

Systematics and zoogeography of Asteroidea (Echinodermata) from Inhaca Island, Mozambique

J.H.C. Walenkamp

Walenkamp, J.H.C. Systematics and zoogeography of Asteroidea (Echinodermata) from Inhaca Island, Mozambique.

Zool. Verh. Leiden 261, 15.x.1990: 1-86, figs. 1-33, tables 1-5.— ISSN 0024-1652.

Key words: Echinodermata, Asteroidea; descriptions, systematics, rectifications, distribution, Mozambique, Inhaca Island.

Sixteen out of the seventeen species of shallow-water starfishes reported with certainty from Inhaca Island and Maputo Bay were collected by the author. The seventeenth, *Archaster angulatus*, was recorded from there by Jangoux (1973). An identification key to these species, both in English and in Portuguese is presented. Four species have not been mentioned previously from Inhaca waters, viz. *Astropecten monacanthus* (because of earlier incorrect identifications), *Monachaster sanderi*, not known to occur further south than Zanzibar, *Fromia milleporella* and *Ophidiaster hemprichii*, which were not previously known to occur south of Madagascar. *Stellaster equestris* was found washed ashore on a sandy beach a little north of Maputo. The earlier recorded presence in Inhaca waters of some species, viz. *Astropecten granulatus*, *A. acanthifer*, *A. antares*, *Leiaster leachii*, *Asterina coronata*, *Patriella dyscrita* and *Linckia guildingii* is doubtful. *Patriella exigua*, which is widely distributed in subtropical-temperate waters of the southern hemisphere, possibly including South America, is the only species occurring on the exposed rocks of Cabo da Inhaca (figs. 2 and 33); it is absent in the warmer, sheltered waters of Inhaca Island and Maputo Bay, where the sixteen other species were found. The last-named species are all tropical and widely distributed in the western Indian Ocean, the Indo-West Pacific and sometimes even reaching the East Pacific Barrier. For ten of them, Inhaca Island and Maputo Bay form the southern-most limit of distribution. A juvenile specimen of the usually reef dwelling *Linckia laevigata* was found on exposed tidal rocks at Ponta de Ouro, on the border with South Africa. Four species are recorded as far south as Natal (29° S). On the eastern side of its distribution area, *Stellaster equestris* has been reported from northern New South Wales, Australia; in the western Indian Ocean, Maputo Bay is the southern-most locality (fig. 16). The results thus agree well with those of A.M. Clark & Courtman-Stock (1976). The fact that Mozambique lies in the lee of Madagascar and has reduced wave action compared to northern Natal (Hartnoll, 1976), combined with the sheltering effect of the eastern ridge of Inhaca Island itself, may be the reason why, as far as asteroids are concerned, the East African Tropical Province extends into Maputo Bay. The taxonomy of some starfishes, notably the "Scoparius-group" of *Astropecten* and the asterinids, needs further clarification. The investigation of the coral communities off northern Natal could also render interesting data.

J.H.C. Walenkamp, c/o Nationaal Natuurhistorisch Museum (Rijksmuseum van Natuurlijke Historie), P.O. Box 9517, 2300 RA Leiden, The Netherlands.

Contents

Introduction	4
Taxonomic review of the Asteroidea of Inhaca Island	8
Key to the species of Asteroidea in Inhaca waters	9
Chave de identificação das estrelas-do-mar nas águas da Ilha da Inhaca	11
Survey of the species	13
<i>Luidia maculata</i> Müller & Troschel, 1842	13
<i>Luidia savignyi</i> (Audouin, 1826)	18
<i>Astropecten monacanthus</i> Sladen, 1883	21
<i>Astropecten hemprichii</i> Müller & Troschel, 1842	26
<i>Archaster angulatus</i> Müller & Troschel, 1842	31

<i>Monachaster sanderi</i> (Meissner, 1892)	32
<i>Stellaster equestris</i> (Retzius, 1805)	38
<i>Asterodiscides elegans</i> (Gray, 1840)	42
<i>Culcita schmideliana</i> (Retzius, 1805)	45
<i>Pentacaster mammillatus</i> (Audouin, 1826)	48
<i>Protoreaster linkii</i> (Blainville, 1830)	51
<i>Fromia milleporella</i> (Lamarck, 1815)	53
<i>Linckia laevigata</i> (Linnaeus, 1758)	58
<i>Linckia multifora</i> (Lamarck, 1815)	61
<i>Ophidiaster hemprichii</i> Müller & Troschel, 1842	63
<i>Asterina burtonii</i> Gray, 1840	67
<i>Patriella exigua</i> (Lamarck, 1815)	72
Sumário	76
Acknowledgements	77
References	77

Introduction

Studies of the zoogeography and systematics of the shallow-water marine invertebrate fauna of South-East Africa have largely focussed on the central-east coast of Africa, the islands of the southwestern Indian Ocean and, predominantly, South Africa (Stephenson and co-workers (1931-44); Jackson, 1976; Berry, 1980). The few, general faunal investigations of Mozambican waters have been mainly concerned with Inhaca Island, southern Mozambique (Kalk, 1954; 1958; Macnae & Kalk, 1958; 1962; 1969). This is partly for practical reasons, the Island being close to the capital city of Maputo (formerly Lourenço Marques), but also because of the interesting geographic position of Inhaca.

The Inhaca peninsula, the Island itself and the shoals to the north are influenced by an inshore, rather unpredictable, temporary, cold counter-current, running from the Cape Province in northeasterly direction (Macnae, 1969). This current lowers the relatively high water temperature caused by the warm (26° C) Mozambique current, which flows southward along the edge of the continental shelf (fig. 1).

Although Boshoff's (1969; 1980) contention that Inhaca Island harbours the southern-most coral reefs of the western Indian Ocean appears to be refuted by reports of similar reefs in northern Zululand (Branch & Branch, 1981: pl. 26), the sheltered position of most of Inhaca's shores is expected to cause the faunal communities to show more tropical elements. The exposed eastern shore has strong subtropical affinities.

The geographic and oceanographic setting of Inhaca Island have been described by Macnae (1969); the general physical conditions may be found in Kalk (1958). The coastal marine habitats of southern Africa were reviewed by Brown & Jarman (1978), and the physico-chemical characteristics of the south-west Indian Ocean by Schumann & Orren (1980).

In studies of the distribution of inter- and subtidal animals and plants, and the establishment of the southern boundary for tropical species, southern Mozambique and Natal appear to be crucial areas, although there exists considerable difference of opinion, depending on the type of habitat, the groups of organisms investigated, and the interpretations of the authors. Whereas some biologists consider the tropical

