W, 630 m depth: three specimens, R/r = 11/8 mm (lectotype), 9/8 and 7/5 mm (paralectotypes), British Museum (Natural History), Nos. 90.5.7.741, 90.5.7.742 and 90.5.7.743, respectively.

b. "Luymes" Guyana Shelf Expedition ,1970, station 80: (1), R/r = 13/9 mm, no. 5175.

c. "Skagerak" Expedition, 1946 (Madsen's specimens), 35°43'N 08°16'W, 2156-2360 m depth: (4), R/r = 10/5.5, 11/6.5, 12/8 and 13/8 mm; the first two are in the Zoologisk Museum, Copenhagen, the last two in Naturhistoriska Museet, Gothenburg, Echin. nos. 4016, 4017.

d. Campagne Walda, 1971, Sta. 30, CY 21, 00°40,1'S 06°48,8'E, 3034 m depth (Sibuet's specimen), R/r = 17/10 mm, Centre Océanologique de Bretagne.

Diagnosis. — Body small and pentagonal, in larger specimens (R>10 mm) with rather sharp interbrachial arcs. The five or six paxillar spinelets usually long, flaring or tapering, mostly longer than the pedicels. Supradorsal membrane thin and transparent or thick and fleshy, mostly elevated in varying degrees by the paxillar spinelets, which, however, rarely if ever pierce the membrane. The valves of the osculum consist of about twelve spines and form a pyramid when closed. Oral plates with three or two suboral spines, smooth or thorny, and one to three oral furrow spines, one of which is usually very similar to the suboral spines. Adambulacral spines three or four, in curved oblique series, partly webbed together, but free from the large ventro-lateral spines.

Description. — Based on the Guyana specimen (cf. Variability). The body is small and pentagonal, with five short rays (R/r ratio 13/9 = 1.4). The skin is very thin and perfectly transparent. The dorsal as well as the ventral surfaces are convex in the radii and concave in the inter-radii. The sides of the body are almost straight, slightly curved inwards only, mainly as a result of damage to the ventro-lateral spines. All arm tips are turned upwards to a greater or lesser degree; this may, however, be exaggerated by shrinkage.

The supradorsal membrane is thin and transparent, although much less

so if the specimen is dried. It lacks spicules and muscular bands and fibrillar structures are very faint. The spiracula are numerous, roughly between ten and twenty to each area between two paxillar spinelets of one paxilla; the spiracula are evenly distributed and quite variable in size. The supradorsal membrane is delimited by the tips of ventro-lateral spines.

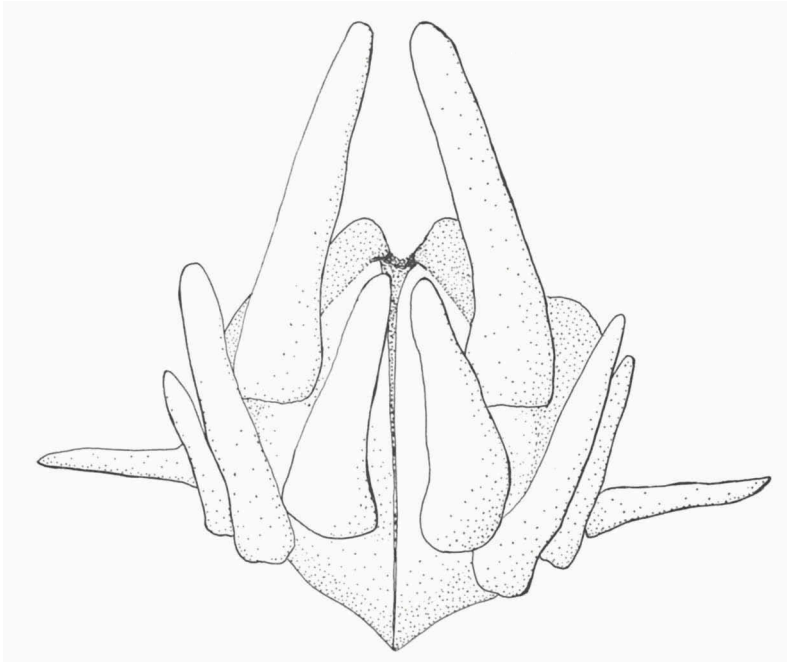

Fig. 24. Oral plate of *Calyptraster coa*. Specimen from Guyana, R/r = 13/9 mm; 50 ×, aboral side upwards.

The paxillae have their bases mid-radially and are arranged in longitudinal series. The longest radial series of each ray consists of about thirteen paxillae, which very rapidly and strongly decrease in size towards the tip of the arm; the distal paxillae are smaller than the diameter of the pedicel of the proximal ones. The supradorsal membrane is supported, radially as well as interradially, by radial paxillae. The paxillae, which support the membrane interradially have their bases deeper in the body and emerge from under the inner longitudinal series. As the former paxillae have to reach farther to support the membrane, they have longer pedicels and longer spinelets. The longest paxillar spinelets may attain a length of about two mm. The number of longitudinal series of paxillae increases from three, proximally, to about nine in the middle of the ray; beyond these the number of longitudinal series diminishes to about four in the tip of the rays. The paxillar spinelets are

long, longer in the lateral than in the mid-radial paxillae, and usually longer than their own pedicels. They support the dorsal membrane, elevating it in high, tent-like peaks. This feature, however, is probably mainly dependent on the mode of preservation. Quite often, particularly in the interradii, the spinelets appear to protrude through the membrane, but as this membrane is extremely thin and delicate, this feature is very difficult to make out with certainty. The paxillae have six, interradially sometimes five, widely expanded spinelets with even, pointed or flaring tips; not rarely all three types are found on one paxilla. There is no central spinelet.

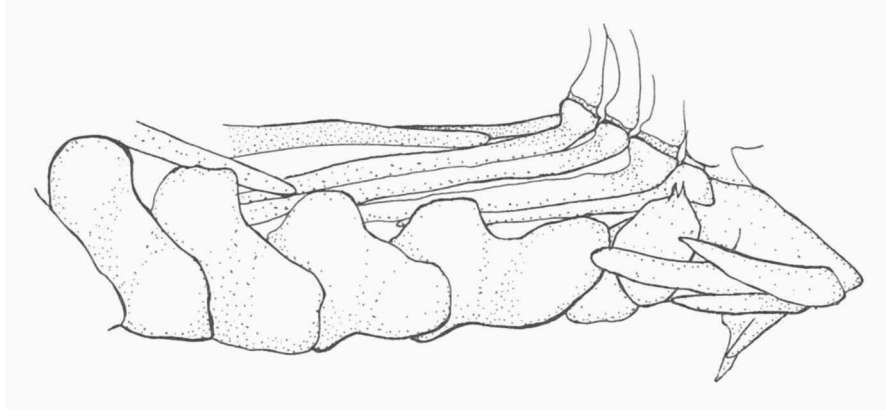

Fig. 25. *Calyptraster coa.* Specimen from Guyana, R/r = 13/9 mm. Detail of the proximal part of a ray after removal of the adambulacral spines, the ventral membrane and the aperture-papillae, except the first, 25 ×.

The osculum (= oscular orifice) is slightly over three mm in diameter. It is surrounded by five radial ossicles, which are very conspicuous, mainly because they are pure white. These ossicles have a straight interior and a semicircular exterior margin. They bear two series of spines: the interior series consists of about twelve spines, increasing in length towards the centre of the ossicle, the longest spine being about two mm long. These interior spines constitute the oscular valves, which, when closed over the osculum, form a five-sided pyramid. The exterior series consists of about eight spinelets: four on the exterior margin of the ossicles, and two on either side, which more or less bridge the gap between two adjacent ossicles. The exterior spinelets support the supradorsal membrane just like the paxillar spinelets.

The short, wide terminal plates bear a transverse comb of twelve to fourteen small, glassy, pointed spinelets.

The ventral surface is generally convex, although interradially somewhat concave. The ventral membrane is quite as transparent as the supradorsal

membrane. On each side of the ventro-lateral area there are about 26 spines, of which the first is slightly over one mm long and the seventh and longest slightly over four mm. Distal to the longest ventro-lateral spine the spines rapidly decrease in size, the last ten being crowded on the tip of the arm. The ventro-lateral spines are interradially free and radially attached to the wide aboral part of the adambulacral plates. They are in fact adambulacral spines, but very much larger than, and not connected by webbing with the other four adambulacral spines.

The flat adambulacral plates consist of a narrow adoral part slightly wider than long, which bears the four adambulacral spines and the aperture-papilla, and a wide aboral part, which is almost twice as wide. The interior half of the latter part is mostly hidden by the proximal half of the next plate; the exterior half bears the "ventro-lateral" spine. The two parts of the adambulacral plates are slightly swollen and separated by a shallow, narrow groove, which widens exteriorly and has a somewhat more glassy appearance. The aperture-papillae are about a fourth the size of the proximal part of the adambulacral plates. They are small and flat, with a rounded outline, often tapering exteriorly. They have a median ridge, which is often drawn out into a small, pointed protuberance; interiorly the plates are often slightly constricted. The papillae stick quite firmly in the ventral membrane. The first papilla of each series is about three times as large as the others and has a median ridge running from the exterior to the interior edge, without, however, always being produced into a point. The adambulacral plates have a series of four, partly webbed spines, which have a relatively wide base and strongly taper to an acute point. The four spines increase in size towards the mouth: the aboral spine is about 0.5 mm long; the longest adoral spine is more than twice as long and distinctly stouter. The adambulacral spines are proximally usually slightly shorter and thicker and less glassy and pointed than distally. On each plate the four spines form a curved, oblique series, in which the small aboral spine stands in the furrow and the base of the largest, adoral spine is very close to the aperture-papilla. The series are generally almost longitudinal on the first plates and transverse on the distal plates. The webbing, which connects the spines, is very thin and transparent. It does not include the "ventro-lateral" spine, and usually does not reach beyond the basal half of the spines.

The adambulacral grooves are wide, slightly wider in the middle of the ray than proximally or distally, and have two series of long, suckered tube-feet.

The oral plates are rather high, distally separated by a triangular gap and on their ventral surface by a very narrow groove. On the strongly

widened interior edges of the plates stand, on either side, three slender, tapering, pointed oral furrow spines, distally decreasing in size from 1 to 0.6 mm. On the ventral surface there are two stout suboral spines on either side of the groove; the interior spine next to the groove, the exterior suboral spine at a level between the interior spine and the first oral furrow spine. The suboral spines are strong, tapering, bluntly pointed and about as long as the longest adambulacral spines, although much thicker. They lie on the ventral surface, pointing exteriorly and are difficult to move in the preserved specimen; there is, however, no trace of webbing between the spines of the oral plates. The suboral spines are very slightly curved inwards, the exterior spines slightly stronger than the interior ones (cf. fig. 24).

Exteriorly to the mouth plates and parallel to the adambulacral plates run four long spines on either side, which in the mid-interradius are produced in paired elevated ossicles. Well inside the body there are a few more of these spines. The most exterior spine of the four superficial ones reaches to the fourth adambulacral plate. All these spines are covered by the ventral membrane and the first "ventro-lateral" spines, which have to be removed to disclose these truly ventro-lateral structures (cf. fig. 25).

Variability. — The most obvious variation in the hitherto found specimens of this small and rare species is seen in the texture of the supradorsal and ventral membranes. In the three syntypes of Sladen these membranes are very thin and perfectly transparent. A similar texture is found in Sibuet's specimen, in two of the four investigated specimens of Madsen and in my own specimen. Two of Madsen's specimens, however, have a thick and opaque skin. Even these last two specimens show some variation, viz. the specimen from the Gothenburg Museum (no. 4016) has membranes, which appear milky, but are still thin enough to discern the underlying skeletal elements under proper illumination; one of the two Copenhagen specimens has a thicker skin, which makes it virtually impossible to see the underlying paxillae.

The spiracula in the supradorsal membrane vary in size and number from two to three fairly large holes per area between two paxillar spinelets of one paxilla to about ten or twenty small spiracula per area. One of Madsen's specimens shows both extremes and the gradations in between.

The paxillae may be long and fine or rather short and sturdy. The paxillar spinelets are usually as long as their pedicels, but may occasionally be slightly longer.

Between a supradorsal membrane merely supported by the paxillae and one which is highly elevated, many gradations are found, sometimes even in one specimen. This feature may well be dependant on the mode of preservation.

The five oscular valves form a five-sided pyramid when closed. If they form a flat structure over the opening, as is the case in the type specimens, this is clearly due to preservation.

The R/r ratio's vary from 1.7 to 1.1; the sides of the body may be straight or, particularly in larger specimens, form an obtuse angle, as much as 110°.

The adambulacral spines are three or four in number. If there are four spines the most aboral one is often very small, but it may also be up to three quarters the length of the largest, most adoral spine. The first adambulacral plates have often only two or three spines; if there are four spines on these plates the most aboral one is very small. The webbing between the adambulacral spines may be distinct, as is the case in the thick-skinned specimens, or hardly noticeable.

Although Sladen's drawing of the type specimen shows otherwise, the free interradial space between the ventro-lateral spines is petaloid in all specimens that I investigated.

The spines of the oral plates vary in their appearance, numbers and configurations, sometimes even in one specimen. The spines are smooth and pointed, and often slightly curved in the type specimens and in my own specimen; the spines have thickened and thorny tips in the specimens of Sibuet and Madsen, although in varying degrees. There may be two or three pairs of large suboral spines, and one to three oral furrow spines on either side. Many of the possible combinations of these numbers are found. The oral furrow spines are usually smooth and pointed, but the largest, most adoral spine is often very similar to the suboral spines.

Discussion. — Sladen (1882) described a new species of Pterasteridae, for which he proposed the new generic name *Calyptraster*, with the following diagnosis: "Form depressed, marginal contour pentagonal, dorsal area plane, actinal area convex. Supradorsal membrane very delicate, perfectly tranparent. No muscular fibrous bands. Spiracula present. No spicules. Paxillae with short robust spinelets (5 or 6 in the type species), usually flaring at the extremity, crown widely expanded, not protruding through, or even elevating, the membrane, simply supporting it. Ambulacral spines forming transverse combs; spinelets perpendicular in position, webbed together. Segmental apertures present. Aperture-papillae not free, opening laterally only. Mouth-plates with two or three pairs of superficial secondary spines. Mouth-spines proper 2, or occasionally 3. Actino-lateral spines merged in the actinal floor. No independent lateral fringe." Sladen gave the new species the name *Calyptraster coa*. In 1889 he again described the same specimen of the three syntypes, and illustrated the description with not completely accurate drawings (Sladen, 1889: pl. 78, figs. 1-2, pl. 79, figs. 1-3). The three syntypes

of the species are in the British Museum (Natural History), coll. nos. 90.5.7. 741-743. The original descriptions, notably the length of the rays (R/r = 11/8 mm), indicate very clearly which of the three specimens Sladen described, so, according to Article 74a of the Rules of Zoological Nomenclature, I designate this syntype as the lectotype, and the other two (R/r = 9/8 and 7/5 mm) become paralectotypes (coll. nos. 90. 5. 7. 741 (lectotype) and 90. 5. 7. 742-743 (paralectotypes).

In later years some more specimens of this rare, but widely distributed deep-sea species were described by Madsen (1947), Cherbonnier & Sibuet (1972), Downey (1973) and Sibuet (1975). Madsen thought his specimens to represent a different species, although he also hinted at the possibility of his specimens and the type of *Calyptraster coa* being only varieties of the same species, an opinion which has been rejected by Downey (1973). Following a suggestion of Mortensen, Madsen identified his five specimens, which were caught during the "Skagerak" Expedition of 1946 in the eastern Atlantic, with *Cryptaster personatus* Perrier (1894). As Madsen did consider his specimens to belong to the genus *Calyptraster*, he synonymized *Cryptaster* Perrier, 1894, and *Calyptraster* Sladen, 1882. Cherbonnier & Sibuet (1972), Downey (1973) and Sibuet (1975) followed Madsen in describing their specimens as *Calyptraster personatus* (Perrier, 1894).

Perrier's single specimen of *Cryptaster personatus*, which is in the Muséum National d'Histoire Naturelle, Paris, cannot now be found. Madame Sibuet, who has seen it, wrote me that it is in a disastrous condition: all that is left are remnants of three suboral spines, but no marginal spines, five or six spinelets on a paxilla and three adambulacral spines. Madame Sibuet suggested designating a Madsen specimen of *Calyptraster personatus* (Perrier, 1894) as a neotype.

Notwithstanding its (present) bad condition, or even absence, the description and illustrations of *Cryptaster personatus* by Perrier (1894) very clearly indicate some distinct differences between his specimen and the specimens of *Calyptraster* I have investigated (cf. Material examined). In *Cryptaster personatus* the oral plates only bear three small oral spines, the adambulacral spines are not webbed, nor are they in transverse or oblique series, the valves of the osculum lack spines, the ventral skin is too thick to see the ventrolateral spines and the supradorsal membrane has only one spiraculum in an area between two paxillar spinelets. Because of these differences, and because the holotype of *Cryptraster personatus* cannot now be found and is heavily damaged, I should prefer to let the name *Cryptraster personatus* rest until further investigation of the holotype or of specimens, which closely fit Perrier's description, is possible.

Madsen (1947) himself thought his specimens to resemble *Calyptraster coa* very closely. He writes: "In fact the only more important difference between *C. coa* and the specimens described here (Madsen's *Calyptraster personatus* J. W.) is that there is no muscular meshwork in the dorsal membrane of the former. Further in *C. coa* the innermost furrow spine is distinctly smaller than the others, and the suboral spines are not thorny, but of these characters the latter at least is subject to great individual variation, as appears from the study of the material described here".

It is remarkable that of the four specimens of Madsen I could examine, two have a thick skin, although I cannot judge whether or not it is muscular, and two have a skin as thin and transparent as in the types of *Calyptraster coa.* The specimen sent to me by Madame Sibuet is equally transparent. The innermost furrow spines of the type specimens are only very small on the first two adambulacral plates; on other plates they may be as large as three quarters of the longest adambulacral spines.

The feature in which, in my opinion, the specimens of Madsen and Sibuet differ most strongly from the types and the Luymes specimen, viz. the presence of thorny, respectively smooth and pointed suboral spines, is, as Madsen correctly states "subject to great individual variation", although not to such an extent as to connect the two series by a complete gradation.

Summarizing the discussion above: after investigating four of the five specimens of *Calyptraster* examined by Madsen (1947) and one investigated by Sibuet, which they identified as *Calyptraster personatus* (Perrier, 1894), and after comparing these specimens with the syntypes of *Calyptraster coa* Sladen, 1882. I find the differences between the specimens too small and variable to distinguish two different species (cf. Variability).

As regards *Cryptaster personatus* Perrier, 1894, I see no reason to synonymize this species with any specimen of *Calyptraster* hitherto described, and I suggest to postpone further action until more details concerning this species are known.