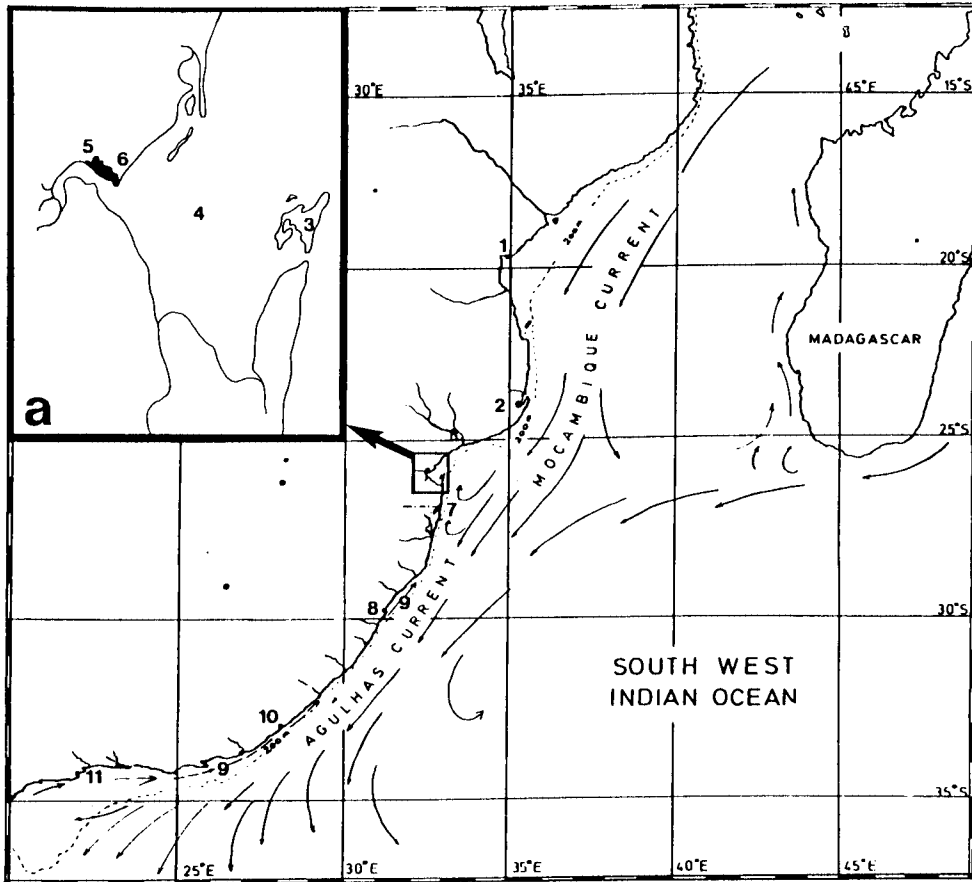


Fig. 1. South-East Africa, current systems and shore stations; a, inset Maputo Bay and Inhaca Island. Explanation of the numbers used: 1, Beira; 2, Inhambane; 3, Inhaca Island; 4, Maputo Bay; 5, Maputo; 6, Costa do Sol; 7, Ponta de Ouro, border Mozambique-South Africa, Kosi Bay; 8, Durban; 9, counter current; 10, East London; 11, Mossel Bay. After a map in Day (1969).

fauna to extend to northern Natal or even further south (e.g., Ekman, 1967; Jackson, 1976; Berry, 1980), others suggest that the Tropical Province is really confined to the north of Inhambane, Mozambique (e.g., Day, in Brown & Jarman, 1978). Only rarely are zoogeographical surveys based on sound taxonomical studies, like in Day (1967).

The echinoderms of southern Africa have been extensively studied by (1) H.L. Clark (1923), who made a clear distinction between the, badly known, Mozambican species and those from South Africa, by (2) Mortensen (1933a), who recognized Natal as the southern limit of many tropical species, but otherwise ignored Mozambique, and by (3) A.M. Clark & Courtman-Stock (1976), who did include southern Mozambique in their survey. H.L. Clark (1923) reported 74 species of South African asteroids, of which 35 are "truly littoral" (< 20 fms). Of those 35 species, thirteen are endemic; of the remaining 22, eighteen are East Indian or Indian Ocean species.

Mortensen (1933a) reported that of the 85 species of South-African starfishes, 58 are endemic. Of the 22 South African shallow-water (< 35 m) species, nine also occur off Mozambique and/or further north. A.M. Clark & Courtman-Stock (1976) divided southern Africa between the Tropic of Capricorn and the Cape of Good Hope into nine areas, of which the "Durban area" (The Haven to Kosi Bay) and the "Lourenço Marques area" (Mozambican border to the Tropic of Capricorn) are of particular interest here. Of the 45 South African shallow-water (0-99 m) and intertidal species, 32 occur in the "Durban area", and of those, six are also found in the "Lourenço Marques area" and/or further north. Conversely, of the fifteen species reported from southern Mozambique, four occur as far south as the "Durban area", where they are found in shallow water, as opposed to intertidally in southern Mozambique. Seven other species are not found south of Maputo (= Delagoa) Bay.

The Asteroidea of Inhaca Island have been the object of studies by Lopes (1939), Balinsky (1958; 1969) and Jangoux (1973), who included the overall geographic distribution of the species in the account of his collection. In ecological surveys of Inhaca Island, such as those by Kalk (1958) and Macnae & Kalk (1962), the starfishes are mostly listed by habitat.

During a series of irregular visits to Inhaca Island in the years 1982-1987, the author, often aided by interested students and staff of the Faculty of Biology in Maputo, made extensive collections of littoral and infralittoral invertebrates. The echinoderms were collected by hand at low tide and by skin diving. In the last year, means became available to trawl in the deeper waters west of the island. Most asteroid specimens were found along the western shores and near the corals of Barreira Vermelha, Ponta Torres and Ilha dos Portugueses (fig. 2). Additional starfishes were collected in the Inhaca Channel, on the tidal flats between the Marine Biological Station and Ponta Punduini, on the exposed tidal rocks of Cabo da Inhaca and on the tidal flats of Ilha dos Portugueses and Costa do Sol, north of Maputo (figs. 1-2). No asteroids were found on the mudflats north and south of the Island and on the exposed eastern beach.

In dealing with the material at hand, older systematic accounts often proved to need some revision (see "Notes" (p. 9) to the taxonomic review). The collection numbers beginning with AE refer to the natural history museum of the Faculty of Biology of the Eduardo Mondlane University, Maputo; the specimens marked with an asterisk (*) are kept in the Nationaal Natuurhistorisch Museum, Leiden. Those beginning with RMNH and BM(NH) represent specimens from the echinoderm collections in the Nationaal Natuurhistorisch Museum, Leiden, and the British Museum (Natural History), London, respectively. The starfish collection from Inhaca Island in the Musée Royal de l'Afrique Centrale in Tervuren, Belgium, is indicated by the letters MRAC.

All the species collected by the author are given a full synonymy, a description and an overall geographic distribution; occasionally the reader is referred to another publication for these items. In the discussions, the taxonomical considerations, which are summarized in the synonymies, are justified, or the reader is referred to the relevant publications. The keys include both the specimens correctly reported from Inhaca waters and those of which the actual occurrence is doubtful but not improbable ("Notes", p. 9).