Since *Calyptraster coa* and its variability are now known to a greater extent, it has been necessary to amend the diagnosis of the species.

Bernasconi described two other species of *Calyptraster*, viz. *Calyptraster tenuissimus* Bernasconi, 1966a, and *Calyptraster vitreus* Bernasconi, 1972, both from the continental shelf off southeastern Argentina. The former species differs mainly from the type species in the larger number of adambulacral spines, in the paxillae, which have six to seven marginal and one central spinelet, and in the larger number of oral furrow spines on the oral plates. *Calyptraster vitreus* is distinguished from the type species by its larger number of paxillar spinelets (seven to fourteen), its shorter "ventro-

lateral" spines, which do not form the interbrachial margin, its larger number of adambulacral spines (six or seven), its seven oral furrow spines and its large and glassy distal suboral spine. The genus *Calyptraster* therefore appears to contain three species, viz., *Calyptraster coa* Sladen, 1882, *Calyptraster tenuissimus* Bernasconi, 1966a and *Calyptraster vitreus* Bernasconi, 1972. Like Bernasconi I have revised the diagnosis of the genus according to this new information.

Distribution. — This rather rare species is found on both sides of the Atlantic Ocean, between 40°N and 10°S, and near the Azores (cf. fig. 23).

Bathymetrical range. — 618-3150 m depth. *Calyptraster tenuissimus*: 116 m depth. *Calyptraster vitreus*: 145 m depth.

Echinaster brasiliensis Müller & Troschel, 1842 (figs. 26, 29; pl. 15 figs. 1-4; pl. 16 figs. 1-4)

Echinaster brasiliensis Müller & Troschel, 1842: 22. — Lütken, 1859: 93. — Verrill, 1867: 343; 1915: 41, pl. 26 fig. 1. — Perrier, 1875b: 367. — Rathbun, 1879: 148. — Ludwig, 1882: 7. — Sladen, 1889: 553, 808. — Ives, 1890: 324, 326, pl. 8 figs. 16-18. — Bernasconi, 1956b: 137-138, pl. 4 fig. 5. — Tommasi, 1958: 22-23, pl. 4 fig. 3; 1970: 16-17, pls. 24-25 figs. 44-45. — Brito, 1960: 66; 1962: 2; 1968: 13. — Gray, Downey & Cerame-Vivas, 1968: 156. — Hiroki, 1971: 329, figs. 2, 14. — Downey, 1973: 88, pl. 42 figs. C, D. — Walenkamp, 1976: 78-81, figs. 8e, 27, pl. 18 figs. 3-4.

Othilia brasiliensis — A. Agassiz, 1869: 308.

Echinaster antonioensis De Loriol, 1904: 29-30, pl. 2 figs. 4. — Bernasconi, 1955: 72-73, pl. 6 figs. 1-2. — Tommasi, 1958: 22, pl. 4 fig. 2. — Brito, 1968: 15.

Material examined: a. "Luymes" Guyana Shelf Expedition, 1970: 26 specimens form fourteen stations in Guyana waters. Sta. 7: (1), R/r = 59/10 mm, no. 5203; Sta. 38: (1), R/r = 22/5 mm, no. 5211; Sta. 63: (2), R/r = 17/4 and 26/6 mm, no. 5204; Sta. 65: (2), R/r = 20/4 and 24/5 mm, no. 5199; Sta. 68: (1), R/r = 13/3 mm, no. 5222; Sta. 69: (1), R/r = 28/6 mm, no. 5202; Sta. 72: (3), R/r = 20/5, 21/5 and 23/5 mm, no. 5198; Sta. 85: (2), R/r = 16/4 and 17/4 mm, no. 5214; Sta. 87: (2), R/r = 8/2 and 10/2.5 mm, no. 5221; Sta. 96: (1), R/r = 44/9 mm, no. 5205; Sta. 103: (2), R/r = 21/5 and 21/6 mm, no. 5219; Sta. 107: (3), R/r = 15/4, 16/3 and 19/4 mm, no. 5220; Sta. 113: (3), R/r = 18/4, 18/5 and 21/5 mm, no. 5216; Sta. 120: (1), R/r = 38/7 mm, no. 5201.

b. "Coquette" Cruise, 1957, (material in the Surinaams Museum). Cruise 3, Sta. C3: (1), R/r = 13/3 mm; Cruise 15, Sta. 283: (1), R/r = 12/3 mm.

c. One specimen, R/r = 65/12 mm, from Rio de Janeiro, Muséum d'Histoire Naturelle de Genève, Switzerland.

Discussion. — Tommasi (1970: 17) synonymized *Echinaster antonioensis* De Loriol, 1904: 29, with *Echinaster brasiliensis*. Without giving details, Tommasi stated that the differences between the two species, as mentioned by De Loriol, are dependant on the mode of preservation or concern characteristics, which show a large intraspecific variation.

Bernasconi (1955: 73) remarked that *Echinaster antonioensis* is closely

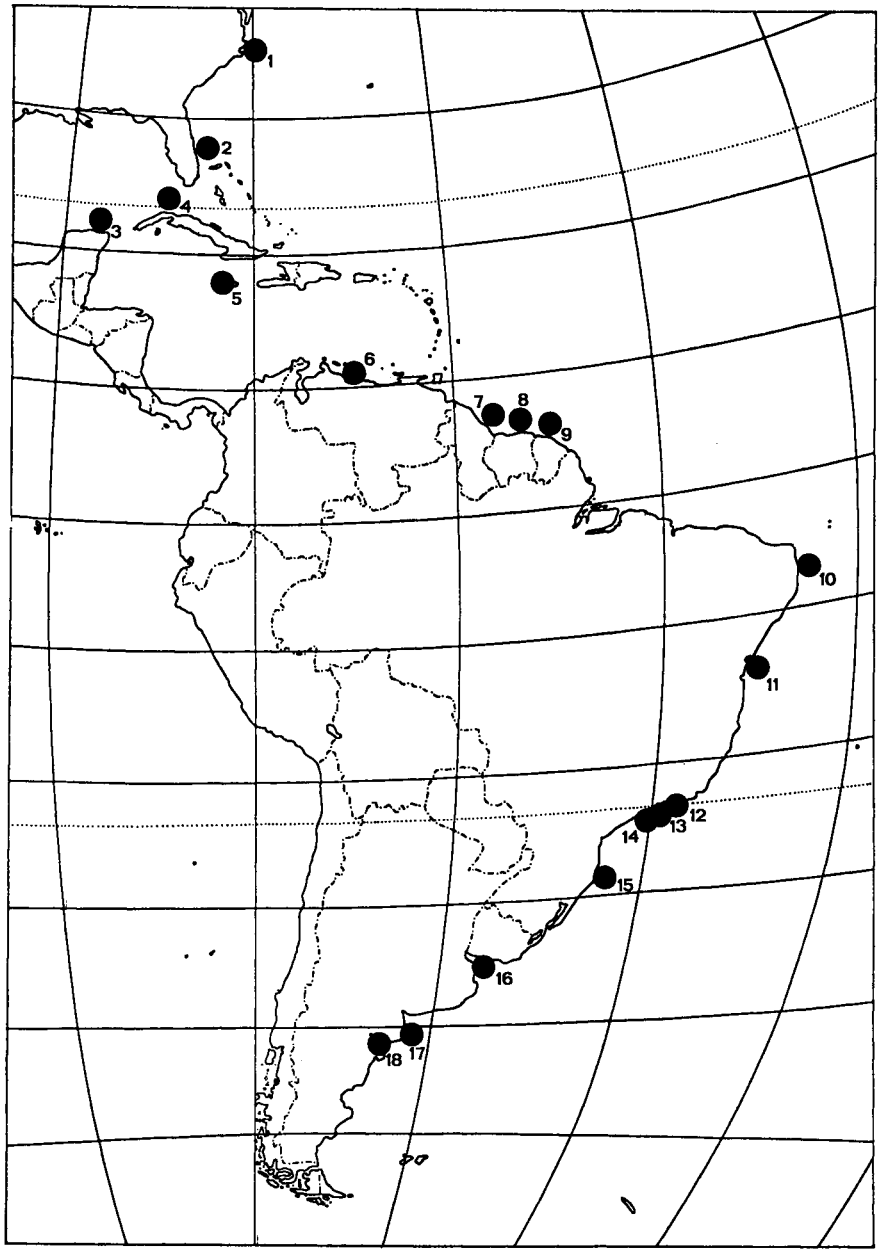

Fig. 26. Distribution of *Echinaster brasiliensis* Müller & Troschel, 1842. Explanation of the numbers used: 1, Cape Hatteras, North Carolina; 2, Florida; 3, Yucatan; 4, Cuba; 5, Jamaica; 6, Puerto Cabello, Venezuela; 7, Guyana; 8, Surinam; 9, French Guyana; 10, Pernambuco, Rio Formoso; 11, Bahía; 12, Rio de Janeiro; 13, Ubatuba, São Sebastião; 14, Isla Santo Amaro, Santos; 15, Santa Catarina; 16, San Antonio; 17, Bahía San Blas; 18, Golfo San Matías, Patagonia.

related to *Echinaster brasiliensis*, from which species it differs in the shape and aspect of the arms, the greater number of spines on the ventral surface and the number of adambulacral spines.

De Loriol stated his new species to differ from *Echinaster brasiliensis* by its completely cylindrical arms, its deeper and more distinctly marked papular areas, its shorter spines, its adambulacral plates, which bear four spines, of which the marginal is longer than the three others, and the colour, which is yellow in stead of purplish.

Judging from the distinct photographs of the type specimen of *Echinaster antonioensis*, sent to me through the courtesy of Dr. Cl. Vaucher of the Natural History Museum of Geneva, and from the variation in *Echinaster brasiliensis*, as I observed in my specimens, as well as in literature on this species, I am inclined to agree with Tommasi. Still, it is appropriate to stress again the need for a thorough revision of the genus.

The photographs, which Dr. Vaucher sent me, also show that the legends accompanying the photographs of *Echinaster lepidus* and *Echinaster antonioensis* on plate II (5) in De Loriol (1904) are interchanged.

Distribution. — Cape Hatteras, North Carolina. Florida. Yucatan. Cuba. Jamaica. Puerto Cabello. Venezuela. Guyana. Surinam. French Guyana. Brazil: Pernambuco, Rio Formoso, Bahía, Rio de Janeiro, Ubatuba (type locality), São Sebastião, Isla Santo Amaro, Santos, Santa Catarina. Argentina: San Antonio, Bahía San Blas, Golfo San Matías, Patagonia.

Bathymetrical range. — Badly recorded generally. 20-100 m depth.

Echinaster modestus Perrier, 1881 (figs. 27, 29; pl. 17 figs. 1-2)

Echinaster modestus Perrier, 1881: 7; 1884: 206-207, pl. 3 fig. 7. — Sladen, 1889: 553, 554, 811. — Ives, 1890: 326. — Verrill, 1915: 43-44. — H. L. Clark, 1941: 55. — A. H. Clark, 1954: 376. — Tortonese & Downey, 1977: 829, 830.
Verrillaster spinulosus — Downey, 1973: 89-90, pl. 43 figs. A, B. — Jangoux, 1978: 97-98.
Non *Echinaster modestus* — Downey, 1973: 87-88, pl. 40 figs. C, D.

Material examined: a. O.C.P.S. expedition I, 1966: three specimens from two different stations. Sta. G 56: (2), R/r = 26/5.5 and 36/7 mm, no. 4427; Sta. H 57: (1), R/r = 33/8 mm, no. 4426.

b. "Luymes" Guyana Shelf Expedition, 1970: nine specimens from two different stations: Sta. 14: (7), R/r = 35/8, 34/8, 33/7, 27/6, 26/6, and 23/6 mm, no. 5207; Sta. 50: (2), R/r = 37/7 and 23/4 mm, no. 5208.

c. Two type specimens, labelled "Type" and "Cotypes", from the Museum of Comparative Zoology, Harvard University, Cambridge, Massachusetts, U.S.A.; No. 1080, collected by the "Blake", northwest of Cuba, at a depth of 101 fms; R/r = 39/7 and 29/6 mm.

d. One specimen from the United States National Museum, Smithsonian Institution, USNM Acc. No. 273551, E 12627, collected by the "Oregon", Sta. 3210, 29°50'N 87°08'W, 66 fms depth, February 1961; R/r = 31/6 mm (labelled *Verrillaster spinulosus* Downey, 1973).

Diagnosis. — Five rather long, slender, tapering arms, which at their bases are slightly constricted. Dorsal surface formed by openly reticulated, smooth plates, leaving larger, sunken papular areas, which contain two to five papulae. Dorsal and marginal spines small, forming about nine irregular longitudinal rows, which scattered spines in between. One or two compressed adambulacral spines deep in the furrow, usually two larger spines on the furrow margin and one or two (usually one) spines on the ventral surface of the adambulacral plates. Madreporite circular, with a crown of spinelets and a spineless central area with gyri.

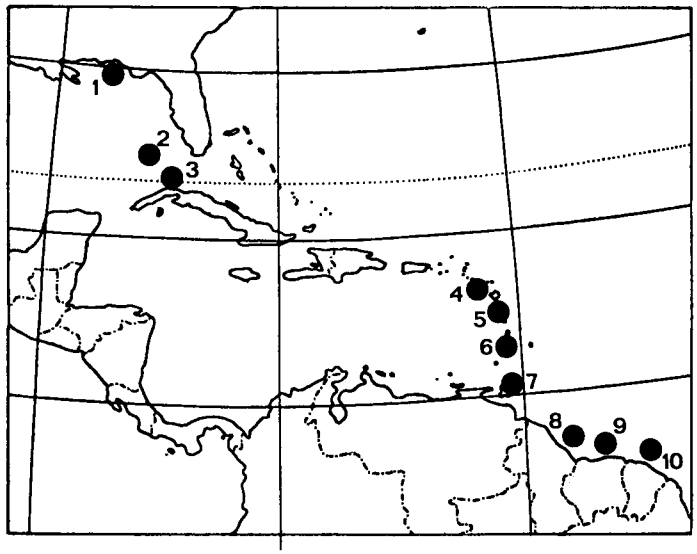

Fig. 27. Distribution of *Echinaster modestus* Perrier, 1881. Explanation of the numbers used: 1, Pensacola, Florida; 2, Off Southwest Florida; 3, Playa Baracoa, Havana Province, Cuba; 4, Montserrat; 5, Dominica; 6, St. Vincent; 7, Between Tobago and Trinidad; 8, Guyana; 9, Surinam; 10, French Guyana.

Description. — This elegant species has five arms, which are slightly constricted at their bases. Distal to the thickest part the arms taper to a slender tip, which, in the preserved specimens, is usually turned upward. The body is entirely covered by a rather thick, whitish skin. The disk is small and has steep sides. The R/r ratio ranges from 4 to 5.7.

The dorsal plates form an open network of irregular plates, of which the distal ones imbricate over the proximal ones. The plates are smooth, without a trace of granules or tubercles, but with one slight elevation, where the spine is attached. Most dorsal and lateral plates bear one, rather short,

bluntly pointed spine. Four to six plates surround an open area, which is up to twice as large as one of the plates. In these areas between the spines the skin shows several holes, which do not all show a papula. There are one to six, usually three or four papulae in each area. In the proximal parts of the arms the open areas form about eight, quite regular, longitudinal series; in the distal part of the rays there are only six or five of such series. There are series of spines on either side of the series of open areas. In the proximal part of the arms there are nine series of spines adjacent to the open areas. On the transverse separations of the open areas there are often one or two spines too; this last feature, however, is quite variable: in some specimens the transverse spines are virtually absent ,while in others there are usually one or two spines. The most exterior series of open areas are on either side of the arms bordered by the supero-marginal plates. Between the supero- and infero-marginal plates there is one series of intermediate plates running halfway the length of the ray. In the interradial corners there is a short second intermediate series between the marginal series, which consists of about four plates.

Between the infero-marginal and adambulacral plates there are three longitudinal series of ventro-lateral plates. The longest, interior series runs, very regularly, halfway the length of the ray; three or four plates more distally than the longest intermediate series between the supero- and infero-marginal plates. The second series of ventro-lateral plates is about half as long as the first and consists of similar, although slightly smaller plates. The exterior series is half as long as the middle series and consists of about eight, still smaller, but similar plates. The proximal ventro-lateral plates imbricate over the distal plates, whereas in the marginal and dorsal series the distal plates imbricate over the proximal ones. Except for the extreme distal plates, the ventro-lateral plates each bear a single spine, like the intermediate plates between the marginal series. The supero- and infero-marginal plates, at least in the proximal half of the ray, usually bear two spines. There are no open areas or papulae below the supero-marginal plates.

The terminal plates are rounded, small and inconspicuous.

The rather small adambulacral plates correspond with the adjacent ventro-lateral plates. Deep in the ambulacral furrow the plates bear a small and slender, ad- and aborally flattened spine. On the rim of the furrow stands a slightly thicker, less compressed spine, which is about twice as long. The stoutest adambulacral spine is situated slightly more distally and exteriorly. It is about 0.8 mm long and bluntly pointed. One or two short spines are placed in a transverse series on the ventral surface of the plates.

The oral plates have a very broad median groove, which is about as wide

as each half of the plate. On either side the plates bear, on the rim of the ambulacral furrow, four spines, which increase in size towards the mouth. Well within the ambulacral furrow, and completely hidden by the furrow spines, there are, on either side, four other, much smaller spines, situated under the three aboral spines of the rim. There are no spines under the two most adoral furrow spines. The ventral surface of the oral plates bears a single spine on each side of the groove; this spine is very similar to the spines on the adjacent ventro-lateral plates.

The anus is surrounded by a circlet of ten to fifteen spinelets.

The madreporite is circular and has a crown of about fifteen short, pointed, broadly-based spinelets. It has radiating gyri, which broaden towards the edge of the plate and become correspondingly shallower.

The colour in alcohol 70% is whitish.

Discussion. — The curators of the Museum of Comparative Zoology of Harvard University, Cambridge, Massachusetts, were kind enough to send me two type specimens of *Echinaster modestus*, with which my own specimens are doubtlessly identical. As I suggested earlier (Walenkamp, 1976: 81-82) Perrier overlooked the often lacking, small and compressed adambulacral spine, which stands deep in the furrow. The armature of the adambulacral plates of my specimens (cf. description above) is identical to that of the type specimens.

Miss Downey kindly sent me the material that she (Downey, 1973: 89-90) identified as *Verrillaster spinulosus* (Verrill, 1869). Comparison of these specimens with my own material of *Echinaster modestus* and with the type specimens of that species, convinced me that all belong to a single species. Downey (1973: 89) described the skin in her material as "relatively thin", while in my material, as well as in the types, it could be called rather thick. Here too a direct comparison shows the skin in all specimens to be quite similar.