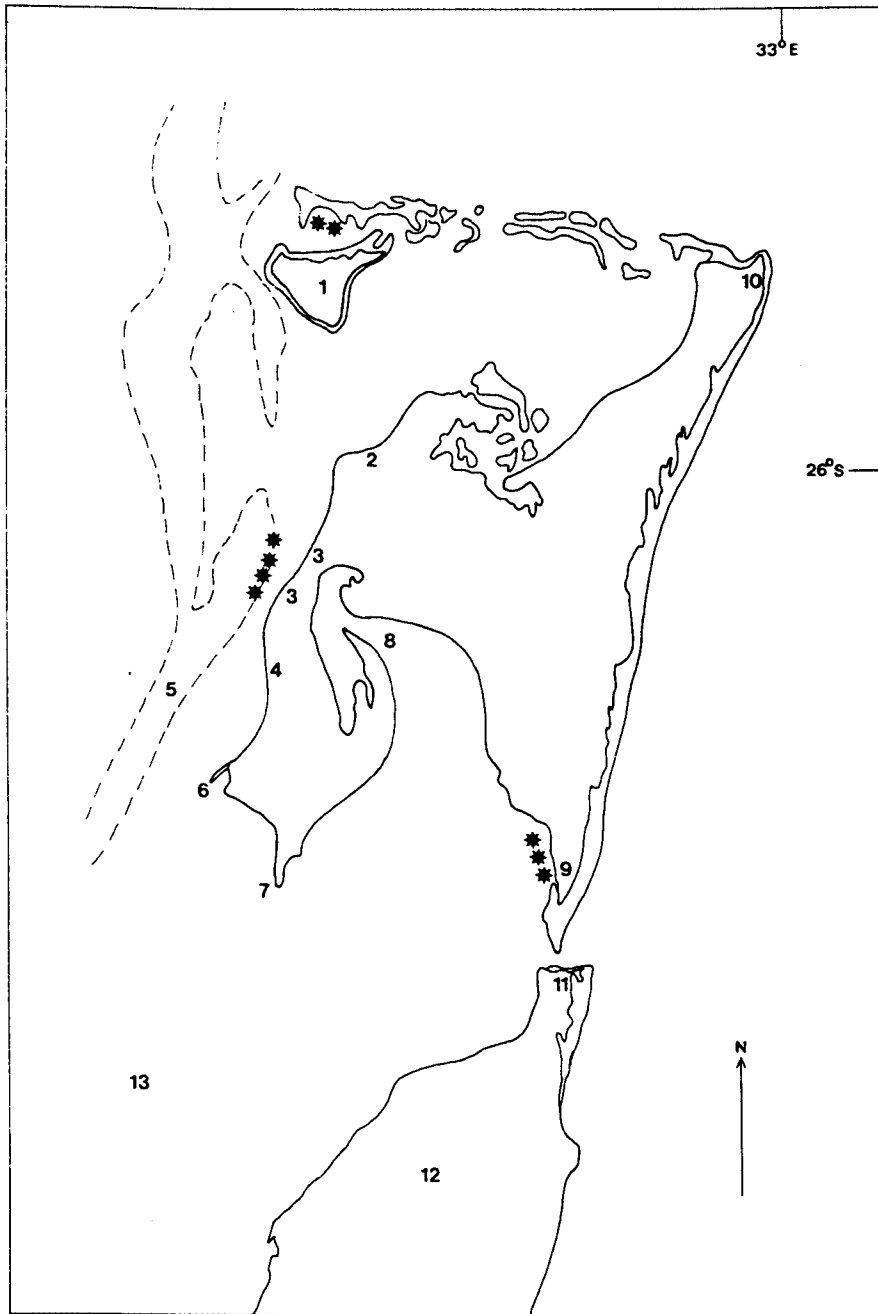


Fig. 2. Inhaca Island, Mozambique; 1:100,000. Explanation of the numbers used: 1, Ilha dos Portugueses; 2, Portinho; 3, Barreira Vermelha; 4, Marine Biological Station; 5, Inhaca Channel; 6, Ponta Rasa; 7, Ponta Punduini; 8, Saco da Inhaca; 9, Ponta Torres; 10, Cabo da Inhaca; 11, Cabo da Santa Maria; 12, Inhaca Peninsula, Machangulo; 13, Maputo Bay. ** indicate coral reefs. After an aerial photograph.

Taxonomical review of the Asteroidea of Inhaca Island
(including species which may occur in this area)

- Order PLATYASTERIDA Spencer, 1951
 Family Luidiidae Verrill, 1899
 Genus *Luidia* Forbes, 1839
 L. maculata Müller & Troschel, 1842
 L. savignyi (Audouin, 1826)
- Order PAXILLOSIDA Perrier, 1884
 Family Astropectinidae Gray, 1840
 Genus *Astropecten* Gray, 1840
 A. monacanthus Sladen, 1883
 A. hemprichii Müller & Troschel, 1842
 ? *A. granulatus* Müller & Troschel, 1842
 ? *A. antares* Döderlein, 1926
- Order VALVATIDA Perrier, 1884
 Family Archasteridae Viguiier, 1878
 Genus *Archaster* Müller & Troschel, 1842
 A. angulatus Müller & Troschel, 1842
- Family Goniasteridae Forbes, 1841
 Genus *Monachaster* Döderlein, 1916
 M. sanderi (Meissner, 1892)
- Genus *Stellaster* Gray, 1840
 S. equestris (Retzius, 1805)
- Family Asterodiscididae Rowe, 1977
 Genus *Asterodiscides* A.M. Clark, 1974
 A. elegans (Gray, 1840)
- Family Oreasteridae Fisher, 1911
 Genus *Culcita* L. Agassiz, 1935
 C. schmideliana (Retzius, 1805)
- Genus *Pentaceraster* Döderlein, 1916
 P. mammillatus (Audouin, 1826)
- Genus *Protoreaster* Döderlein, 1916
 P. linkii (Blainville, 1830)
- Family Ophidiasteridae Verrill, 1867
 Genus *Fromia* Gray, 1840
 F. milleporella (Lamarck, 1815)
- Genus *Linckia* Nardo, 1834
 L. laevigata (Linnaeus, 1758)
 L. multifora (Lamarck, 1815)
 ? *L. guildingii* Gray, 1840
- Genus *Ophidiaster* Agassiz, 1835
 O. hemprichii Müller & Troschel, 1842
- Genus *Leiaster* Peters, 1852
 ? *Leiaster leachii* (Gray, 1840)
- Family Asterinidae Gray, 1840
 Genus *Asterina* Nardo, 1834

- A. burtonii* Gray, 1840
 Genus *Patiriella* Verrill, 1913
P. exigua (Lamarck, 1815)
 ?*P. dyscrita* (H.L. Clark, 1923)

Notes.—1. The record of Simpson & Brown (1910) of *Luidia aspera* from Mozambique (also Jangoux, 1973) is based on an incorrect identification (Fisher, 1919; A.M. Clark, 1953). The species is not known to occur in the western Indian Ocean (Aziz, 1986).

2. *Astropecten antares* Döderlein, 1926, is known from southeastern South Africa (A.M. Clark & Courtman-Stock, 1976). The type locality of the species is given by Döderlein as "Mozambique, nine m depth, on sandy bottom, collected by G. v. Düben". If this locality is correct, the species may also be found in Inhaca waters.

3. The records of *Astropecten granulatus* and *A. acanthifera* (*sic*) from Inhaca Island are either certainly (Jangoux, 1973) or probably (Balinsky, 1958; 1969; Macnae & Kalk, 1962) based on incorrect identifications. The occurrence of *A. granulatus* in Inhaca waters is, however, not improbable (John, 1948). *A. acanthifer* Sladen, 1883, is not known to occur south of Aden (Aziz, 1986).

4. *Stellaster equestris* was not collected at Inhaca, but on the continental side of Maputo (= Delagoa) Bay, on the beach at Costa do Sol, north of Maputo.

5. *Linckia guildingii* was reported from Inhaca Island by Jangoux (1973), but not, as he stated, by Balinsky (1969). Of the eleven specimens of *L. guildingii*, reported from Inhaca by Jangoux as being distinguished by "the adambulacral spines, [which] do not alternate with coarse ventral granules as in *L. laevigata* and *L. multifora*", five could be located in the Tervuren Museum. They proved to be *Linckia laevigata*. Assuming the southern African record of *L. guildingii* mentioned by A.M. Clark & Courtman-Stock (1976) to refer to Jangoux (1973), this species probably has not been found south of Madagascar.

6. *Leiaster leachii* (Gray, 1840) was mentioned by Balinsky (1958; 1969: 99) as "... the enormous blood red *Leiaster leachi*, found at the foot of the main coral reef." [i.e., off Barreira Vermelha, J.H.C.W.]. The species is not further mentioned and despite many attempts, I have not been able to find a single specimen. Its occurrence in southern Mozambique is, however, not improbable (A.M. Clark & Rowe, 1971; but see also A.M. Clark & Courtman-Stock, 1976: 70).

7. *Asterina coronata* Martens, 1866, is mentioned from Inhaca by Kalk (1958) and Jangoux (1973), but both records most probably refer to *A. burtonii*.

8. *Patiriella dyscrita* (H.L. Clark, 1923) is listed in Balinsky's (1958; 1969) "Key to Echinodermata" as *Asterina dyscrita*, but not clearly defined and not mentioned in the text or in the "List of animals collected at Inhaca". It seems likely that the species is restricted to the colder waters of southern South Africa (A.M. Clark, 1974).