Miss Downey's specimens, which she described as *Verrillaster spinulosus* differ quite considerably from Verrill's descriptions of *Echinaster spinulosus* (Verrill, 1869: 386; 1915: 40, pl. 4 figs. 1-2), and from six syntype specimens of *Echinaster spinulosus* from Egmont Key, Florida, sent to me through the courtesy of Dr. W. D. Hartman, Curator of the Peabody Museum of Natural History, Yale University, New Haven, Connecticut, U.S.A., R/r = 64/14, 51/13, 46/12, 41/9, 40/10 and 33/8 mm, YPM no. 1771. These differences are:

a. Verrill's *Echinaster spinulosus* has its dorsal and lateral plates granulated by small, glassy tubercles, which are absent in Downey's *Verrillaster spinulosus*.

b. The colour is purplish brown in Verrill's specimens and whitish in Downey's. In this respect it is interesting to note that H. L. Clark (1941: 55) mentions a single, large specimen of *Echinaster modestus* from waters off Playa Baracoa, Havana Province, Cuba, and reports that "Whatever its color may have been in life, it is now light yellowish-brown, "Museum color", quite unlike most West Indian Echinasters, which are commonly quite dark, even when dried".

c. Verrill mentioned three adambulacral spines per plate; Downey four to six.

d. Verrill reported 15 to 21 longitudinal series of spines dorsally to the infero-marginal plates of the rays; Downey found maximally eleven.

For these reasons too I am convinced that the specimens, which Miss Downey identified as *Verrillaster spinulosus*, are in fact specimens of *Echinaster modestus*.

Downey (1973: 87-88) gave a description of material, which she identified with *Echinaster modestus*, but which shows the following differences from the material of that species seen by me, viz. (a) the type specimens of *Echinaster modestus* lack, as do my specimens, any trace of granulation on the dorsal and marginal plates; Miss Downey describes the plates of her specimens with a round patch of glassy tubercles on the proximal surface. b, in the type specimens and in mine the proximal part of the ray shows, dorsally to the supero-marginal series, seven longitudinal series of plates; in Downey's description only three such series are mentioned, viz. one carinal, and one adradial series on either side. Miss Downey was kind enough to send me one of the specimens that she had identified as *Echinaster modestus* (R/r = 32/7 mm) and this specimen proved to be conspecific with the type specimens of *Echinaster spinulosus* from the Peabody Museum.

Downey (1973: 89-90) described six specimens of a species, which she, incorrectly ,identified as *Echinaster spinulosus* Verrill, 1869. For this species she proposed the new generic name *Verrillaster* with the following diagnostic characters: a single isolated spine on each dorsal plate; no patches of glassy tubercles on the plates; tegument relatively thin, lifted in tent-like peaks by the spines.

As the type species of the genus *Echinaster*, viz. *Echinaster sepositus*, also lacks glassy tubercles and considering the little importance of the other diagnostic characters, the new generic name *Verrillaster* seems not justifiable, as has already been recognised by Tortonese & Downey (1977), who did synonymise *Verrillaster* and *Echinaster*.

Tortonese & Downey (1977) briefly discussed the taxonomic importance of the presence of glassy tubercles on the principal plates and proposed for

those species having glassy tubercles the generic name *Othilia* Gray, 1840. The authors added: "The genus *Othilia* includes the species *serpentaria, echinophora, senta, modesta* and *brasiliensis*, all from the western Atlantic, and possibly others". The species *spinulosus*, which also possesses glassy tubercles, hence belongs to those "possible others".

Now *Echinaster* badly needs to be revised thoroughly, and because so little at present is known about the systematic value of characters like the presence of glassy tubercles, I should like to postpone any major action until such a revision is being made. Therefore I have assigned the species *modestus, brasiliensis* and *echinophorus* for the time being to the genus *Echinaster*.

Distribution. — Gulf of Mexico: Pensacola, Florida; Southwest Florida. Playa Baracoa, Havana Province, Cuba. Montserat. Dominica. St. Vincent. Between Tobago and Trinidad. Guyana. Surinam. French Guyana.

Bathymetrical range. — 67-468 m.

Echinaster echinophorus (Lamarck, 1816) (figs. 28-29; pl. 18 figs. 1-4)

Pentadactylosaster spinosus regularis Linck, 1733: 35, pl. 4 fig. 7.
Pentadactylosaster, spinosus regularis, Virginianus — Seba, 1761: 13, pl .7 fig. 4.
Asterias spinosa (pars) Retzius, 1805: 18.
Non *Asterias spinosa* Pennant, 1777: 129.
Asterias echinophora Lamarck, 1816: 560. — Perrier, 1875a: 1272.
Non *Asterias echinophora* — Delle Chiaje, 1825: 356, pl. 18 fig. 5.
Non *Asterias spinosus* — Say, 1825: 142-143.
Stellonia spinosa — Nardo, 1834: 716.
Othilia spinosa — Gray, 1840: 282; 1866: 12.
Non *Othilia aculeata* — Gray, 1840: 282.
Echinaster spinosus (pars) Müller & Troschel, 1842: 22.
Echinaster spinosus — Lütken, 1859: 90-91. — Dujardin & Hupé, 1862: 342. — Perrier, 1869: 57. — Sladen, 1889: 553, 554-555, 656, 698, 810, 811. — Ives, 1891: 339. — H. L. Clark, 1898: 6.
Echinaster (Othilia) crassispina Verrill, 1868: 368, pl. 4 fig. 7 .
Echinaster crassispinus — Lütken, 1871: 283. — Ives, 1890: 326.
Echinaster echinophorus — Perrier, 1875b: 364-366; 1878: 14. — — Rathbun, 1879: 147. — Ives, 1889: 171. — Verrill, 1915: 42-43. H. L. Clark, 1933: 29-30. — Bernasconi, 1958: 15-17, pl. 1 figs. 1-2. — Kempf, 1966: 505-507, figs. 1-9. — Tommasi, 1970: 16, figs. 41-43. — Downey, 1973: 86-87, pl. 39 figs. C, D. — Ferguson, 1974: 57-60, fig. 1.

Material examined: a. "Luymes" Guyana Shelf Expedition, 1970, station 96, off Guyana: (1), R/r = 27/5 mm, no. 5215.

b. Muséum National d'Histoire Naturelle, Paris. Four dried syntypes of *Echinaster echinophorus* from North America, no. 122a; R/r = 45/10, 43/9, 41/10 and 39/10 mm. One specimen of *Echinaster echinophorus* in alcohol from Central America (leg. Morelet, 1849); R/r = 52/14 mm. Three specimens of *Echinaster echinophorus* in alcohol from Bahia (leg. Serre); R = 51/9, 43/9 and 31/7 mm. Four specimens, labelled *Echinaster sentus*, from "St. Jamaique", U.S. Fish Commission, Steamer Albatross; R/r = 52/9,

43/8, 30/6 and 28/6 mm. One specimen, labelled *Echinaster sentus*, from Gibara (Cuba), leg. Chaper, 1883; R/r = 54/11 mm. Cf. Discussion.

c. Peabody Museum of Natural History, Yale University, New Haven, Connecticut: Verrill's holotype of *Echinaster crassispina*, YPM No. 1527, R/r = 49/12 mm, from Abrolhos Reefs, Brazil. One specimen form "Parahyba do Norte" (below Natal), Brazil, YPM No. 9591, labelled "Echinaster crassispina?", R/r = 46/11 mm. Two specimens from "Parahyba do Norte", Brazil, YPM No. 5210, labelled "Echinaster crassispina" and, later, "spinosus", R/r = 45/9 and 37/9 mm. One specimen from Periperi, Bahia, Brazil, YPM No. 9604, labelled "Echinaster sp.", R/r = 55/14 mm.

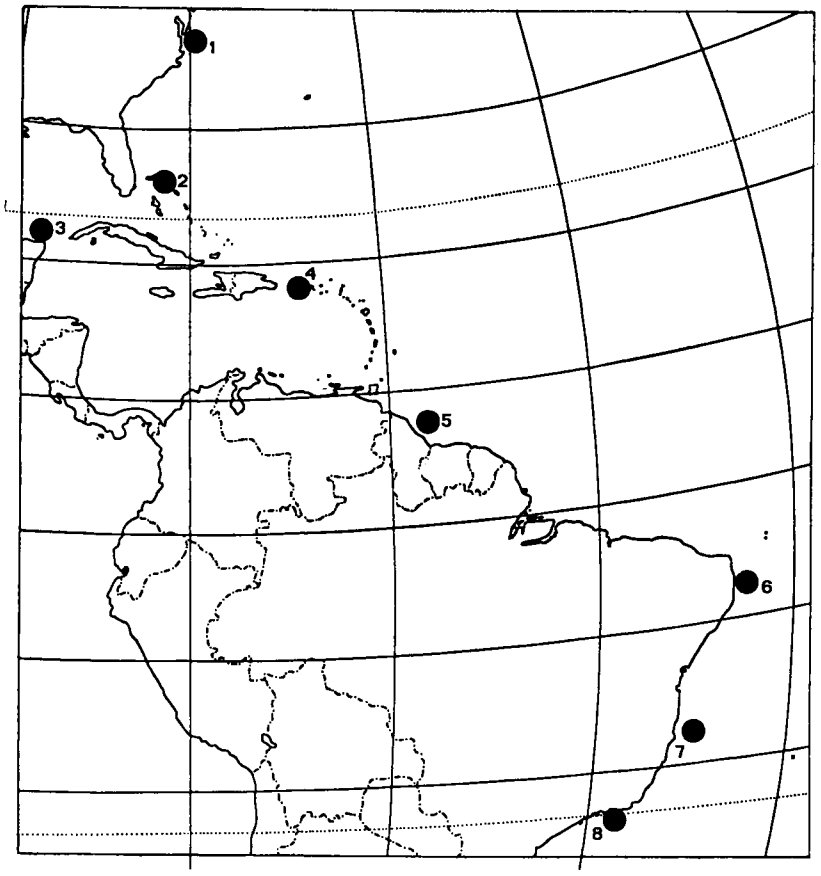

Fig. 28. Distribution of *Echinaster echinophorus* (Lamarck, 1816). Explanation of the numbers used: 1, Virginia; 2, Bahamas; 3, Yucatan; 4, Puerto Rico; 5, Guyana; 6, Paraiba, Recife (Pernambuco), Periperi (Bahia); 7, Abrolhos Reefs; 8, Rio de Janeiro.

Diagnosis. — Five short, rounded, bluntly tipped arms. Dorsal and marginal plates with fine, glassy granulation. Many dorsal and marginal plates with a smooth and highly swollen area of variable extend, which bears a

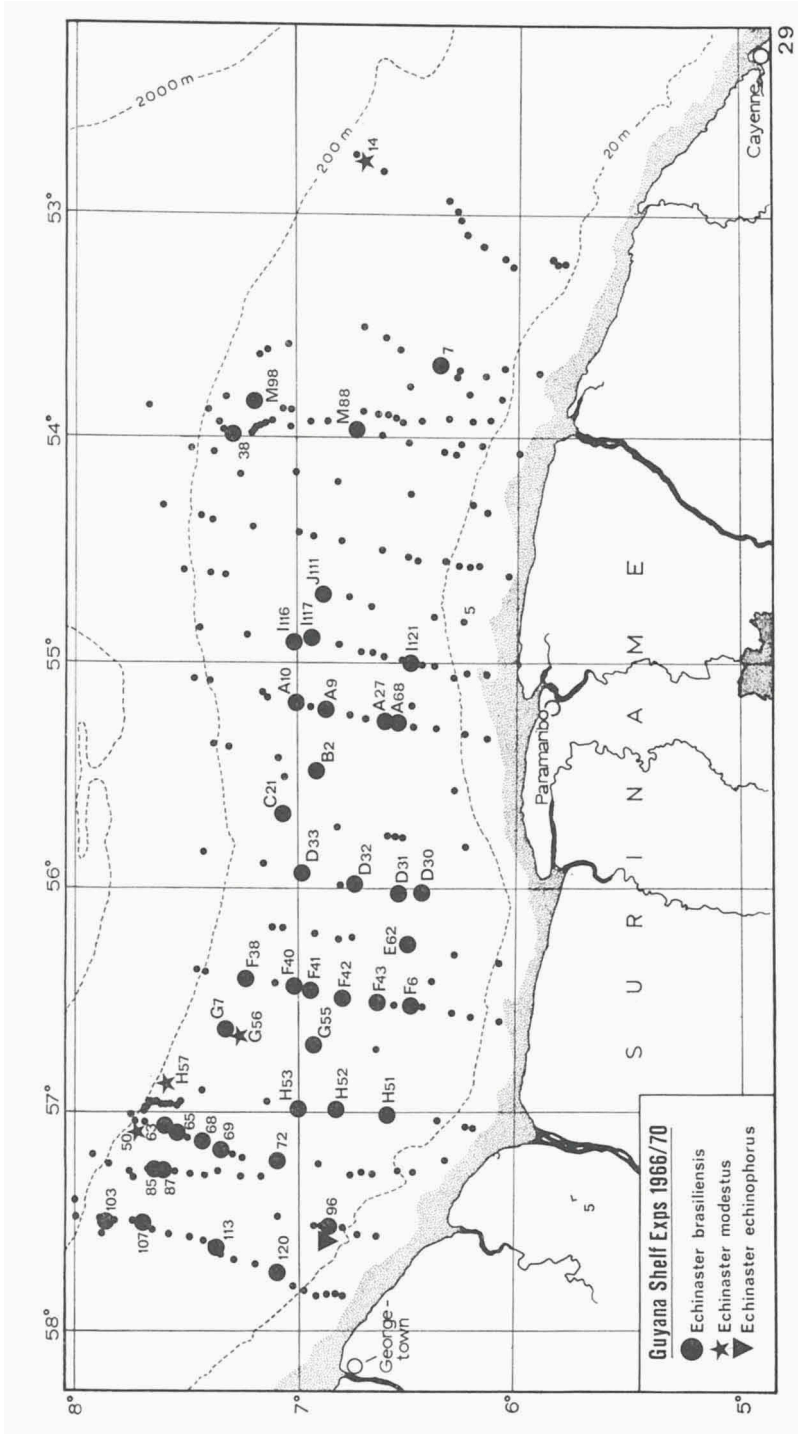

Fig. 29. Records of *Echinaster brasiliensis*, *Echinaster modestus* and *Echinaster echinophorus* in Guyana waters; cf. stationlist and Walenkamp, 1976.

single, long, stout, sharply pointed spine. Dorsal and marginal spines in six to nine longitudinal series of not more than fifteen spines. Adambulacral plates with one or two, slender, compressed spines deep in the adambulacral furrow, and one or two stouter spines on the margin. Oral plates with three rod-shaped spines on either side and, occasionally, about two much smaller spines, deep in the furrow.

Description. — The Guyana specimen has five stout rays of varying length: R = 27, 27, 26, 24 and 18 mm. The R/r = ratio is 27/5 = 5.4. The blunt arm tips are turned upwards and show many small, crowded plates. Dorsal to the adambulacral plates there are seven longitudinal series of plates. Except for the small adambulacral and oral plates and the few intermediate secundary plates, all plates are covered, wholly or partly, by fine, glassy granules. Many plates bear a relatively large spine on a smooth, highly swollen part of the plate, which may comprise less than half to almost the whole surface of the plate.

The carinal plates are spineless, except for the first and a few plates in the distal part of the arm. Often zigzagging the carinal is the most irregular of all series. Like those of the other series the plates are small and densely crowded in the distal part of the arm. Some of the plates of the adradial series bear a spine; such spine-bearing plates are separated by one to five plates without spines, the arrangement being rather irregular. The supero-marginal series have a spine on every second plate; the spines, as well as the mamillary elevations on which they articulate, are the largest of all series. The spines are over one mm long. In the arm corners there are a few small and smooth secundary plates between the adradial and supero-marginal series and between the supero- and infero-marginal series. The infero-marginal plates are not or scarcely swollen and have, at least in the proximal half of the ray, on almost each plate a single spine. The spines, however, are less than half the length of the supero-marginal spines. There are no ventro-lateral plates. Dorsal to the infero-marginal plates papulae are present between all series in irregular, sunken areas containing up to fifteen papulae. In two rays (B and E) there is, between the first and second carinal plate, a very large and deep area. A similar feature, but in all rays, is to be seen in a photograph of a representative of this species in Downey (1973: pl. 40, fig. A). Between the five first carinal plates and the five smaller, more sunken interradial plates ,there is a roughly circular area with a tumid central plate, bearing a spine, connected with the surrounding plates by several small, smooth plates. The anus lies between the central plate and the interradial plate in interradius DE, and is surrounded by a few small granules. Four of the five first carinal plates bear two, proximal, spines. Between the infero-marginal

and adambulacral plates there are light brown dermal bodies, but no papulae.

The short adambulacral plates have two small, slender, compressed spines deep in the ambulacral furrow, one above the other. On the rim of the plates stands the largest spine, which, however, is still distinctly smaller than the infero-marginal spines. Exterior to this spine, often somewhat more aborally, stands a fourth, slightly smaller spine. The ventral surface of the plates is largely bare.

The oral plates are rather small with a fairly broad median groove and a bare ventral surface. There are three (in one interradius four) rod-shaped spines on either side, including the two oral furrow spines. Under the second and third spine there are, well hidden, two very small, but fairly thick spinelets.

The granulated, but spineless terminal plates are wider than long, rounded and hardly noticeable between the crowded distal dorsal and marginal plates.

The madreporite is slightly larger than the corresponding other interradial plates, but smaller than the first carinal plates. It has rather coarse radiating gyri and a crown of small, thick, blunt spinelets.

Discussion. — Retzius (1805: 18) described the species briefly under the name *Asterias spinosa,* which specific name, however, is not available, as Pennant (1777: 129) had used it to describe another species of the genus *Asterias*, viz. *Marthasterias* (then *Asterias*) *glacialis*. Retzius' short diagnosis makes it difficult to determine with certainty which species he did in fact have before him.

Lamarck (1816: 560) correctly named the species *Asterias echinophora.*

Delle Chiaje (1825: 356) described and figured a specimen of *Marthasterias glacialis* as *Asterias echinophora.*

Say (1825: 142) used the name *Asterias spinosus* (Linck, 1733), stating, that the name was changed by Lamarck to *echinophora,* but that "... there can be no doubt respecting priority in this case." As, however, Linck's description is of 1733, well before 1758, the priority rule does not apply here. Verrill (1866: 348) states furthermore, that Say identified his *Asterias spinosa* (Say himself wrote *spinosus*) entirely erroneously with the species *spinosus* of Linck, and in 1915 Verrill wrote: "The *Asterias spinosa* of Say (1825) was primarily the common *Asterias forbesi* of our coast, but also included *A. vulgaris,* for he has specimens from the coast of Maine". Lütken (1859: 91) also had his objections against Say's identification, mainly because his specimens did not agree with Linck's illustrations.

Nardo (1834: 716) and Gray (1840: 281) proposed new generic names, viz. *Stellonia* and *Othilia,* respectively; both authors maintained the specific name *spinosa.*

Gray (1840: 282) also described the related species *Othilia aculeata* (see below).

Müller & Troschel (1840: 102) erected the genus *Echinaster*, and in 1842 they gave a description and a synonymy of a species *Echinaster spinosus*, using Linck's *Pentadactylosaster spinosus regularis*, as their source, without referring to either Retzius or Pennant, although both authors are mentioned in their list of references. Müller & Troschel (1842) had investigated Lamarck's specimens, on which he had based his description of *Asterias echinophora*, but apparently they too considered the pre-Linnaean name a valid senior synonym. Müller & Troschel (1842) also included Gray's *Othilia aculeata* in their synonymy. Perrier (1875b: 365) however, considers *Othilia aculeata* a junior synonym of *Echinaster sentus* (Say, 1825) and states it to be clearly distinct from *Echinaster echinophorus*. Verrill (1915: 39) confirms: "Most of the earlier writers, including Lamarck, Müller & Troschel, and many others combined this (*Echinaster sentus*, J.W.) with *E. echinophora* (sic), under the specific name "spinosus" .....".

Verrill (1866: 348) and Perrier (1875b: 365) have opposite views as regards Linck's *Pentadactylosaster spinosus regularis*. Verrill synonymizes the species with *Echinaster sentus* (Say, 1825), and Perrier with Lamarck's *echinophora*. After comparison of Linck's illustrations with specimens of *Echinaster crassispina* (= *Echinaster echinophorus*) from the Peabody Museum, I am inclined to take Perrier's side in this matter, but see below.

In 1868 Verrill described and depicted the new species *Echinaster* (*Othilia*) *crassispina*. Perrier (1875b: 365) considered *crassispinus* a junior synonym of *echinophorus*, in which he is followed by most later authors, including Verrill himself.

Ives (1890: 325-326) compared two specimens of *Echinaster sentus* with "...examples of *Echinaster spinosus* from New Providence, Bahamas", and was "... unable to find any well marked characters separating them from the latter species". Later authors probably were able to distinguish between the two species, as the subject of synonymy has not been brought up again. Dr. Guille of the Muséum National d'Histoire Naturelle de Paris kindly sent me four dried syntypes of *Echinaster echinophorus* and five specimens in alcohol, labelled *Echinaster echinophorus*. He also sent me five specimens in alcohol, labelled *Echinaster sentus* (cf. Material examined). Having investigated all this material, I could not find any differences between the various specimens, important enough to distinguish different species. The number of spines in a series from the centre of the disk to the tip of the arm, which Perrier calls the main feature to separate the species, is most variable.

Unfortunately the type specimen of *Echinaster sentus* Say, 1825, is lost. Dr. Robertson of the Academy of Natural Sciences of Philadelphia could not find it in his collection, although Ives, 1889, mentions two type specimens from Key West, Florida, in his catalogue of the Asteroidea and Ophiuroidea in the collection of the Academy of Natural Sciences of Philadelphia. In his survey of *Echinaster echinophorus*, Perrier (1875b: 364-365) wrote that he compared foresaid species with *Echinaster sentus*, which had been sent to him by Agassiz under the name *Othilia spinosa* Gray. No specimens with that label, however, could be found in Paris. As all specimens I investigated appear to belong to the same species, I have labelled all *Echinaster echinophorus*. Although I have strong doubts about the status of *Echinaster sentus*, I think it best to defer a decision until a general revision of the genus can be made.

Distribution. — Virginia. Bahamas. Antilles (Puerto Rico). Yucatan. Guyana. Brazil: Paraiba, Recife (Pernambuco), Bahia, Abrolhos Reefs, Rio de Janeiro.

Bathymetrical range. — 1-36 m depth.

Henricia antillarum (Perrier, 1881) (figs. 20, 30; pl. 19 figs. 2-4)

Cribrella antillarum Perrier, 1881: 8; 1884: 207, pl. 3 fig. 6. — A. H. Clark, 1954: 376. — Studer, 1883: 129; 1884: 25. — Sladen, 1889: 540, 541, 806.
Henricia antillarum — Verrill, 1914: 210; 1915: 46. — H. L. Clark, 1941: 56. — Downey, 1973: 84-85, pl. 38 figs. A, B.
Henricia microspina Verrill, 1915: 48. — H. L. Clark, 1941: 57. — A. H. Clark, 1954: 376.

Material examined: One specimen from station 80. R/r = 122/13 mm, no. 5188.

Diagnosis. — Five very long and slender, attenuate arms. Plates of disk and arms with several small and slender spinelets. Papular pores large and single.

Description. — The body has a rather small disk with five very long, attenuate arms, which in this preserved specimen are strongly curved up- and inwards. R/r ratio is 122/13 = 9.4. The dorsal and lateral plates are small and numerous. They are imbricatingly connected and usually bi- or trilobed. Except for a few small, roundish secondary plates, all plates show a dorsal elevation, which bears several, often about six, but occasionally many more, slender, pointed spinelets. On the sides of the arms the plates are stronger.

The marginal plates are even stronger and more rounded quadrangular. Proximally the infero-marginal plates are larger than the supero-marginal plates. In general the supero-marginal plates imbricate over the infero-marginal plates; the proximal marginal plates imbricate over the distal ones.

The single large papular pores, which are very numerous on the dorsal side, are much scarcer between the two marginal series and are lacking between the infero-marginal and adambulacral plates. Large marginal plates may bear over fifteen spinelets. The spinelets on the plates are on the ventral surface of the body distinctly stouter than dorsally.

The ventro-lateral area is inconspicuous and very similar in appearance to the surrounding plates. Contrary to the dorsal interradial area the ventro-lateral area does have large, single papular pores. The dorsal and ventral plates and spines are all covered by a tough skin.

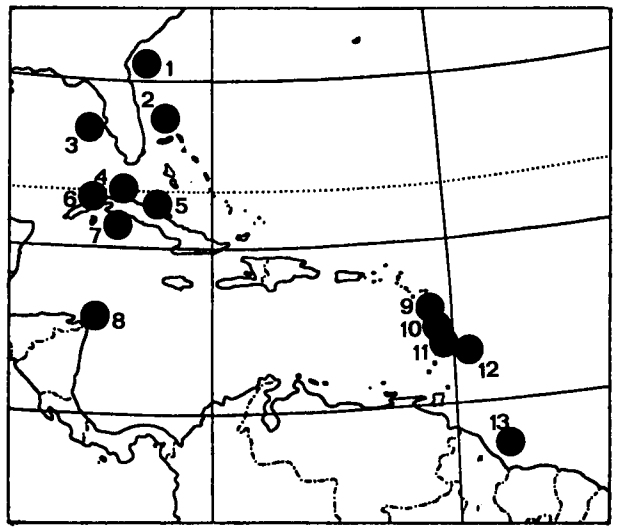

Fig. 30. Distribution of *Henrica antillarum* (Perrier, 1881). Explanation of the numbers used: 1, Georgia; 2, North of Bahamas; 3, Gulf of Mexico; 4, 5, Northern coast of Cuba; 6, Playa Baracao, Havana Province, Cuba; 7, Bahia de Cochinos, Cuba; 8, Off Honduras; 9, Guadeloupe; 10, Martinique; 11, St. Lucia; 12, Barbados; 13, Guyana.

The adambulacral plates are slightly longer than the infero-marginal plates and separated from each other by a broad, deep groove, which centrally is slightly wider than half the length of the adambulacral plates. The groove is covered by a thick skin and contains many tissue fibers connecting the subsequent ossicles. The adambulacral plates protrude sharply into the ambulacral groove. Deep in the groove there are two compressed spines, one above the other. The furrow margin of the plates has two or three spines; if there are three spines the medium one usually stands slightly more

interior. Exterior to this last series there are a few shorter spines. The ventral surface of the plates bears about fifteen blunt spinelets, which exteriorly closely resemble those of the ventro-lateral and marginal plates. The configuration of the adambulacral spines is, however, by no means rigid: many exceptions occur, even in this single specimen.

The oral plates have a deep median groove, similar to the grooves between the adambulacral plates, but narrower. In the mouth the plates have two large spines, which are often flanked by one or two much smaller spines. The mouth spines on the furrow sides of the plates are followed by about seven spines, which shorten distally. The ventral surface of the plates, inside this large V of spines, is set with strong, rod-shaped spines, which decrease in size towards the aboral part of the plates.

The anus is centrally visible as a hole between the apical plates.

The madeporite is over 2.5 mm in diameter. It has deep and broad, usually straight grooves, with scattered pores and it bears short spinelets. The interradial area comprising the madreporite is slightly tumid.

Remarks. — Downey (1973: 84) believes *Henricia microspina* Verrill, 1915, to be synonymous with *Henricia antillarum*, as she could find no specific differences between the types of both species. Although H. L. Clark (1941) does distinguish between the two species, he admitted that the line separating them is by no means sharply drawn.

Distribution. — Georgia ("Albatross" station 2671). East and West Florida. Gulf of Mexico. Cuba. Honduras. Guadeloupe. Martinique. St. Lucia. Barbados. Guyana.

Bathymetrical range. — 315-712 m depth.

Doraster constellatus Downey, 1970 (figs. 20, 31; pl. 20 figs. 1-2)

Doraster constellatus Downey, 1970: 5-12, figs. 2c, 3-11; 1973: 95-97, pl. 46 figs. A, B.
Doraster cancellatus (error for *Doraster constellatus*) — Jangoux, 1978: 98.

Material examined: One specimen from station 34; R/r = 137/14 mm, no. 5197.

Remarks. — Downey (1970) described this species and separated it on generic level from the other known Zoroasteridae, proposing the genus *Doraster* (Downey, 1970: 5). Downey gave a very thorough description of the species, so I shall limit myself here to extend her table of measurements with data from my single specimen.

In the same publication, Downey (1970: 1-5) separated the families Zoroasteridae (recent) and Calliasteridae (fossil) from the other Forcipulatida (the family Brisingidae had already been removed to become the order Euclasteroidea, now Euclasterida, by Tortonese, 1958: 1-3). For the two

removed families Downey proposed the new order Zorocallida. McKnight (1977) however, raises objections against Miss Downey's classification and returns the Zoroasteridae to the Forcipulatida in the suborder Zorocallina, with the following diagnosis: "Only straight pedicellariae present, superambulacral plates present, ambulacral and adambulacral plates compressed,

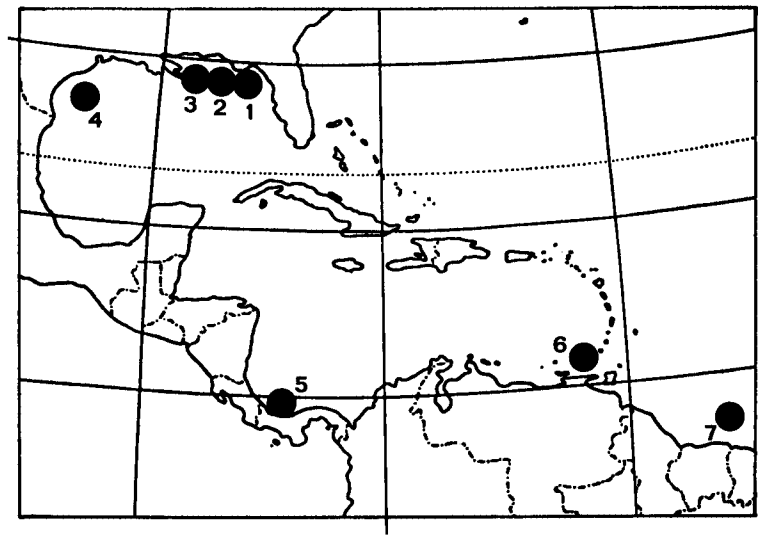

Fig. 31. Distribution of *Doraster constellatus* Downey, 1970. Explanation of the numbers used: 1, Apalachee Bay, Florida; 2, Off Pensacola, Florida; 3, Delta of the Mississippi; 4, Off Corpus Christi, Texas; 5, Golfo de los Mosquitos, Panama; 6, Off Los Testigos, Venezuela; 7, Off eastern Surinam.

adambulacrals alternately advanced into furrow." As long as there are such strong doubts about the status of the Zoroasteridae, I hesitate to adopt a new order and for the time being rather hold on to the conventional Forcipulatida.

Measurements. — R/r = 137/14 mm; R/r ratio: 9.8. Height of disk: 11 mm. Height of arm at third carinal plate: 9 mm. Number of longitudinal, interradial series of ventro-lateral plates: 3. Number of carinal plates: 97.

Distribution. — Gulf of Mexico. Golfo de los Mosquitos, Panama. Off los Testigos, Venezuela. Eastern Surinam.

Bathymetrical range. — 340-630 m depth.

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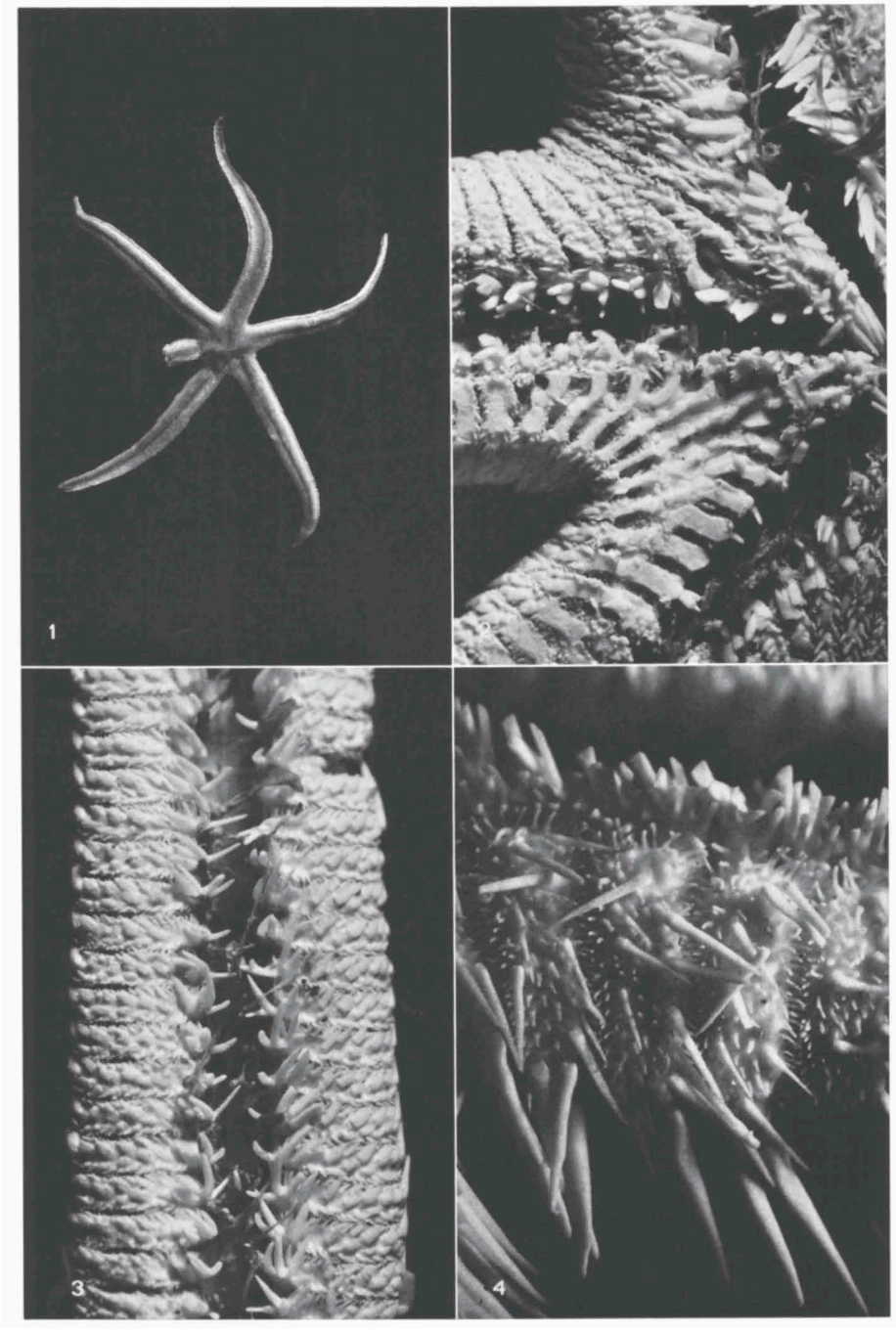
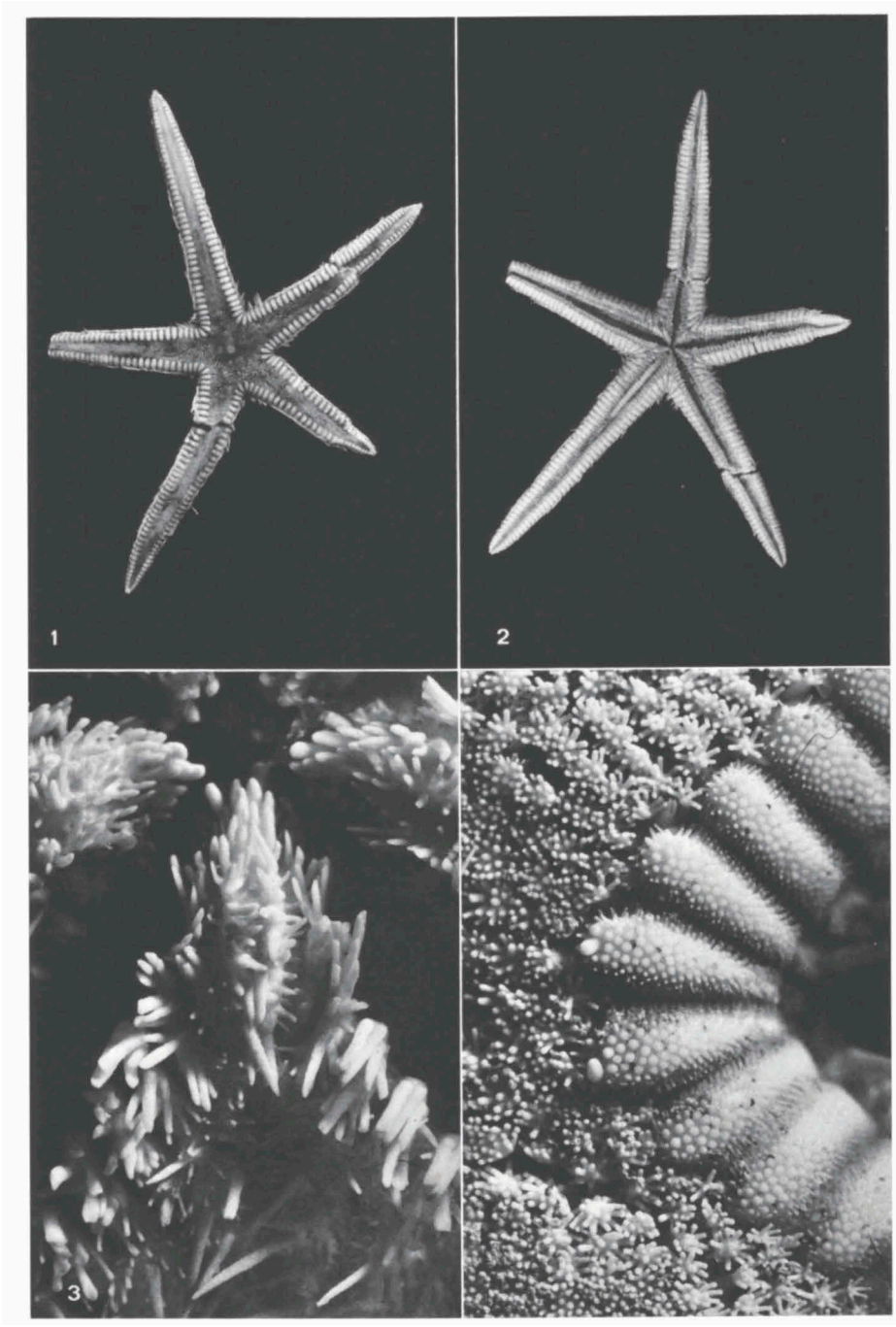
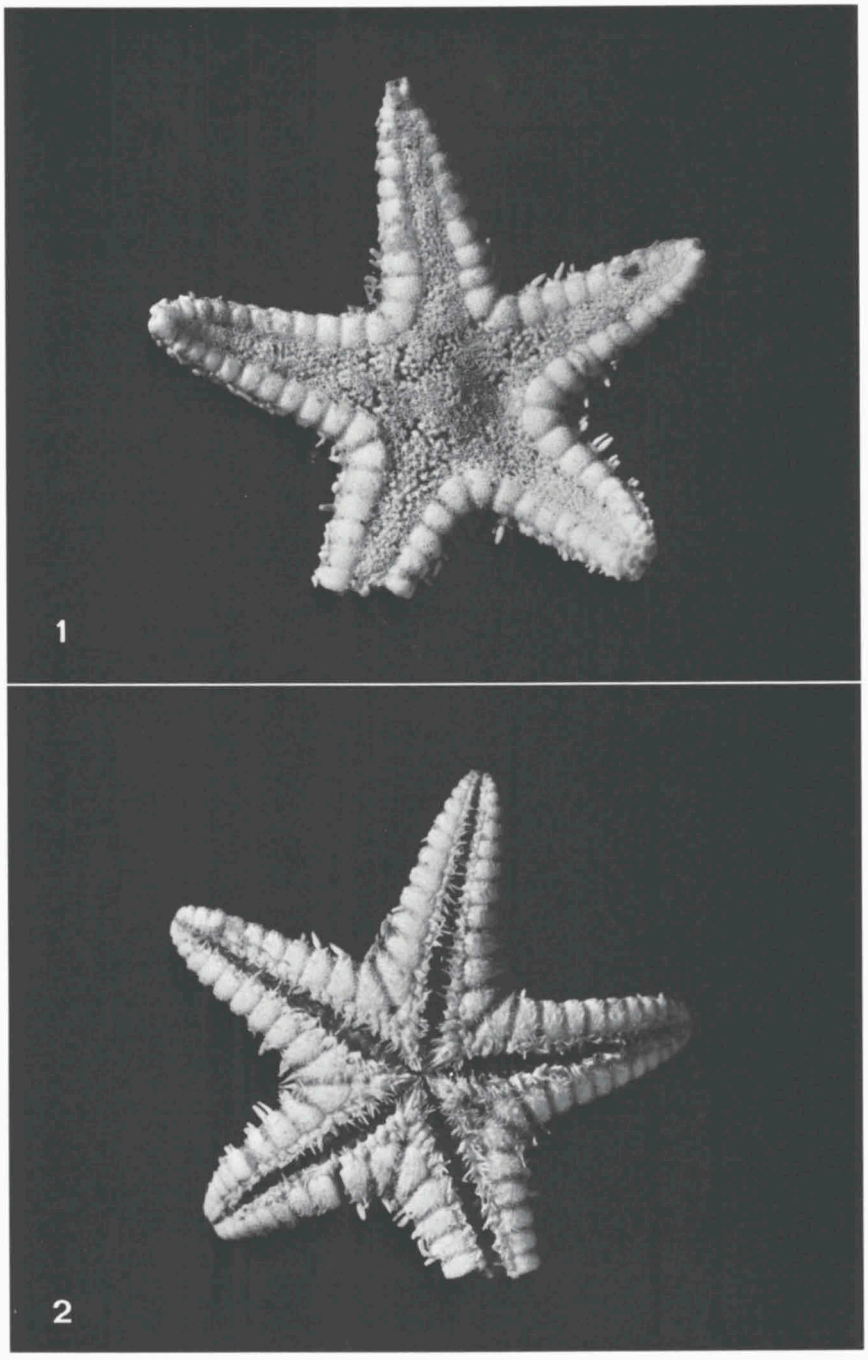