Key to the species of Asteroidea in Inhaca waters
 (including species which may occur in this area)

1. Ambulacral tube feet tapering; without a terminal sucking disc 2
- Ambulacral tube feet cylindrical; with a terminal sucking disc 7
2. No conspicuous marginal plates visible dorsally; supero-marginal plates indistin-

- guishable from paxillae (genus *Luidia*) 3
- Margin of dorsal side clearly defined by distinct supero-marginal plates (genus *Astropecten*) 4
 - 3. Seven to nine arms. Paxillae without a large spine between the spinelets *Luidia maculata*
 - Seven arms (rarely five or six). Many lateral paxillae with a strong central spine *Luidia savignyi*
 - 4. Distal supero-marginal plates each with a distinct spine on the exterior (abradial part) *Astropecten hemprichii*
 - Distal supero-marginal plates without distinct spines, although enlarged granules may occur in *Astropecten monacanthus* 5
 - 5. Ventral surface of the infero-marginal plates evenly covered with short, squamose spinelets, enlarged spinelets only near the large lateral spine. Subambulacral spines flattened and widened *Astropecten monacanthus*
 - Ventral surface of the infero-marginal plates with an aboral row of distinctly enlarged, pointed spinelets. Subambulacral spines rod-like 6
 - 6. R/r ratio about 3. Arms flattened and petaloid; distal supero-marginal plates (and arms) narrowing rapidly *Astropecten antares*
 - R/r ratio 3.5-4.5. Arms relatively narrow and tapering evenly *Astropecten granulatus*
 - 7. Dorsal plates paxilliform. Carinal row of paxillae distinctly enlarged *Archaster angulatus*
 - Dorsal plates not paxilliform 8
 - 8. Marginal plates large, forming a conspicuous side wall to the body. No papulae on the ventral side (family Goniasteridae) 9
 - Marginal plates, when viewed from above, not very conspicuous, or, if so, papulae on the ventral surface 10
 - 9. Disc large and convex. Adambulacral plates with one or two broad subambulacral spines between the granules of the ventral surface *Stellaster equestris*
 - Adambulacral plates without spines or enlarged granules on the ventral surface behind the furrow spines. Only the radial areas of the disc raised *Monachaster sanderi*
 - 10. Dorsal, marginal and ventro-lateral plates obscured by a dense covering of tubercles and surrounding granules. Only the distal-most supero-marginal plates bare and conspicuous *Asterodiscides elegans*
 - Plates not concealed by strong tubercles. Distal-most supero-marginal plates not conspicuously different from the other marginal plates 11
 - 11. Interradial areas small. Body completely covered by a continuous granuliform armament or (*Leiaster*) by a thick, smooth skin. No large, distinct spines on the dorsal surface (family Ophidiasteridae) 12
 - Interradial areas very large. Dorsal and ventral plates with small spinelets (family Asterinidae), or dorsal surface with granules and few to many strong spines, at least along the radii (family Oreasteridae) 17
 - 12. Dorsal plates in regular longitudinal series along the whole length of the arm . 13
 - Dorsal plates, particularly distally, not in regular, longitudinal series. 14
 - 13. Body completely covered with a thick, smooth skin, obscuring the outlines of the

- plates *Leiaster leachii*
- All plates covered by granules. Skin thin and inconspicuous. Some granules of the dorsal and lateral plates enlarged and flattened *Ophidiaster hemprichii*
14. Marginal plates distinct from dorsal plates. Dorsal surface rather flattened. Single papular pores on both surfaces *Fromia milleporella*
- Dorsal, lateral and marginal plates similar. Arms cylindrical. Papular pores in groups; absent from the ventral surface 15
15. Subambulacral spines in two series; those of each plate contiguous with each other and with the furrow spines. No granules between the furrow spines
..... *Linckia guildingii*
- Single, low subambulacral tubercles separated from the furrow spines by several series of ventral granulation. Granules between the furrow spines 16
16. Normally five, stout, bluntly tipped arms of equal length. One madreporite. Colour in life blue, bluish-green or yellow-orange *Linckia laevigata*
- Arms not always five, rather slender and tapering; usually of unequal length. Generally two madreporites. Colour in life variable, variegated bluish, brownish or yellowish, sometimes almost uniform *Linckia multifora*
17. Large starfishes (R > 50 mm) with, at least radially, one or more series of stout spines or strongly raised knobs. Dorsal surface with a smooth plastering of small, densely packed granules (family Oreasteridae) 18
- Small starfishes (R < 50 mm). Dorsal, marginal and ventro-lateral plates with small spinelets (family Asterinidae) 20
18. Body pentagonal and, in life, cushion-shaped. Dorsal surface with thick, granular skin, which conceals the dorsal and marginal plates in adult specimens
..... *Culcita schmideliana*
- Arms well developed. Marginal plates clearly distinguishable 19
19. A few distal supero-marginal plates raised in a strong lateral knob. No spines on the infero-marginal plates. Colour in life a pattern of bright-red lines on a grey or orange background *Protoreaster linkii*
- Supero-marginal spines, in the same specimen, all about the same size. Proximal infero-marginal plates with conical spines and/or enlarged granules. Colour highly variable, yellowish, greenish, reddish, but more or less uniform
..... *Pentaceraster mammillatus*
20. R/r ratio about 2. Radial areas swollen. Adambulacral spines in two, webbed fans *Asterina burtonii*
- R/r ratio about 1.5. Small cushion-shaped forms. Adambulacral plates with one or two furrow spines and one subambulacral spine *Patiriella exigua*

Chave para a identificação das estrelas-do-mar nas águas da Ilha da Inhaca

1. Pés ambulacrários mais largos na base que na ponta; ponta sem disco (ventosa) 2
 - Pés ambulacrários cilíndricos e com disco (ventosa) terminal 7
2. Margem do corpo definida apenas pelas placas infero-marginais. As placas supero-marginais são paxilas, similares às paxilas dorsais (*Luidia*)..... 3
 - Margem do corpo definida por duas séries de placas marginais; placas supero-

- marginais sempre bem distinguíveis das paxilas (*Astropecten*) 4
3. Sete a nove braços. Paxilas sem um grande espinho central *Luidia maculata*
Sete braços (raramente cinco ou seis). Algumas ou muitas paxilas laterais com um grande espinho central *Luidia savignyi*
4. Placas supero-marginais distais cada uma com um espinho forte na parte exterior (abradial) *Astropecten hemprichii*
- Placas supero-marginais distais sem espinho forte, às vezes, todavia, com um tubérculo pequeno 5
5. Além do espinho principal nas placas infero-marginais, não existem espinhos maiores que um quarto do comprimento do espinho principal. Espinhos subambulacrários achatados e largos *Astropecten monacanthus*
- Além do espinho principal, vários espinhos secundários apontados nas placas infero-marginais, perto do espinho grande ao longo do bordo externo ou/e numa série transversal na margem aboral da placa 6
6. $R/r = 3.0$ ou menos. Braços achatados e largos. Placas supero-marginais distais (e braços) estreitando rapidamente *Astropecten antares*
- $R/r = 3.5-4.5$ (quando $R > 20$ mm). Braços relativamente estreitos. Placas supero-marginais distais (e braços) não estreitando abruptamente
..... *Astropecten granulatus*
7. Placas dorsais paxilas, das quais a série carinal de paxilas alargadas
..... *Archaster angulatus*
- Placas dorsais não são paxilas 8
8. Placas marginais grandes, formando uma parede lateral muito conspícua. Superfície dorsal usualmente quase plana, às vezes um pouco convexa. Sem pápulas no lado ventral. Arcos interradiais arredondados (Goniasteridae) 9
- Placas marginais usualmente de tamanho médio ou pequeno. Se são conspícuas, existem pápulas no lado ventral. Lado dorsal do corpo convexo 10
9. Disco largo e convexo. Braços finos e pontiagudos. Superfície ventral das placas adambulacrárias com um grande espinho subambulacrário . *Stellaster equestris*
- Disco só convexo nas áreas radiais. Braços fortes com placas marginais tumescentes. Superfície ventral das placas adambulacrárias somente com grânulos, sem espinho(s) subambulacrário(s) *Monachaster sanderi*
10. Corpo completamente coberto por tubérculos circundados por grânulos. Das placas supero-marginais apenas as terminais visíveis *Asterodiscides elegans*
- Corpo não completamente coberto por tubérculos. Todas as placas marginais igualmente visíveis 11
11. Regiões interradiais pequenas. Corpo coberto por grânulos uniformes e contínuos (Ophidiasteridae) 12
- Regiões interradiais muito grandes. Corpo com espinhos, grânulos ou placas nuas 17
12. Placas dorsais em séries longitudinais regulares ao longo do comprimento do braço 13
- Placas dorsais não formam séries regulares ao longo do comprimento do braço..... 14
13. Corpo inteiramente coberto por uma pele espessa e lisa, obscurecendo as placas dorsais e marginais *Leiaster leachii*
- Todas as placas com grânulos. Pele fina e pouco distinta. Alguns grânulos das placas dorsais e laterais alargados e achatados *Ophidiaster hemprichii*

14. Placas dorsais e marginais bem distintas. Lado dorsal relativamente achatado. Poros singulares, também no lado ventral *Fromia milleporella*
- Placas dorsais, laterais e marginais muito similares. Braços cilíndricos. Poros em grupos, ausentes do lado ventral 15
15. Espinhos subambulacrários em duas séries; os de cada placa contíguos uns aos outros e com os espinhos adambulacrários no sulco *Linckia guildingii*
- Tubérculos subambulacrários muito baixos, situados a uma distância dos espinhos no sulco e circundados pela granulação ventral 16
16. Normalmente cinco braços, de comprimentos iguais, 5-10 vezes mais compridos que largos. Cor dos exemplares vivos azul, azul-verde ou amarela/cor-de-laranja. Apenas um madreporito *Linckia laevigata*
- Espécie fissípara, braços geralmente irregulares em número e comprimento. Usualmente dois madreporitos. Comprimento dos braços mais de dez vezes superior à largura. Cor muito variável, uniforme ou manchada *Linckia multifora*
17. Corpo grande; margem não afinada. Armadura de grânulos e espinhos grossos (Oreasteridae) 18
- Corpo pequeno (R < 40 mm) com a margem afinada. Armadura de espinhos pequenos (Asterinidae) 20
18. Corpo em forma de almofada, pentagonal ou quase circular. Placas marginais escondidas por uma pele grossa e granular *Culcita schmideliana*
- Braços distintos. Placas marginais bem visíveis 19
19. Geralmente algumas placas supero-marginais distais com um forte espinho lateral; as outras placas têm espinhos muito mais pequenos. Os exemplares vivos mostram uma coloração de linhas vermelhas num fundo cinzento ou cor-de-laranja *Protoreaster linkii*
- Protuberâncias nas placas supero-marginais, no mesmo exemplar, mais ou menos iguais. Coloração mais ou menos uniforme, mas muito variável..... *Pentaceraster mammillatus*
20. R/r = à volta de 2. Raios tumescentes. Placas adambulacrárias com dois leques de, respectivamente, cinco (até sete) e quatro espinhos *Asterina burtonii*
- R/r = à volta de 1.5. Corpo em forma de almofada pequena. Placas adambulacrárias com apenas um ou dois espinhos no sulco *Patiriella exigua*

Survey of the species

Luidia maculata Müller & Troschel, 1842

(figs. 3-5, table 1)

Luidia maculata Müller & Troschel, 1842: 77; Peters, 1852: 178; Dujardin & Hupé, 1862: 433; Martens, 1865: 352; 1866: 84; 1869: 131; Perrier, 1869: 302; 1875: 338; 1876: 258; 1878: 35; Walter, 1885: 368; Bell, 1887b: 648; 1888: 384; Döderlein, 1888: 830; Sladen, 1888: 327; 1889: 246; Sluiter, 1889: 313; Lorient, 1893: 379; Bell, 1894: 403; Koehler, 1895: 387; Sluiter, 1895: 55; Thurston, 1895: 114; Döderlein, 1896: 307; Bedford, 1900: 293; Döderlein, 1902: 330; Bell, 1902: 228; Herdman & Herdman, 1904: 143; Fisher, 1906: 1035; Herdman, 1906: 121; Bell, 1909: 19; H.L. Clark, 1909: 529; Brown, 1910: 30; Koehler, 1910a: 10; 1910b: 267; Simpson & Brown, 1910: 49; Goto, 1914: 278; H.L. Clark, 1915: 86; Fisher, 1919: 168; Döderlein, 1920: 262; H.L. Clark, 1923: 252; Döderlein, 1926: 7;

Russo, 1929: 4; Mortensen, 1933a: 238; 1934: 5; H.L. Clark, 1938: 72; Domantay & Roxas, 1938: 208; Hayashi, 1938d: 276; Lopes, 1939: 73; Mortensen, 1940: 63; H.L. Clark, 1946: 71; Habe, 1952: 75; Hayashi, 1952: 144; Balinsky, 1958: 99; Endean, 1961: 289; A.M. Clark & Spencer Davies, 1966: 598; Domantay & Conclu, 1968: 161; Balinsky, 1969: 99; James, 1969: 52; James & Pearse, 1969: 80; A.M. Clark & Rowe, 1971: 43; Domantay, 1972: 73; Hayashi & Hirohito, 1973: 48; Jangoux, 1973: 7; Day, 1974: 94; A.M. Clark & Courtman-Stock, 1976: 45; Marsh, 1976: 216; Celis, 1980: 30; Price, 1981: 5; 1982: 522; A.M. Clark, 1982: 487; Price, 1983: 34; Aziz & Jangoux, 1984: 130; Jangoux, 1984: 279; Jangoux, 1986: 120; Aziz, 1986: 52; Fouda & Hellal, 1987: 10.

Luidia maculata ceylonica Döderlein, 1920: 265.

Luidia (Maculaster) cf. maculata; Marsh, 1974: 68.

Material.— Five specimens from Inhaca Island, Mozambique: Two specimens from the southern tidal flat of Ilha dos Portugueses, 27 vii, 1986; AE 5625: $r = 26$ mm, seven arms, broken off; AE 5626: $r = 24$ mm, eight arms, broken off, R at least 197 mm. AE 5664: one specimen off the Marine Biological Station, 2 m depth, R/r = 128/17 mm; (*) AE 5635 (= RMNH 5774): one specimen North of Portinho, 10 m depth, 2-11-1986, R/r = 196/20 mm; (*) AE 5647 (= RMNH 5775): one specimen off Barreira Vermelha, ("Casa de Christie"), 11 m depth, 14.i.1987, R/r = 56/5 mm.

Diagnosis.— Seven to nine arms, sometimes six. Dorsal paxillae with 10-30 broad-tipped central granules and up to 30 more slender and sometimes even tapering peripheral spinelets. Lateral arm plates quadrangular, forming longitudinal and transverse rows; mid-dorsal arm plates and central disc plates smaller and rounder paxillae. Bold colour pattern of groups of dark, bluish-grey and whitish plates on the dorsal side; ventral surface white. No large spines on the dorsal and supero-marginal plates.

Description.— In his monograph of the genus *Luidia*, Döderlein (1920) gave an extensive description of a series of specimens of *L. maculata* from Japan, indicating the following variation: number of rays 7-9, lateral paxillae in 4 (smaller specimens) to 5-6 (larger specimens) regular longitudinal series, marginal and lateral paxillae with pedicellariae in small ($R < 100$ mm) specimens (pedicellariae relatively larger in smaller specimens), numbers of central spinelets on paxillae increase with size of the animal from 6-9 in the smallest ($R < 65$ mm) to 10-12 ($R = 200$ mm) and 25-30 in the largest specimens ($R = 300$ mm), length of the marginal spines increases with the size of the animal, always being about twice the length of a lateral plate, the number of longitudinal series of ventro-lateral plates increases with the size of the animal from 1 ($R = 65$ mm) to 5-7 in the largest ($R = 300$ mm) specimens, the number of large spines on the infero-marginal plates increases from 1-2 in the smallest to 4-5 in the largest specimens.