Figs. 1-3. *Luidia senegalensis*, a rare six-rayed specimen; Sta. 113, R/r = 83/11 mm. 1, habitus dorsally; 2, two ventro-lateral areas, one of which is mostly denuded; 3, middle part of an arm, ventrally. Fig. 4. *Astropecten comptus*; Sta. 3, R/r = 84/12 mm, detail of some infero-marginal and adambulacral plates.



Figs. 1-4. *Astropecten comptus*; Sta. 3, R/r = 84/12 mm. 1, habitus dorsally; 2, habitus ventrally; 3, oral area; 4, first supero-marginal plates, dorsally.



Figs. 1-2, *Astropecten nitidus*; Sta. 13, R/r = 12/4 mm. 1, habitus dorsally; 2, habitus ventrally.

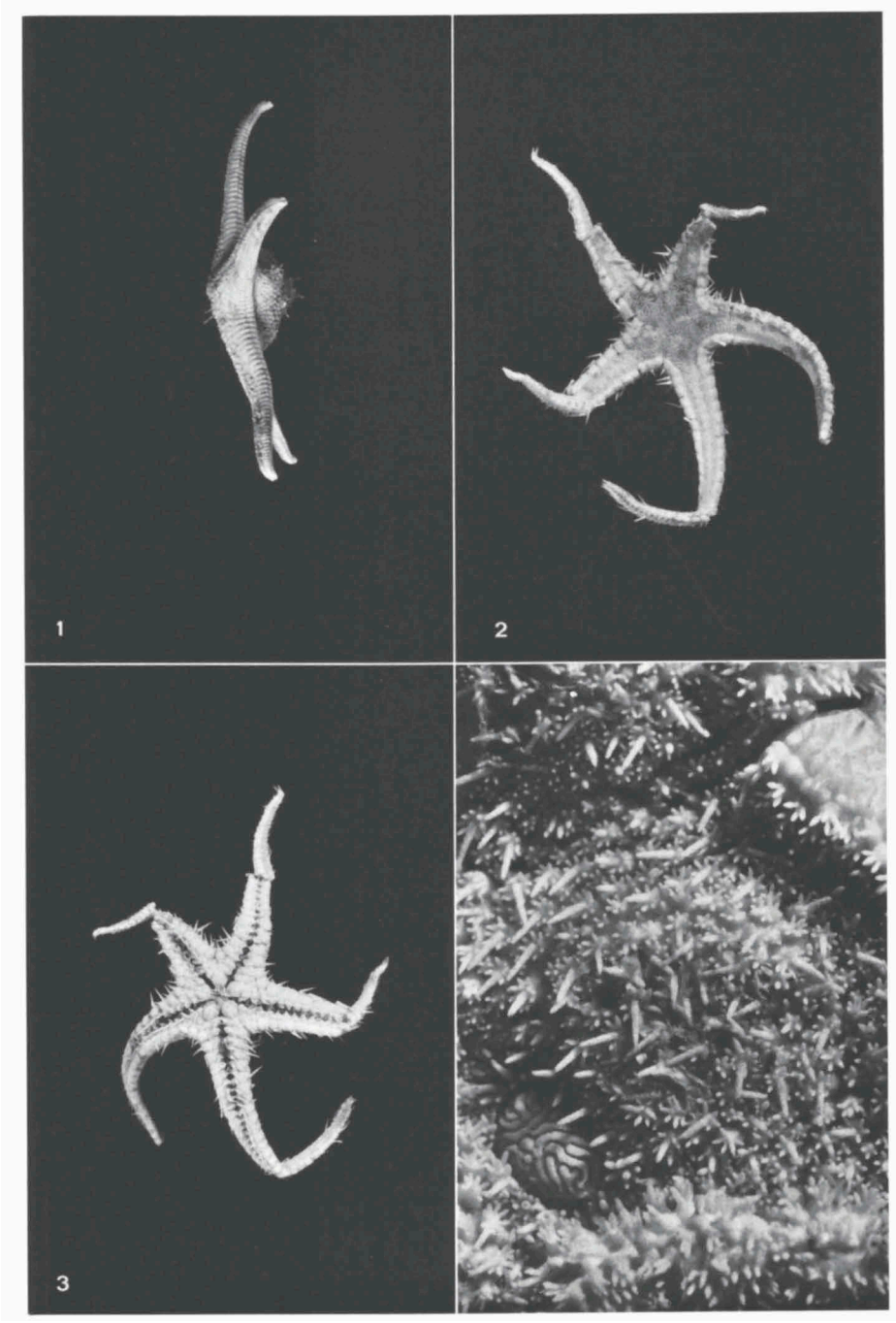
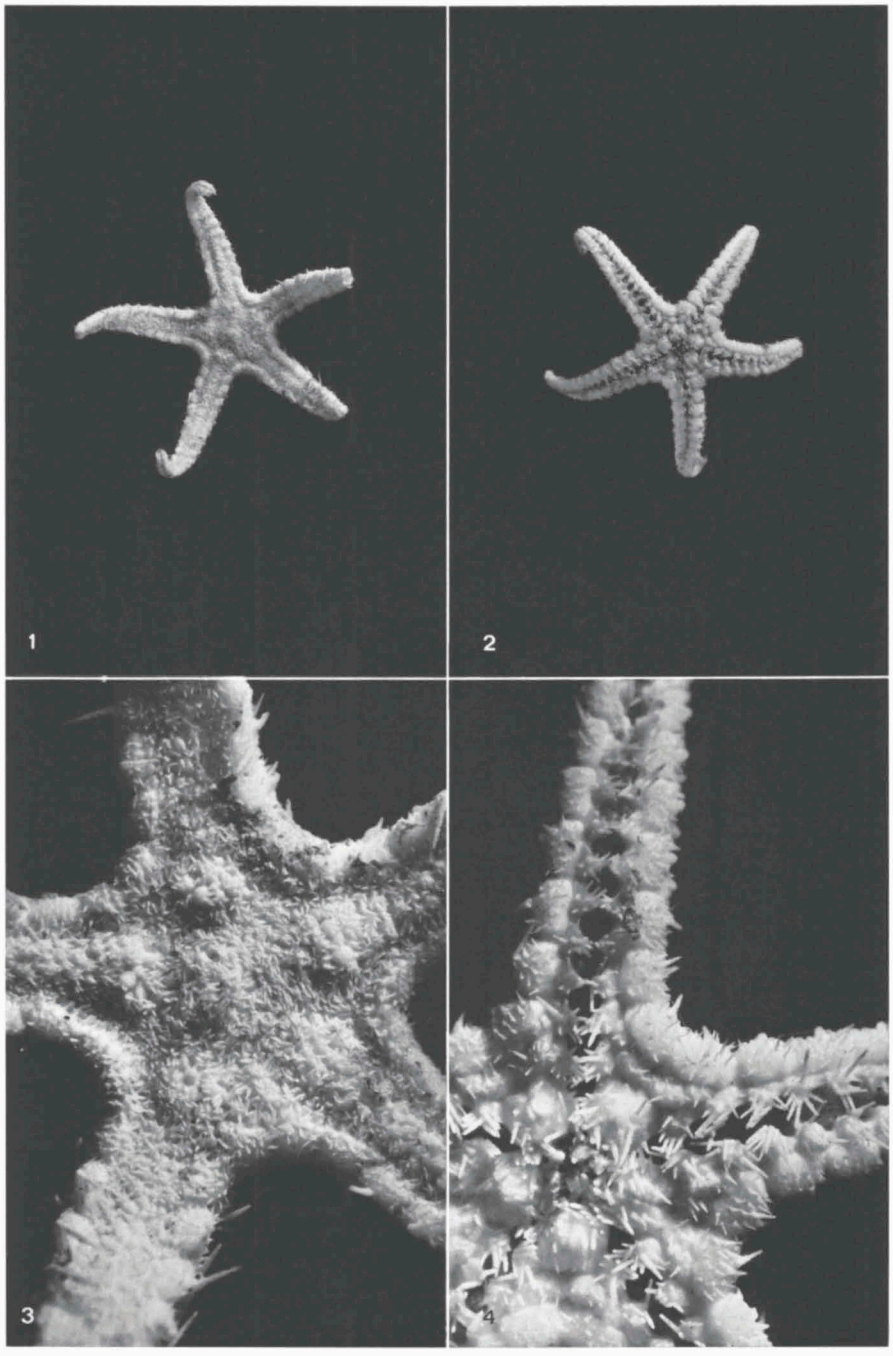
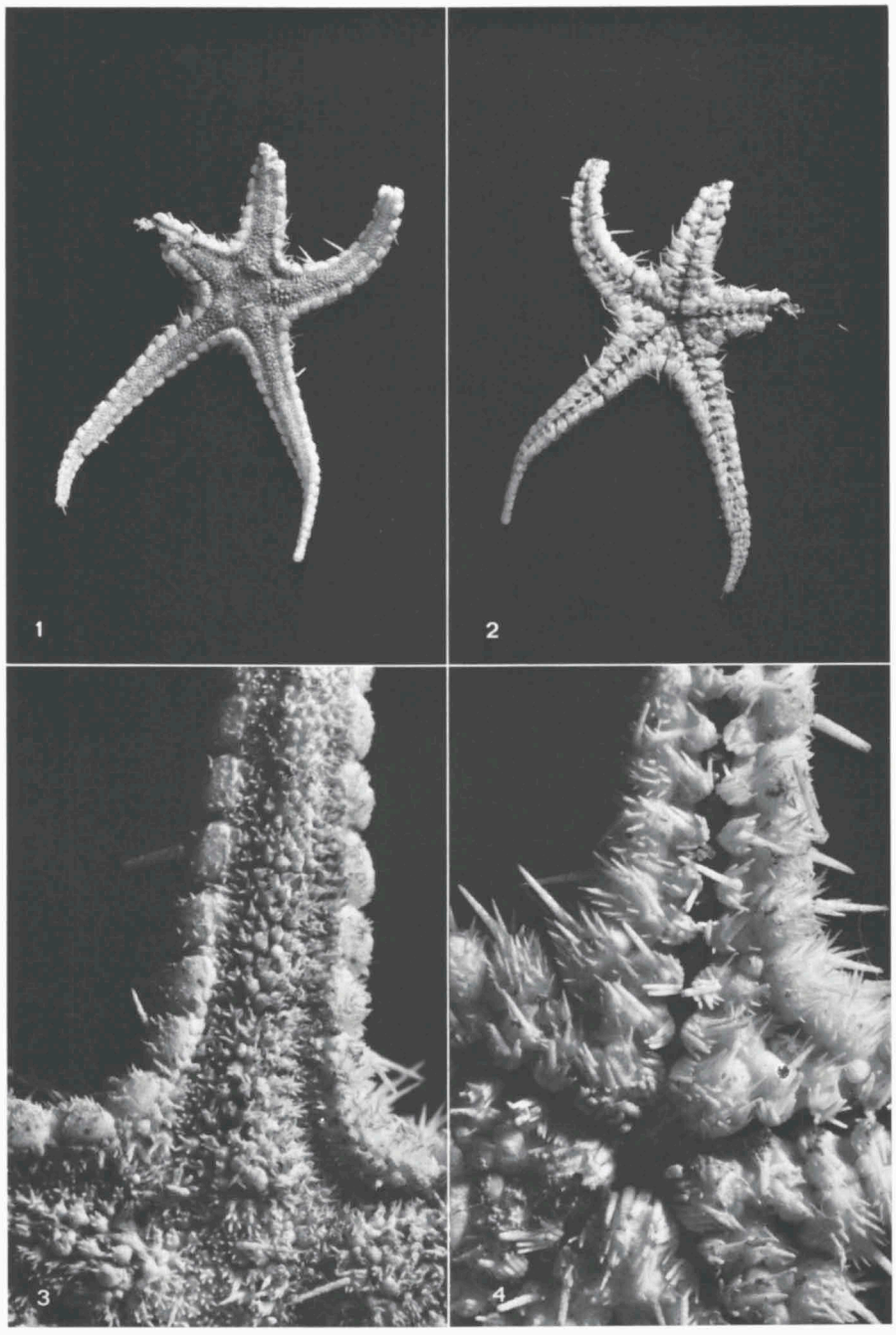


Fig. 1. *Tethyaster vestitus*; Sta. 63, R/r = 39/11 mm; containing an intact specimen of the sea-urchin *Eucidaris tribuloides*; habitus laterally. Figs. 2-4. *Cheiraster mirabilis*; Sta. 48, R/r = 53/8 mm. 2, habitus dorsally; 3, habitus ventrally; 4, detail of an arm basis and the madreporite.



Figs. 1-4. *Pectinaster gracilis*; Sta. 100, R/r = 15/3 mm. 1, habitus dorsally; 2, habitus ventrally; 3, detail of the disk dorsally; 4, detail of the disk ventrally.



Figs. 1-4. *Pectinaster gracilis*; Sta. 100, R/r = 15/3 mm. 1, habitus dorsally; 2, habitus ventrally; 3, detail of an arm basis and the disk, dorsally; 4, detail of an arm basis and the disk, ventrally.

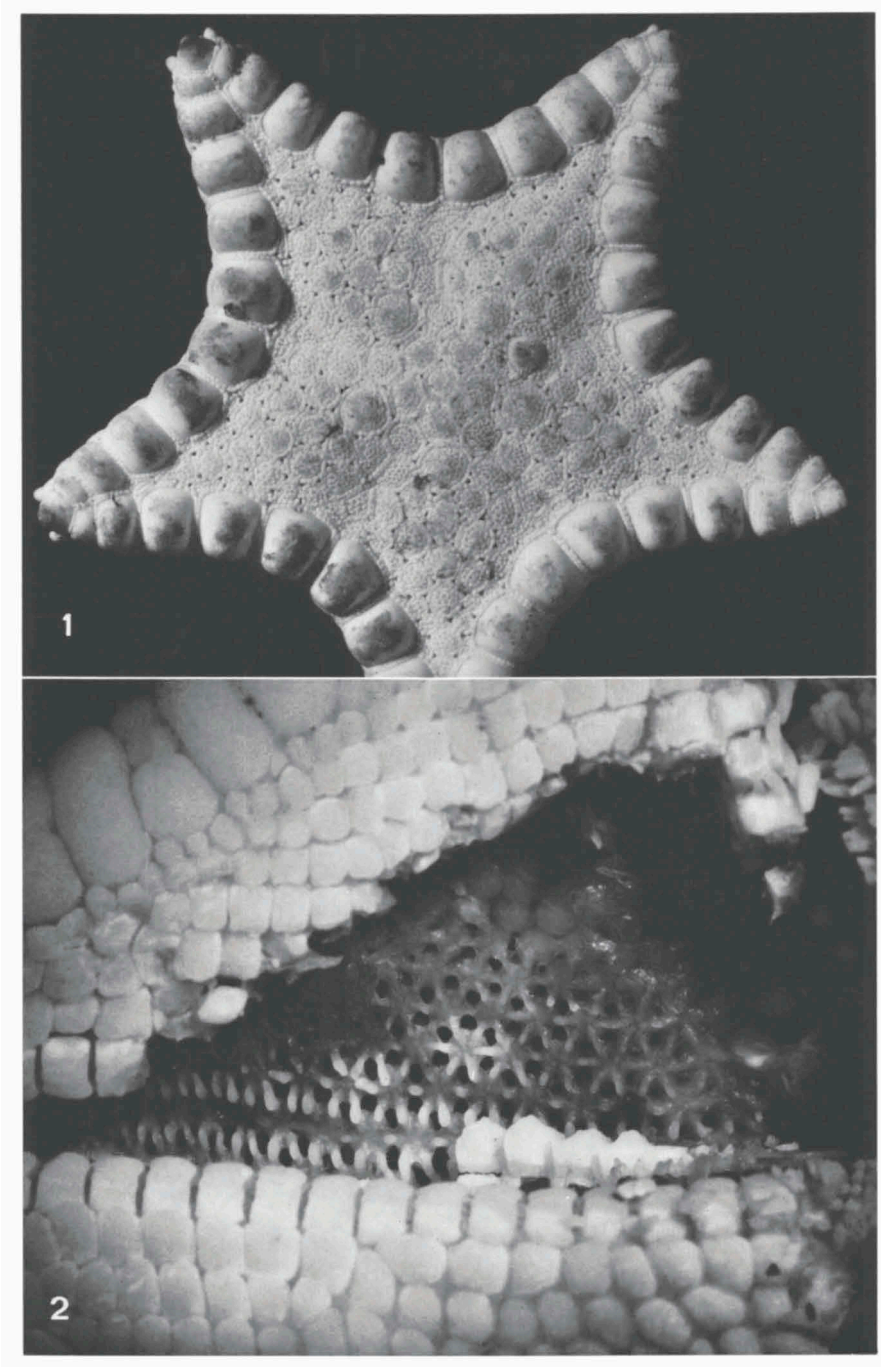
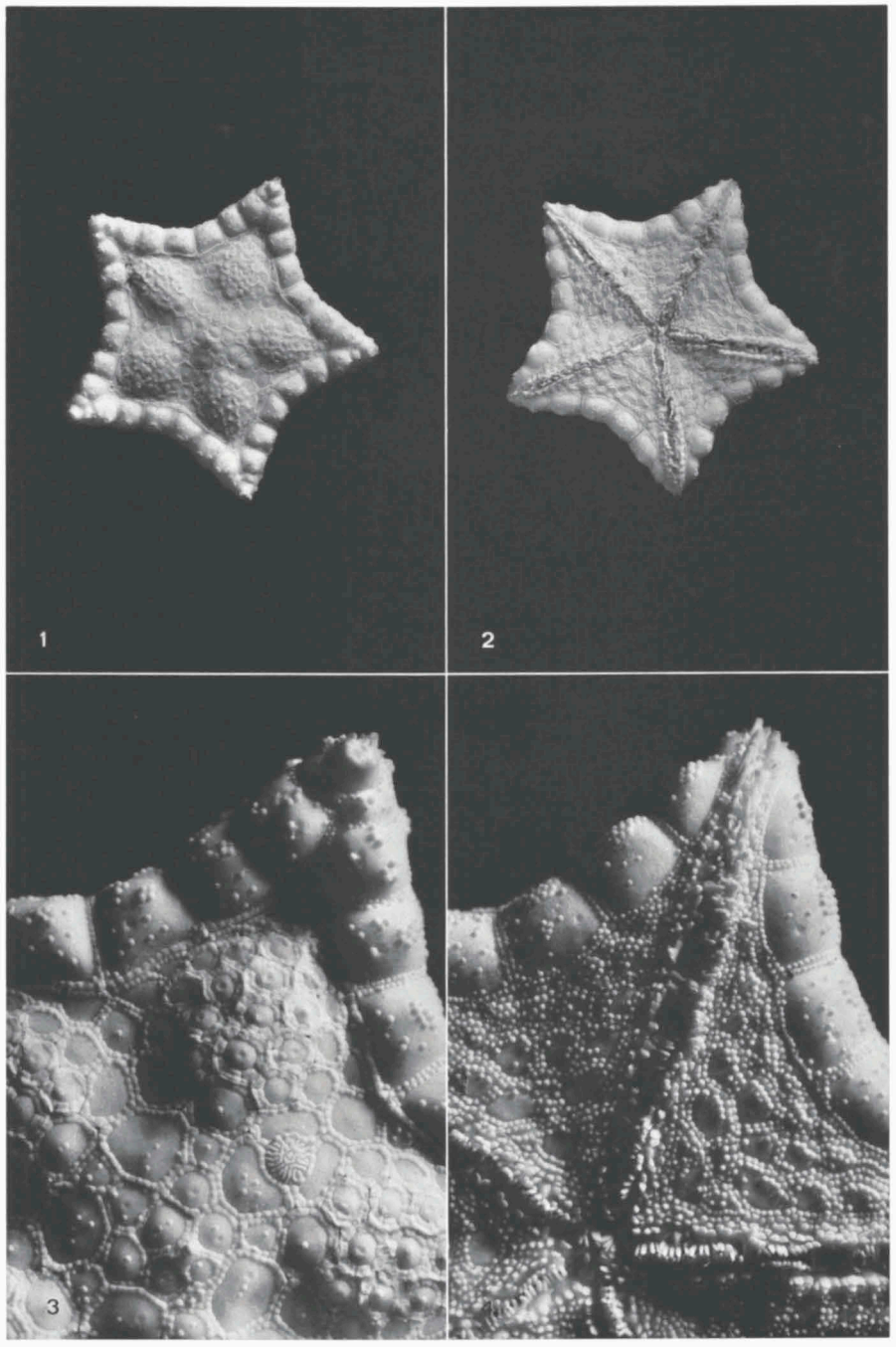
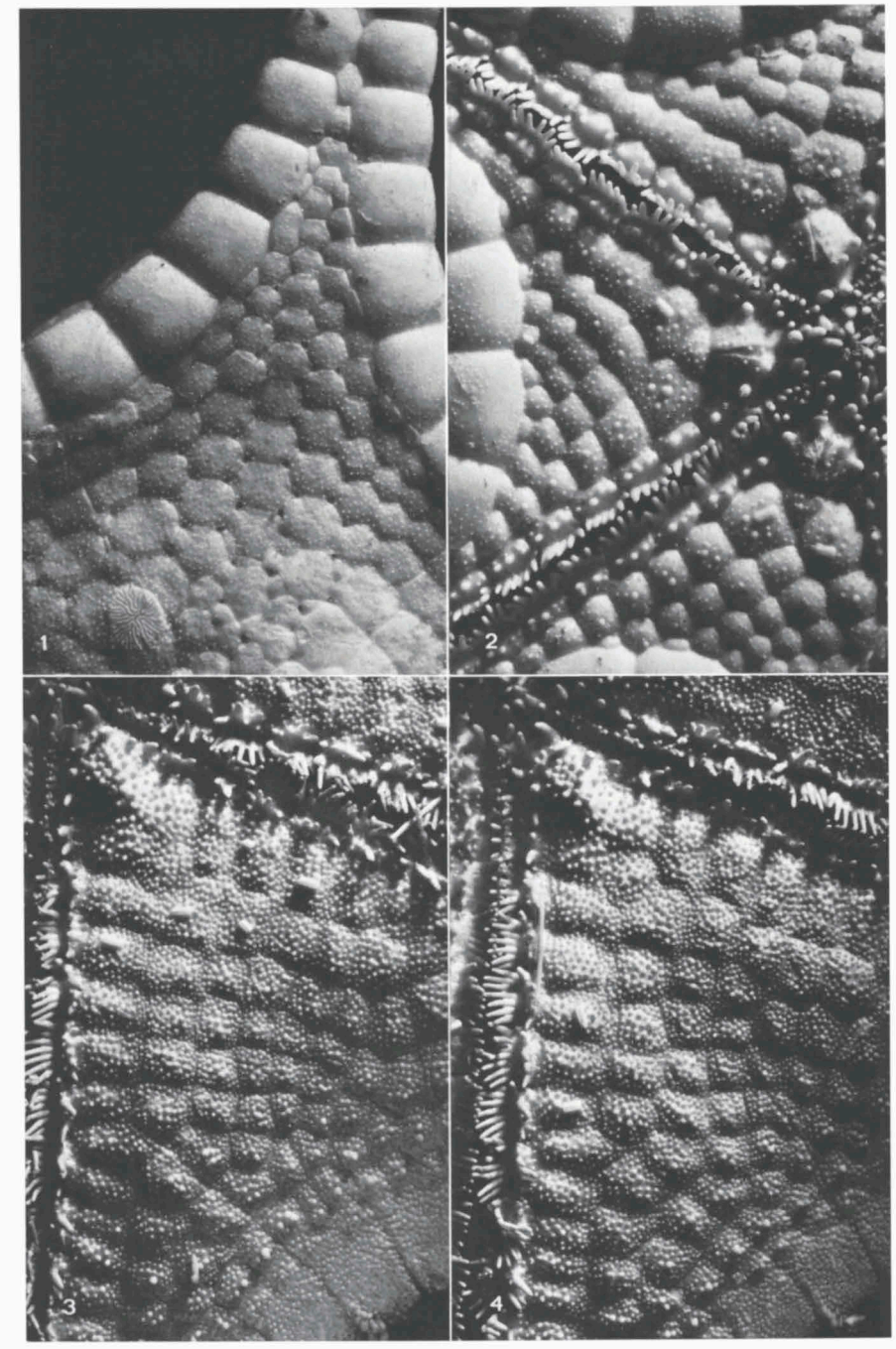


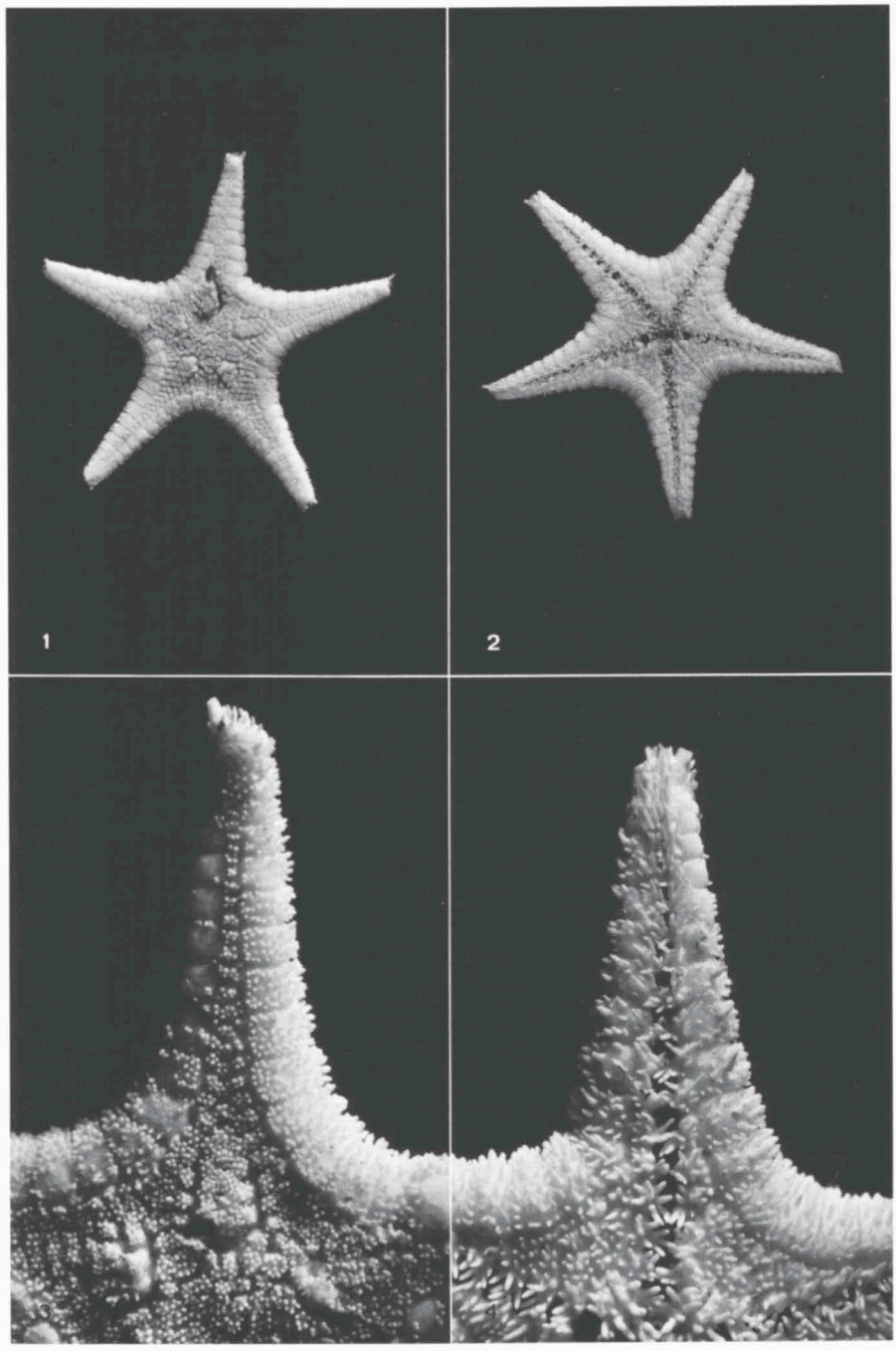
Fig. 1. *Goniaster tessellatus*; Sta. 1, R/r = 16/9 mm; habitus dorsally, showing the absence of dorsal spines. Fig. 2. *Mediaster bairdii*; Sta. 80, R/r = 69/28 mm; detail of the dorsal plates, ventrally, showing the connecting ossicles.



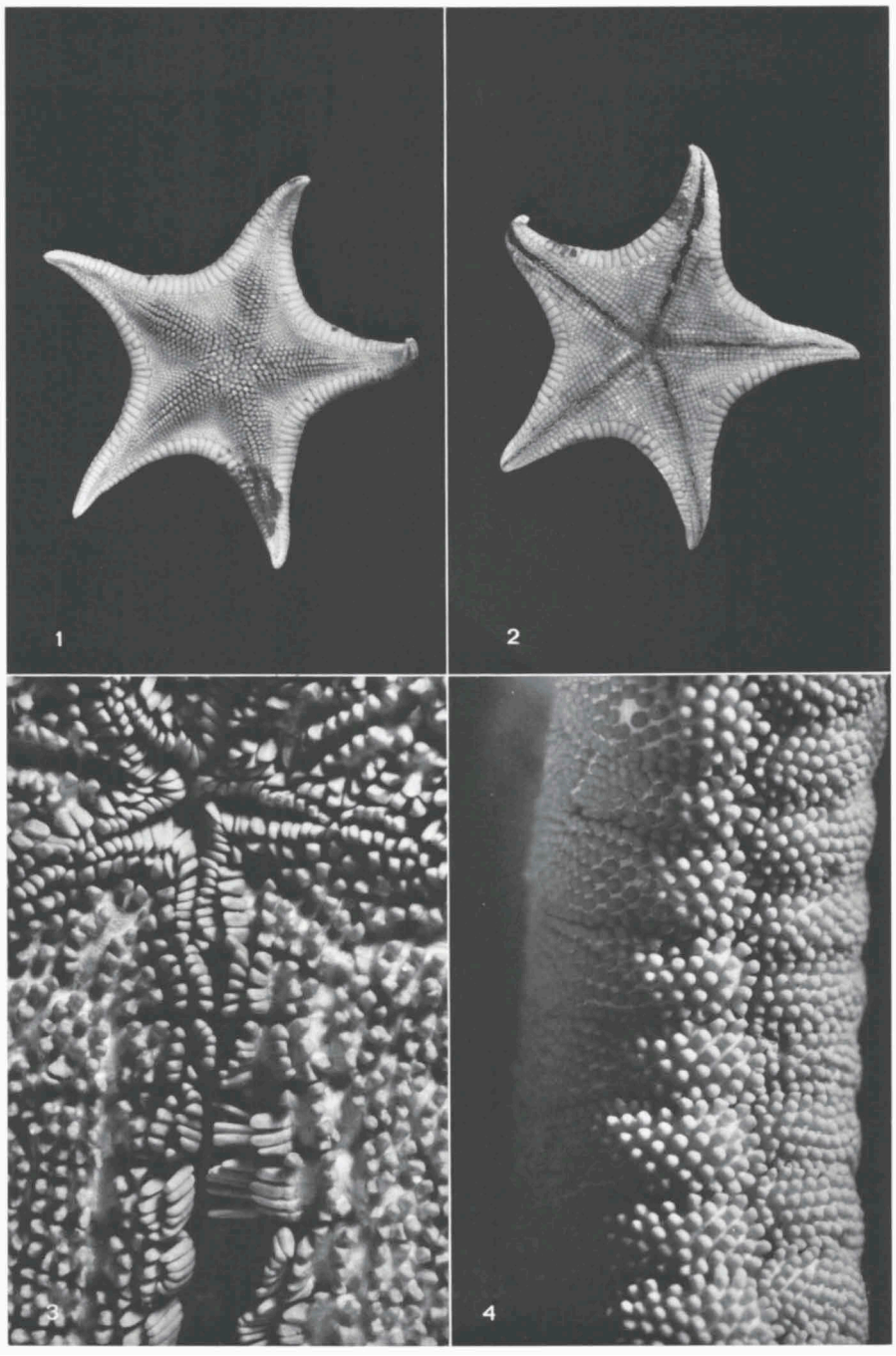
Figs. 1-4. *Tosia parva*; Sta. 50, R/r = 11/7 mm. 1, habitus dorsally; 2, habitus ventrally; 3, detail of a ray dorsally; 4, detail of a ray, ventrally.