The specimens from Inhaca range in size from $R = 56$ mm to 197 mm. The number of arms is seven or eight. The lateral paxillae are arranged in three ($R = 56$ mm) to 4-5 (larger specimens) regular longitudinal series. Pedicellariae are absent on virtually all supero-marginal plates and all lateral plates. In the larger specimens, most infero-marginal plates have a small, inconspicuous, bivalved pedicellaria near the base of the largest, most exterior spine. The smaller specimens have far fewer infero-marginal pedicellariae ($R = 128$ mm) or none at all ($R = 56$ mm). The number of spinelets on the largest lateral paxillae ranges from 10 in the smallest to 26 in the largest specimen. The number of longitudinal series of ventro-lateral plates, measured at half the arm's length, varies from 0 in the smallest to 3 in the largest specimen. In the smallest specimen, one longitudinal series of ventro-lateral pedicellariae extends to the seventh infero-marginal plate. The infero-marginal spines are, in all

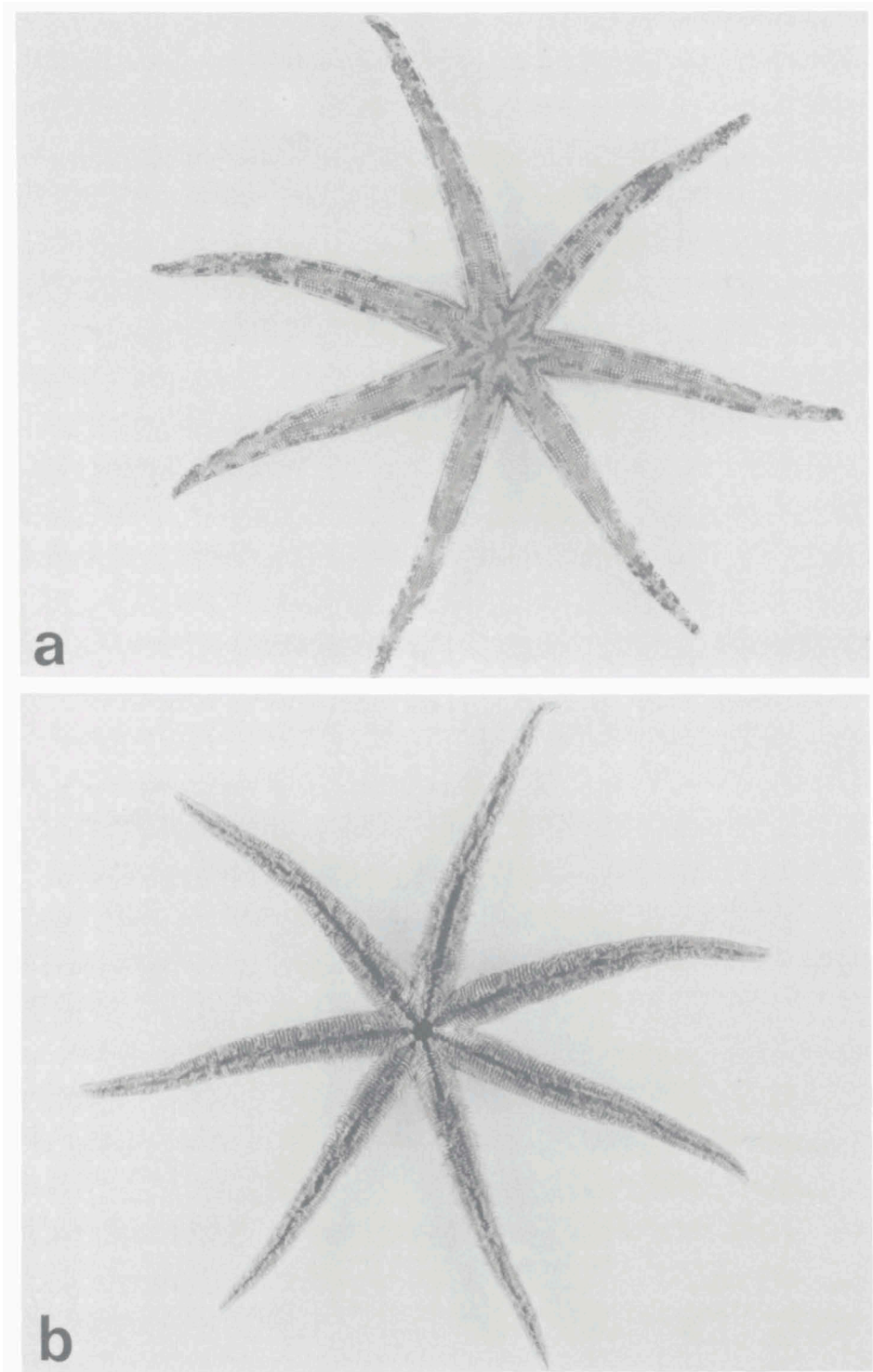


Fig. 3. *Luidia maculata*. AE 5664, R/r = 128/17 mm. a, habitus dorsally; b, habitus ventrally.

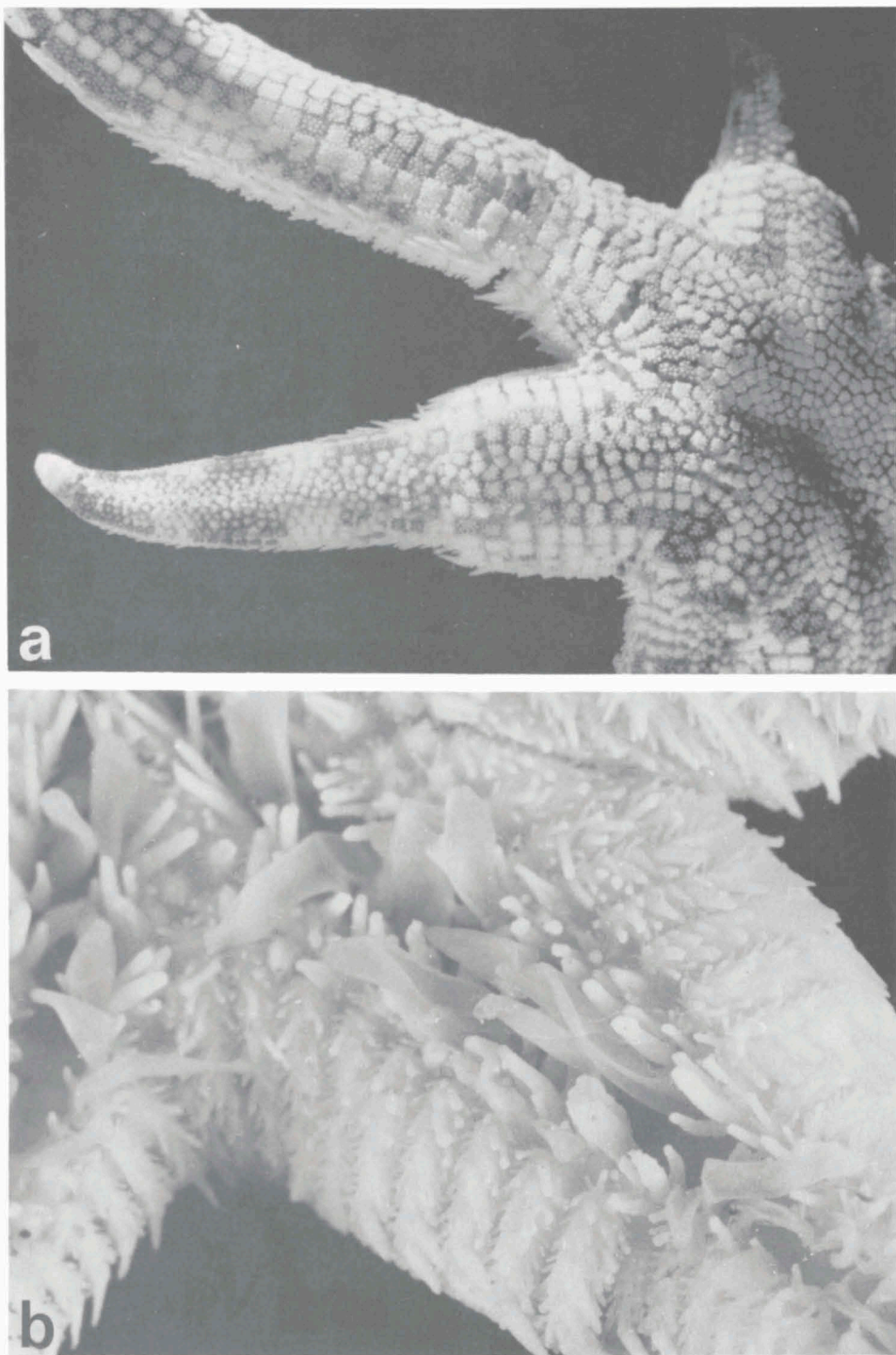


Fig. 4. *Luidia maculata*. Juvenile specimen (AE 5647, R/r = 56/5 mm). a, dorsal view of disk and arm basis; b, ventral view of disk and proximal part of arm.

specimens, about twice the length of a lateral paxilla, but vary in number from 2 in the smallest to 3-4 in the largest specimen. The number of adambulacral spines is invariably four. The pedicellariae on the ventro-lateral plates are shorter and relatively broader in smaller specimens; the length-width relationship is, for example, in the smallest specimen 2/1, and in a larger specimen (R = 128 mm) 14/5 (table 1 and fig. 3).