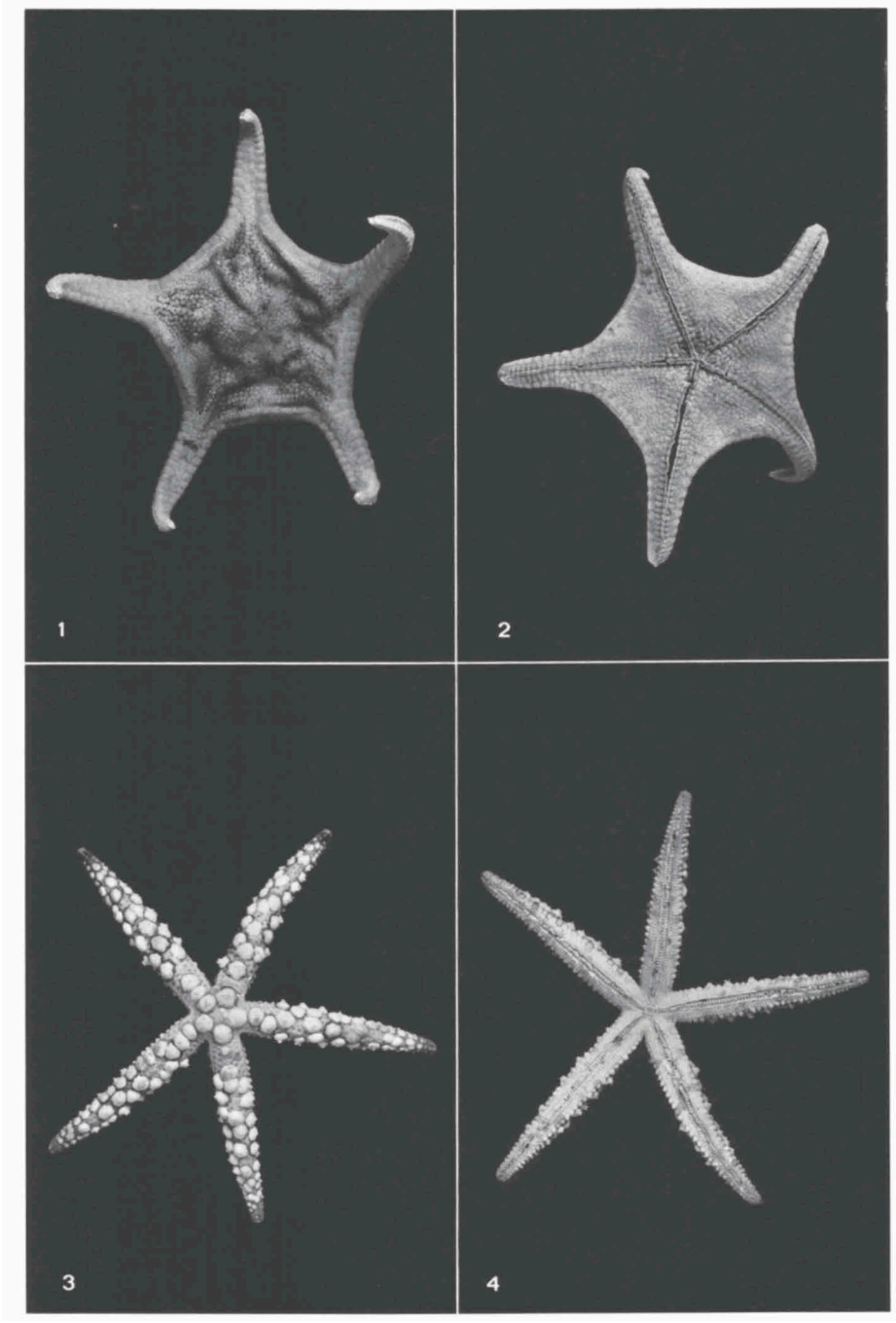
Figs. 1-4. *Anthenoides peircei*. 1-2, Sta. 49, R/r = 28/11 mm. 1, detail of an arm basis, dorsally; 2, detail of a ventro-lateral area; 3-4, Sta. 141 (Saba Bank), R/r = 102/38 mm; two ventro-lateral areas, showing the variation in the occurrence of pedicellariae.



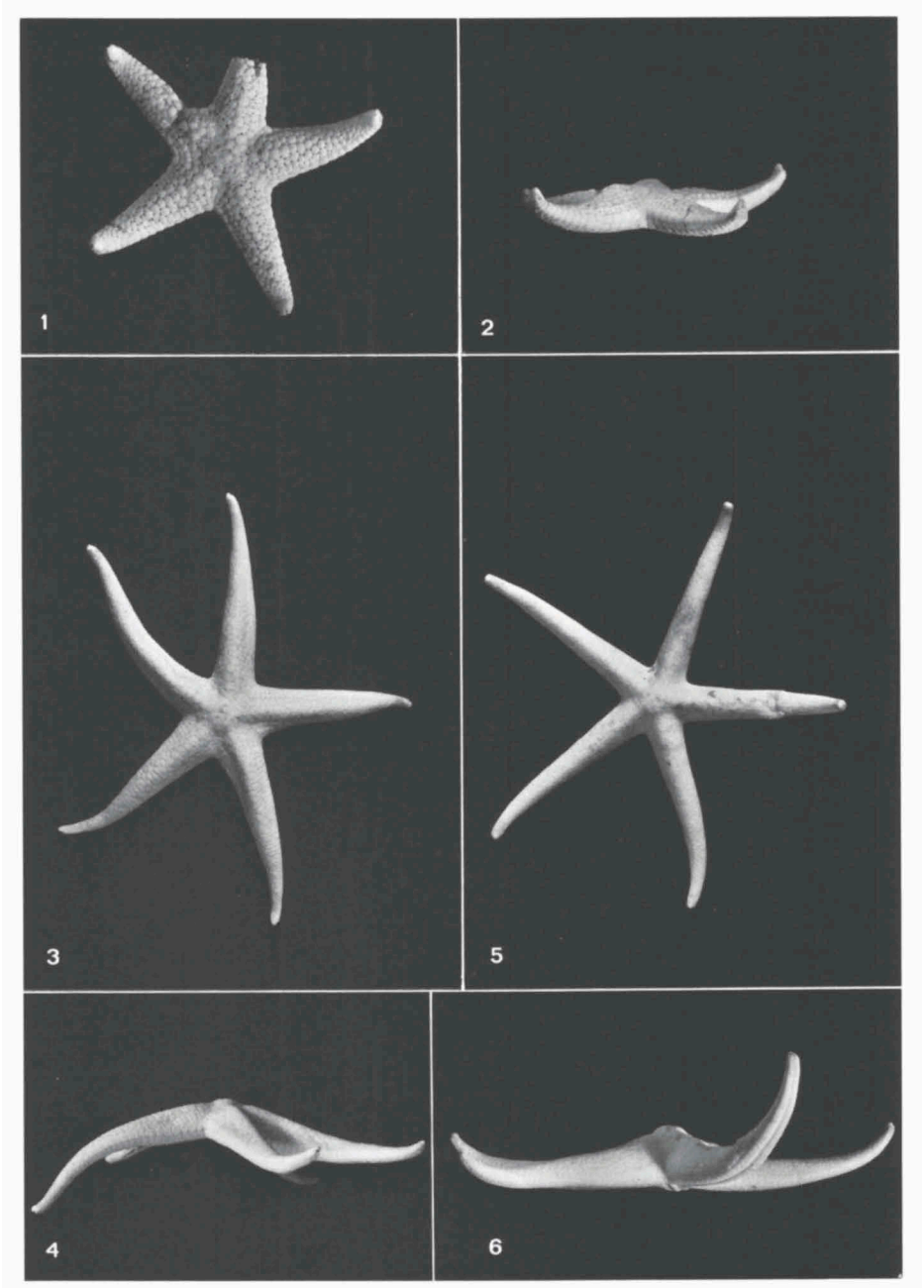
Figs. 1-4. *Pseudarchaster gracilis*; Sta. 80, R/r = 11/4 mm. 1, habitus dorsally; 2, habitus ventrally; 3, detail of an arm and part of the disk, dorsally; 4, detail of an arm and part of the disk, ventrally.



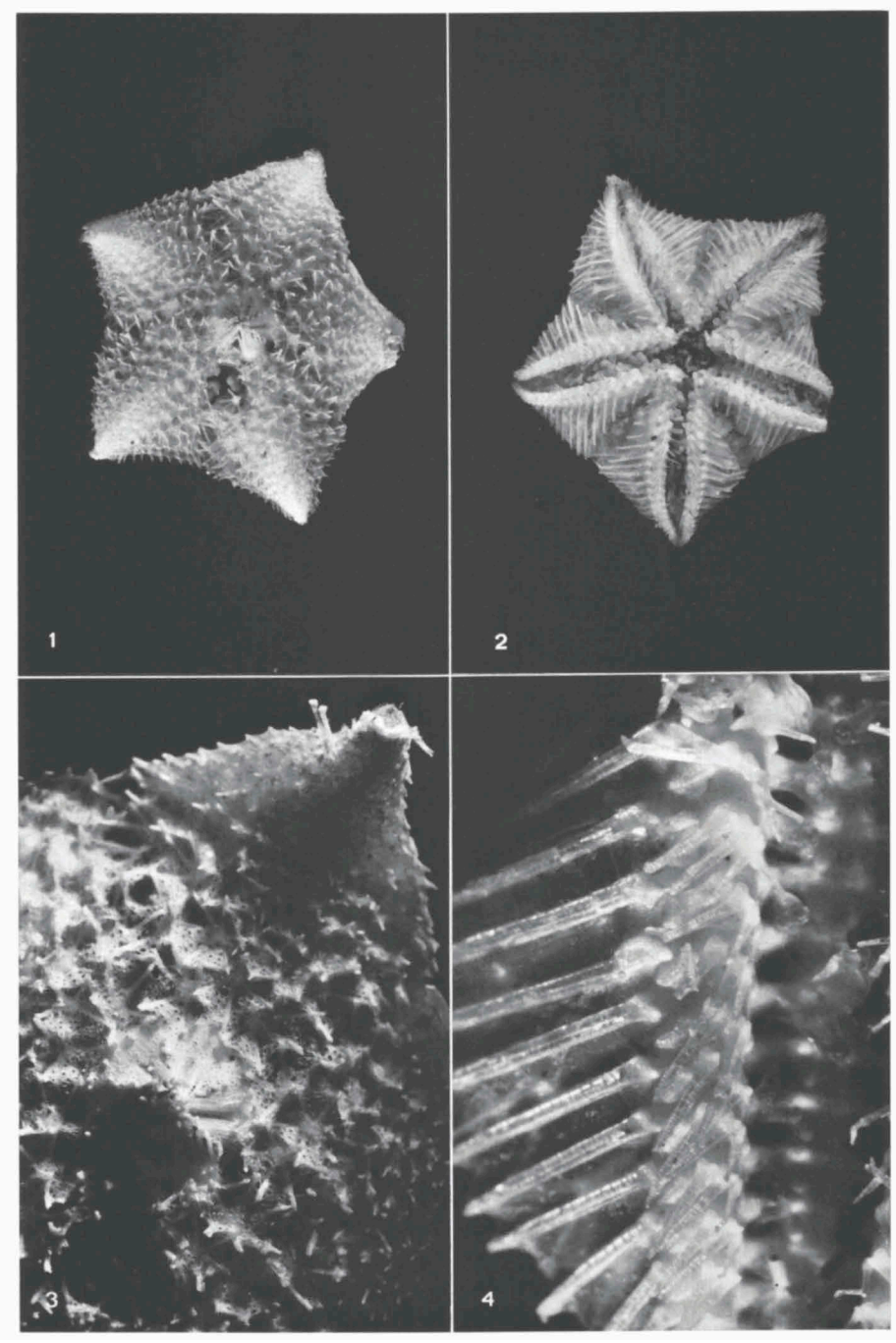
Figs. 1-4. *Mediaster bairdii*; Sta. 80, R/r = 69/28 mm. 1, habitus dorsally; 2, habitus ventrally; 3, detail of the oral and an ambulacral area; 4, detail of the first marginal plates, laterally.



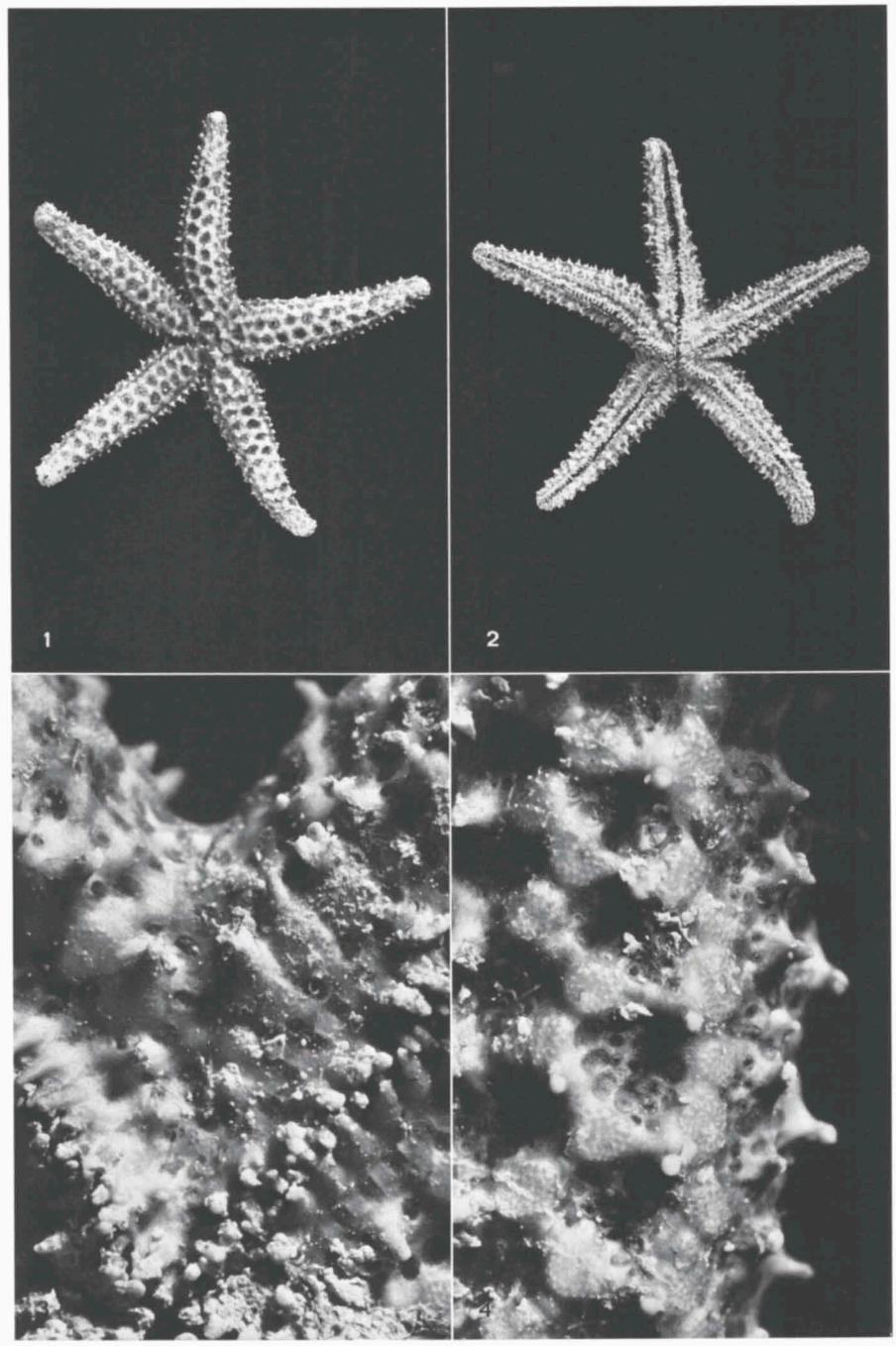
Figs. 1-2. *Circeaster americanus*; Sta. 80, R/r = 94/34 mm. 1, habitus dorsally; 2, habitus ventrally. Figs. 3-4. *Linckia nodosa*; Sta. 14, R/r = 57/7 mm. 3, habitus dorsally; 4, habitus ventrally.



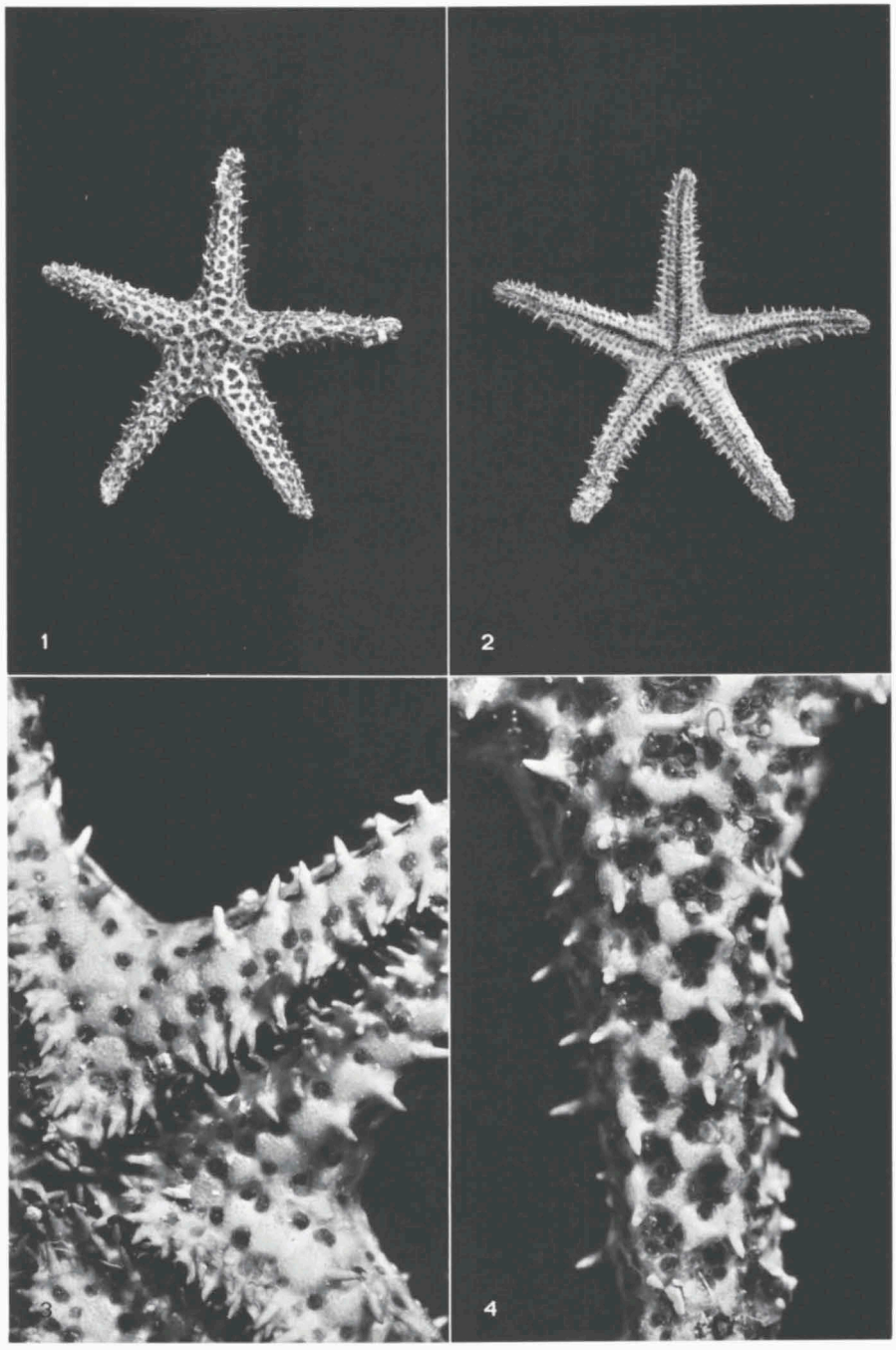
Figs. 1-6. *Narcissia trigonaria*. 1-2, Sta. 14, R/r = 20/5 mm. 1, habitus dorsally; 2, habitus laterally. 3-4, Sta. 87, R/r = 48/9 mm. 3, habitus dorsally; 4, habitus laterally. 5-6, Sta. 65, R/r = 68/11 mm. 5, habitus dorsally; 6, habitus laterally.



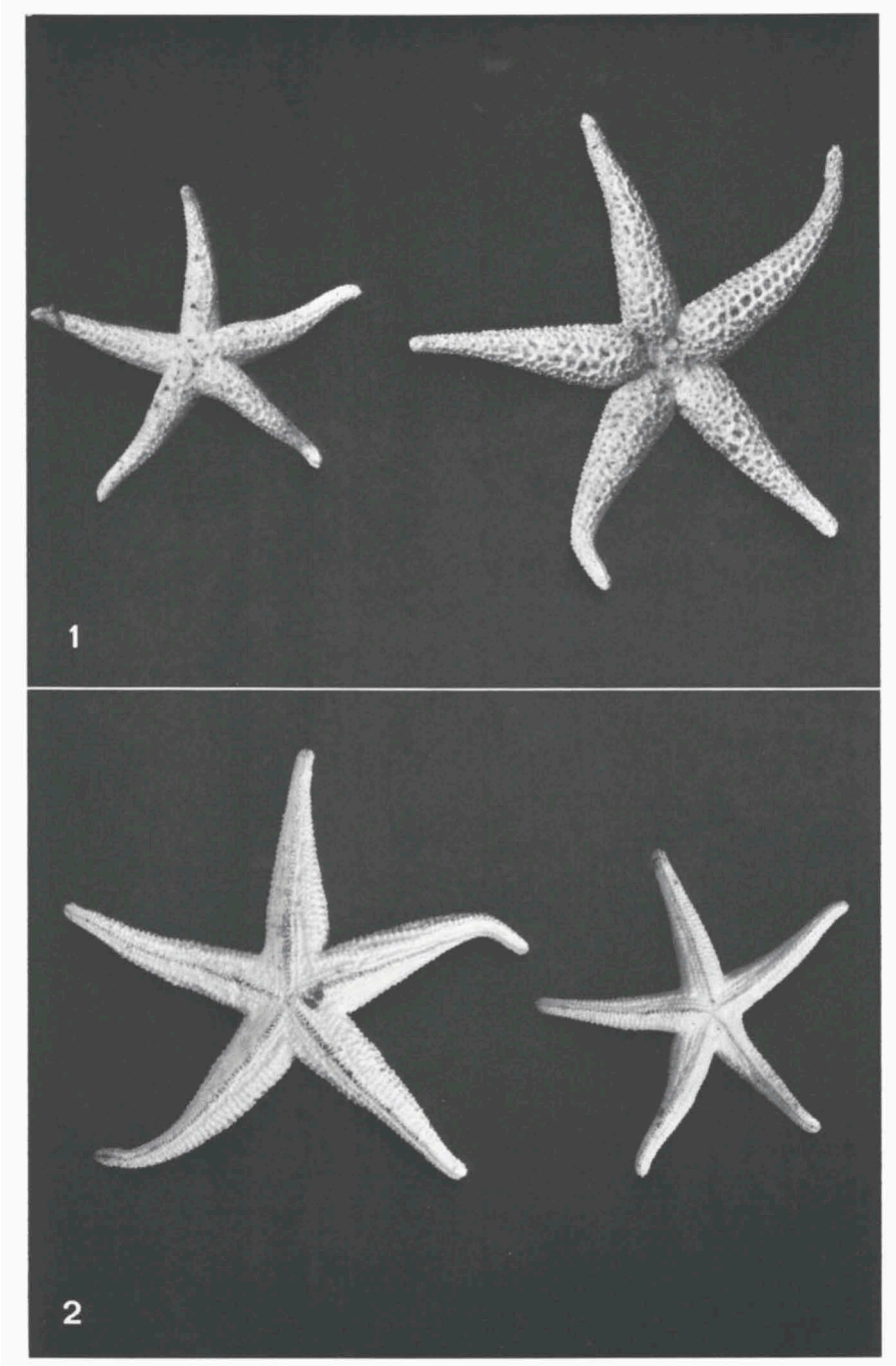
Figs. 1-4. *Calyptraster coa*; Sta. 80, R/r = 13/9 mm. 1, habitus dorsally; 2, habitus ventrally; 3, detail of the osculum and one ray; 4, detail of some proximal adambulacral plates.



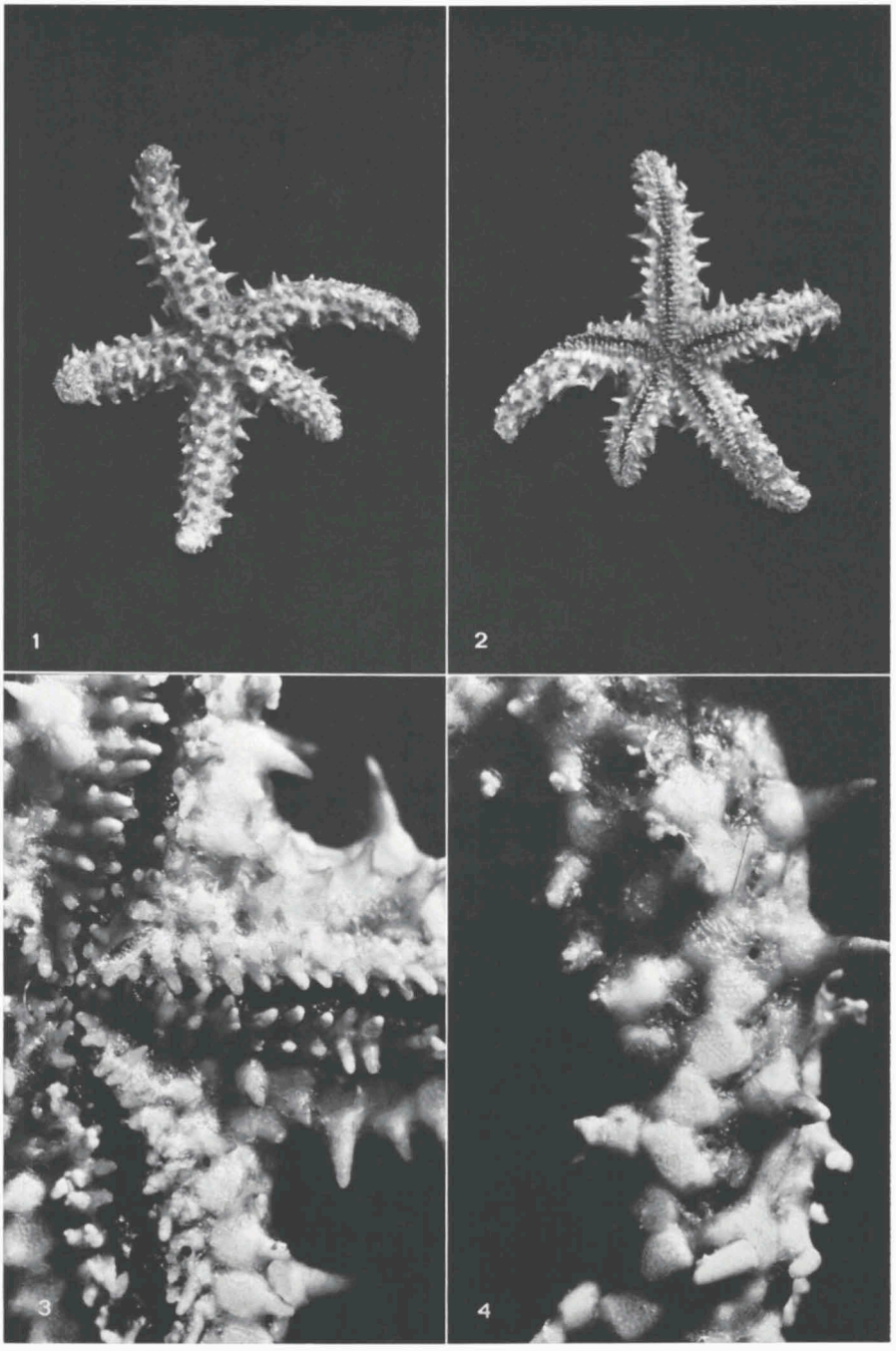
Figs. 1-4. *Echinaster brasiliensis*; Sta. 96, R/r = 44/9 mm. 1, habitus dorsally; 2, habitus ventrally; 3, detail of a ventro-lateral area; 4, detail of some arm plates.



Figs. 1-4. *Echinaster brasiliensis*; Sta. 103, R/r = 21/5 mm. 1, habitus dorsally; 2, habitus ventrally; 3, detail of an arm basis and part of the disk, ventrally; 4, detail of an arm basis, dorsally.



Figs. 1-2. Two specimens of *Echinaster modestus*; Sta. 50, R/r = 23/4 and 37/7 mm. 1, habitus dorsally; 2, habitus ventrally.



Figs. 1-4. *Echinaster echinophorus*; Sta. 96, R/r = 27/5 mm. 1, habitus dorsally; 2, habitus ventrally; 3, detail of arm bases and part of the disk, ventrally; 4, some dorsal arm plates with spines.

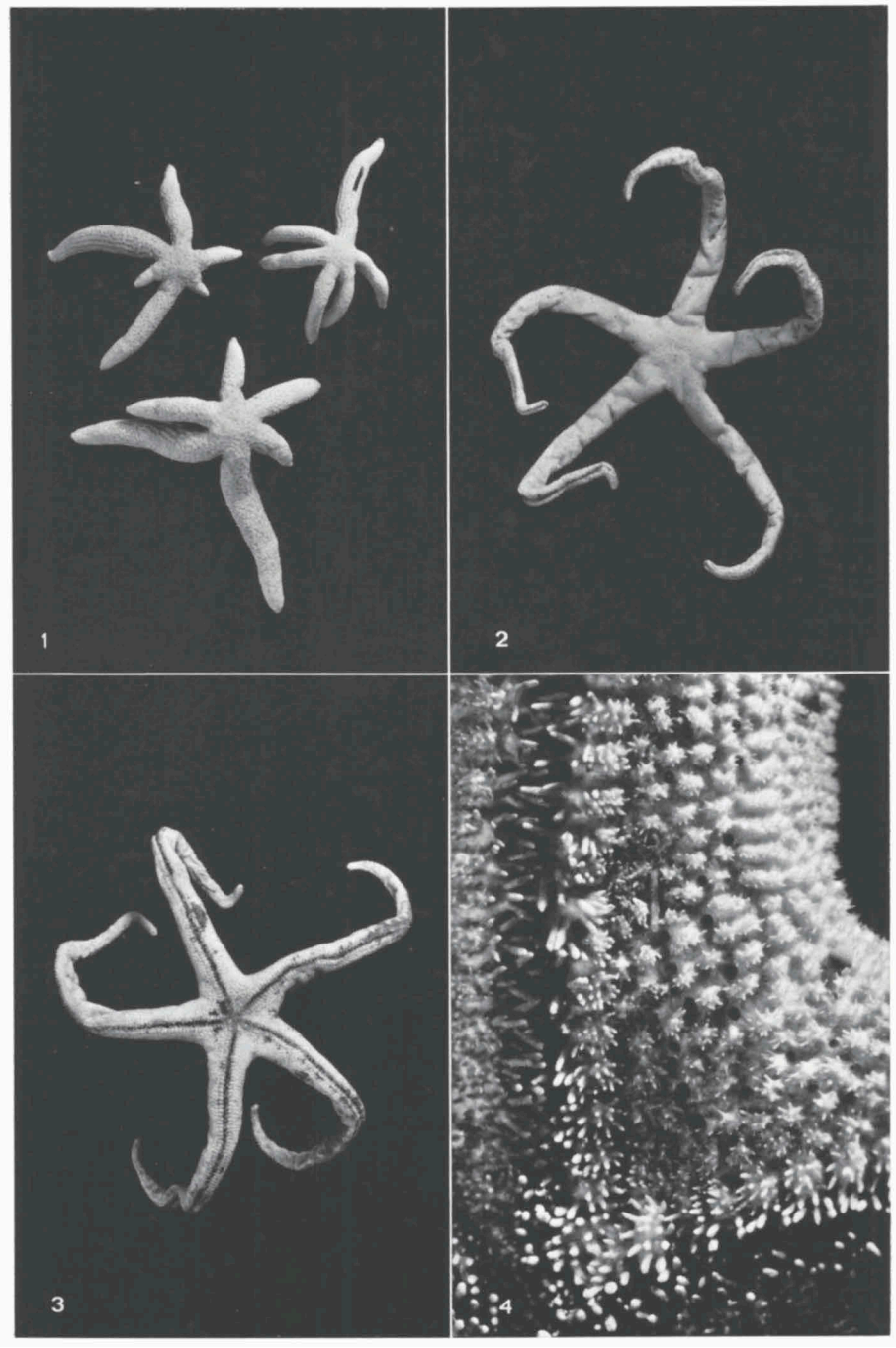
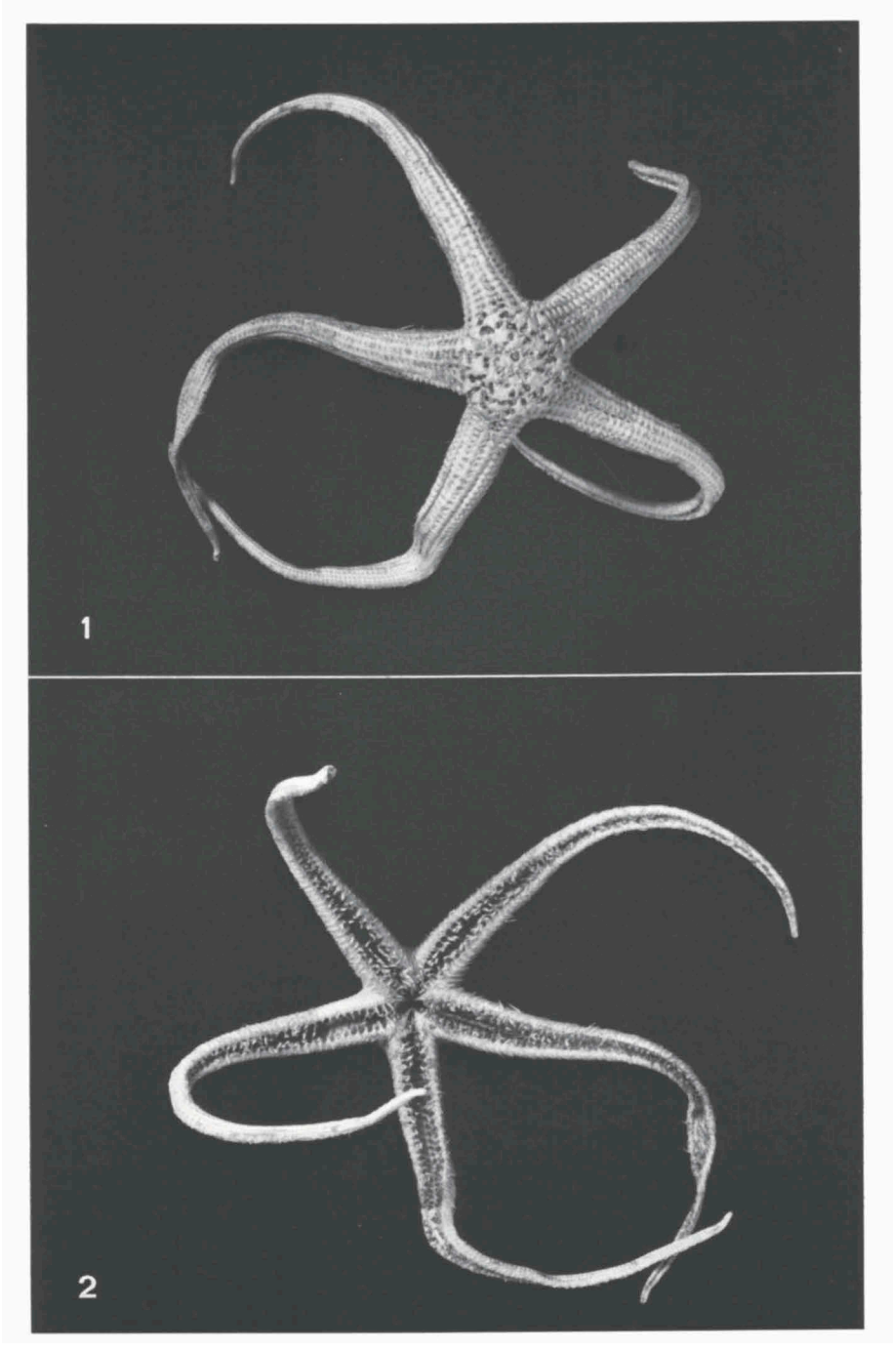


Fig. 1. Three specimens of *Linckia guildingii*; Sta. 14, R/r = 45/5, 46/4 and 65/5 mm; habitus dorsally. Figs. 2-4. *Henricia antillarum*; Sta. 80, R/r = 122/13 mm. 2, habitus dorsally; 3, habitus ventrally; 4, detail of a ventro-lateral area and an ambulacral groove.



Figs. 1-2. *Doraster constellatus*; Sta. 34, R/r = 137/14 mm. 1, habitus dorsally; 2, habitus ventrally.