Distribution.— Common, and widely distributed in shallow waters of the Indo-West Pacific area, from Natal (A.M. Clark & Courtman-Stock, 1976) to the Red Sea and the Persian Gulf (Mortensen, 1940; James & Pearse, 1969; Fouada & Hellal, 1987), and east to Japan (Hayashi, 1938d), Australia (H.L. Clark, 1946), New Guinea, New Caledonia (Jangoux, 1986), possibly Hawaii (Döderlein, 1926), and Marquesas Islands (Marsh, 1974) (fig. 5).

Discussion.— Döderlein (1920) considered specimens of *Luidia maculata* from the western Indian Ocean, with finer and shorter spines on the infero-marginal plates and without any pedicellariae on the lateral and marginal plates, as a separate subspecies: *L. m. ceylonica*. Several authors, including Döderlein himself, have commented on the great variability of the number of pedicellariae in *Luidia*. The specimens from Inhaca Island have normal, strong spines on the infero-marginal plates, lack pedicellariae on the dorsal, lateral and supero-marginal plates, but usually have small, inconspicuous pedicellariae on the infero-marginal plates. The creation of a separate western Indian Ocean subspecies does not appear to be justified. A.M.

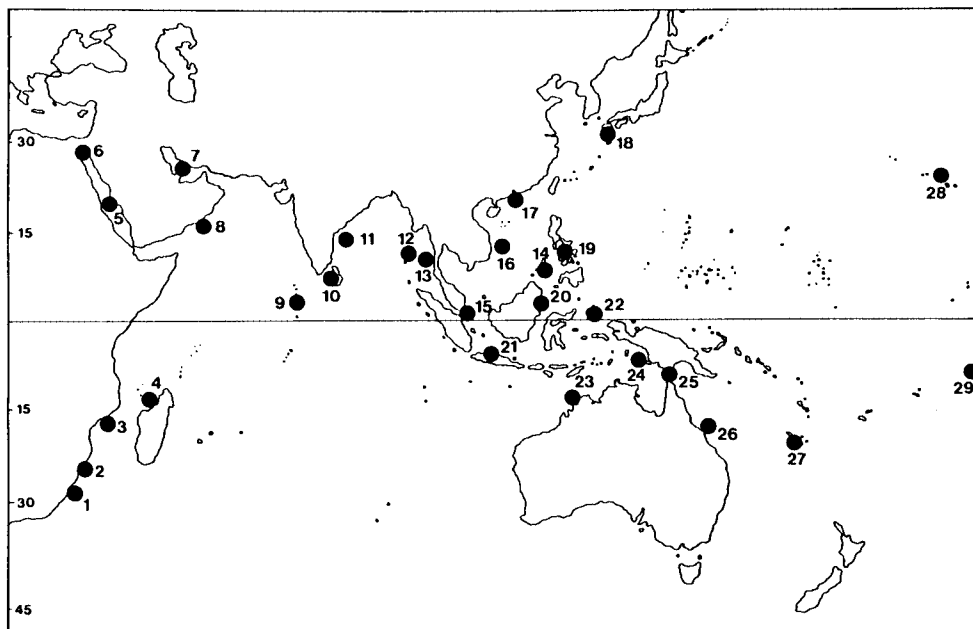


Fig. 5. *Luidia maculata*, geographical distribution. Explanation of the numbers used: 1, Natal (29° S); 2, Inhaca Island; 3, northern Mozambique; 4, Madagascar; 5, Red Sea; 6, Gulfs of Suez and Aqaba; 7, Persian Gulf; 8, SE Arabia; 9, Maldives; 10, Sri Lanka; 11, Bay of Bengal; 12, Andaman Islands; 13, Mergui Islands; 14, Sulu Sea; 15, Singapore; 16, South China Sea; 17, Hong Kong; 18, southern Japan; 19, Philippines; 20, Borneo; 21, Java; 22, Moluccas; 23, NW Australia; 24, Aru and Kei Islands; 25, Torres Strait; 26, Queensland; 27, New Caledonia; 28, Hawaii Islands; 29, Marquesas.

Clark (1953) described a form of *Luidia maculata*, with six arms and an enlarged central spinelet on the paxillae of the disc and the arm basis, as *L. m.* forma *herdmani*, which was later (A.M. Clark & Rowe, 1971) raised to specific rank as *L. herdmani* Clark, 1953. Jangoux (1973) included *Luidia maculata* var. *herdmani* in the synonymy of *L. maculata*, but did not give a justification. Marsh (1974) described, "with some hesitation", an incomplete, juvenile ($R/r = 37/5$ mm) specimen of *Luidia* from the Marquesas Islands as *Luidia (Maculaster) cf. maculata*. The specimen differs from other described forms of *L. maculata* mainly in the shape of its pedicellariae, which "have shorter and broader blades than is usual..."

The collection from Inhaca contains a juvenile specimen of *L. maculata* (fig. 4), which agrees very well with the description of Marsh (1974) of her small specimen. I am inclined to accept this record from the Marquesas Islands. Döderlein (1926: 7) briefly described a very small specimen ($R/r = 11/3$ mm) from Honolulu with eight arms, which he "believed" to be *L. maculata*. For zoogeographical reasons, Jangoux (1973) thought this record to be a confusion with *L. australiae*, and Aziz (1986) reported it as being doubtful, citing A.M. Clark & Rowe (1971), who, indeed, do not report the species from Hawaii. In view of the Marquesas Islands record of *L. maculata* by Marsh (1974), there may be reasons to accept Döderlein's Hawaiian record, although it concerns a very young specimen with few if any of the diagnostic characters developed well enough to make a definite identification possible. Considering the distribution of *L. maculata* known at present, Döderlein's record of the species from Thursday Island (1896) appears to be quite acceptable (H.L. Clark, 1938; Jangoux, 1973).

***Luidia savignyi* (Audouin, 1826)**
(figs. 6-7, table 1)

Asterias savignyi Audouin, 1826: 209, pl.3, fig. 1.

Luidia savignyi; Martens, 1869: 131 Perrier, 1869: 299; 1875: 340; 1876: 260; 1878: 91; Loriol, 1885: 72; Sladen, 1889: 246; Ludwig, 1899: 539; Koehler, 1910a: 10; Fisher, 1919: 170; Döderlein, 1920: 240, 261; H.L. Clark, 1923: 252; Russo, 1929: 4; Mortensen, 1933a: 219; A.H. Clark, 1952: 265; A.M. Clark, 1953: 385; Balinsky, 1958; 1969: 99; James, 1969: 52; James & Pearse, 1969: 81; A.M. Clark & Rowe, 1971: 43; Domantay, 1972: 74; Jangoux, 1973: 5; A.M. Clark, & Courtman-Stock, 1976: 45; Tortonese, 1979: 318; Jangoux & Aziz, 1984: 860; Jangoux, 1984: 279; 1986: 120; Aziz, 1986: 56; Fouda & Hellal, 1987: 11.

Luidia savignii Gray, 1840: 183; Müller & Troschel, 1842 (*pars*): 77; Dujardin & Hupé, 1862: 432; Gray, 1866: 4; 1872: 119; Bell, 1903: 244; 1909: 19. [Not: *Luidia savignii*; Bell, 1889b: 422].

Luidia aspera; Simpson & Brown, 1910: 49. [Not: *Luidia aspera* Sladen, 1889: 248].

Luidia mascarena Döderlein, 1920: 240, 261; A.H. Clark, 1952: 284.

Material.— Four specimens from Inhaca Island, Mozambique. AE 5640: $R/r = 85/10$ mm, off Marine Biological Station, 14 m depth; AE 5629: $R/r = 79/11$ mm, off Marine Biological Station, 3 m depth, 3.xi.1986; (*) AE 5627 (= RMNH 5776): $R/r = 157/15$ mm, off Barreira Vermelha, 1 m depth, 19.x.1986; (*) AE 5665 (= RMNH 5777): $R/r = 56/10$, off Marine Biological Station, 12 m depth.

Diagnosis.—Seven, sometimes fewer, arms. Paxillae with 5-10 central spinelets, surrounded by finer and more numerous peripheral spinelets. Lateral paxillae large and quadrangular, forming transverse rows and up to five longitudinal series on

each side; some lateral plates with a large and pointed central spine. Supermarginal paxillae similar, but narrower than lateral plates and always spineless. No large, bivalved pedicellariae on the adoral surface of the jaws.

Description.— *Luidia savignyi* has been described in detail by Loriol (1885) and Koehler (1910a). The specimens from Inhaca Island all have seven arms, which they did not shed as easily as *L. maculata*. The specimens show little variation. The numbers of regular longitudinal series of lateral paxillae may vary, even within a single specimen, from three to six, their regularity often being disrupted by the larger paxillae, which bear a strong, central spine. There are no dorsal or lateral pedicellariae. Pedicellariae are only found on the small ventro-lateral plates, inserted on the adambulacral plates. There is at most one longitudinal series of these pedicellariae, but often some, or all of these, are replaced by small groups of slender spines. The numbers and size of the central paxillar spinelets are more variable and less related to body size than in *L. maculata*. These spinelets are also less numerous (8-12). The number of large spines on the infero-marginal plates does increase with body size from 3 in the smallest ($R/r = 56/10$ and $85/10$ mm) to 5 in the largest ($R/r = 157/15$ mm) specimens. The largest infero-marginal spines are as long as, or slightly longer than two lateral plates (table 1 and fig. 6).

Table 1. Comparative measurements on five specimens of *Luidia maculata* and four specimens of *L. savignyi* from Inhaca Island, Mozambique.

NA = number of arms; LSLP = longitudinal series of lateral paxillae; IP = infero-marginal pedicellariae (- = none at all, +/- = on some plates, 1 = one small pedicellaria on each plate); NCS = number of central spinelets on largest lateral plates; LSVL = number of longitudinal series of ventro-lateral plates at half the arm's length; IS = number of infero-marginal spines.

A. <i>Luidia maculata</i>							
Coll. No.	R/r mm	NA	LSLP	IP	NCS	LSVL	IS
AE 5647	56/5	7	3	-	10	1	2
AE 5664	128/17	7	4	+/-	17	2	3
AE 5635	196/20	8	4-5	1	19	2-3	2-3
AE 5625	/26	7	4	1	22	2	3-4
AE 5626	197/24	8	4-5	1	26	3	3-4
B. <i>Luidia savignyi</i>							
AE 5665	56/10	7	3	-	8	1	2
AE 5629	79/11	7	3	-	8	1	2
AE 5640	85/10	7	4	-	12	1	2
AE 5727	157/15	7	6	-	10	1	2-3

Distribution.— Indo-West Pacific from Natal (A.M. Clark & Courtman-Stock, 1976) to the Red Sea (Fouda & Hellal, 1987), and east to Sri Lanka and the Andaman Islands (Koehler, 1910a; A.M. Clark, 1953), the Philippines (Fisher, 1919), the Marshall Islands (A.H. Clark, 1952) and New Caledonia (Jangoux, 1986) (fig. 7).

Discussion.— A.M. Clark (1953) synonymized *L. mascarena* Döderlein, 1920, with *L. savignyi*, because the only difference between the two forms, viz. the absence or presence of pedicellariae, proved to be a highly variable feature, as had already been mentioned by Koehler (1910a). A *Luidia* specimen from the Gulf of Manaar, reported by Bell in Herdman (1904) as *L. hardwicki*, may, according to A.M. Clark (1953) come within the range of variation of *L. savignyi* (see Aziz, 1986: 57). Fisher (1919) identified as *L. savignyi* Sladen, 1889, a *Luidia* specimen from Mozambique, recorded by

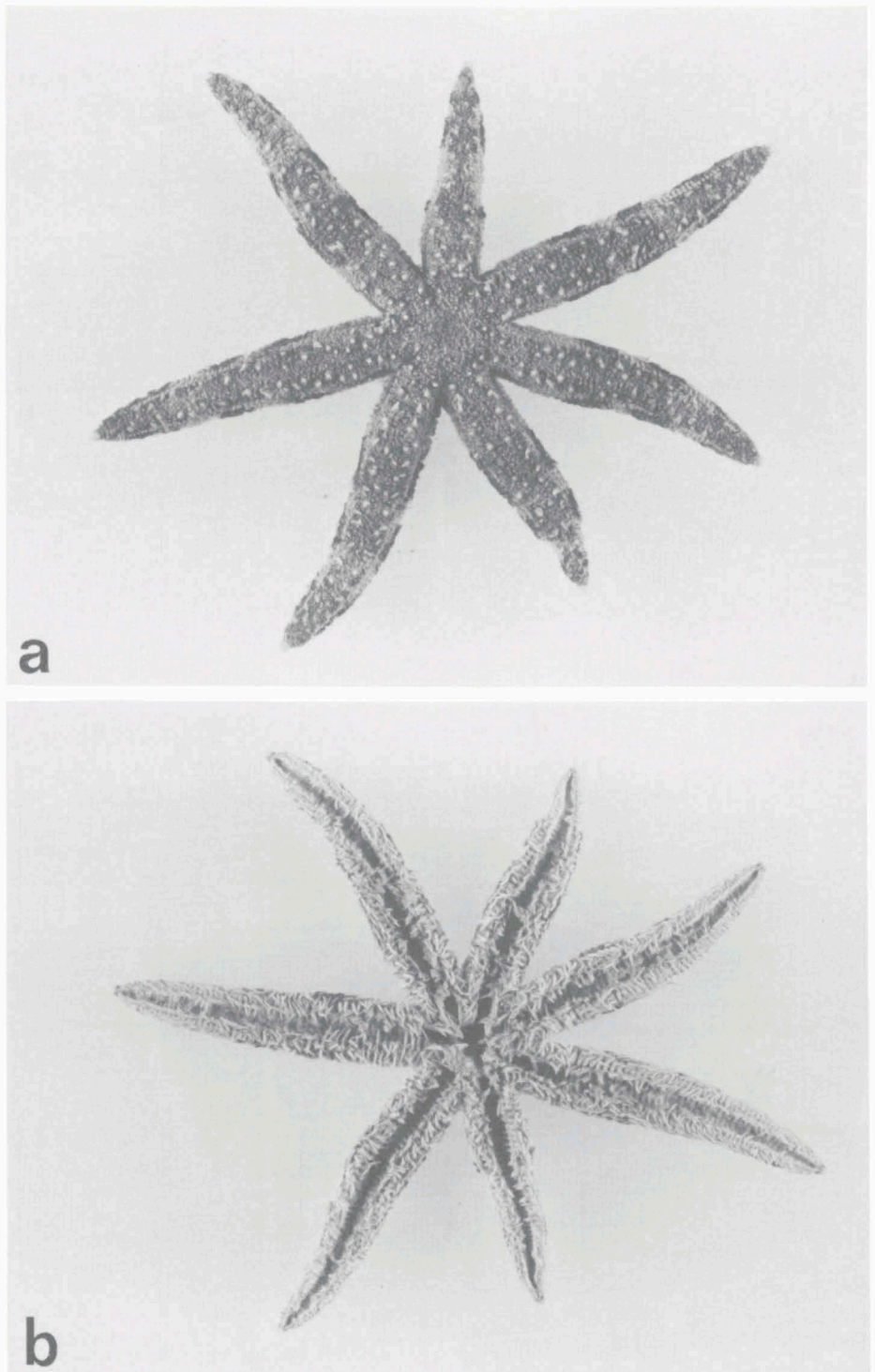


Fig. 6. *Luidia savignyi*. AE 5665, R/r = 56/10 mm. a, habitus dorsally; b, habitus ventrally.

Simpson & Brown (1910) as *L. aspera*. (see also A.M. Clark (1953) and Jangoux (1973)). According to A.M. Clark (1953), the very large nine-rayed specimen from Mauritius, recorded by Bell (1889b: 422), is not *L. savignyi*, but *L. mauritiensis* Koehler, 1910a.

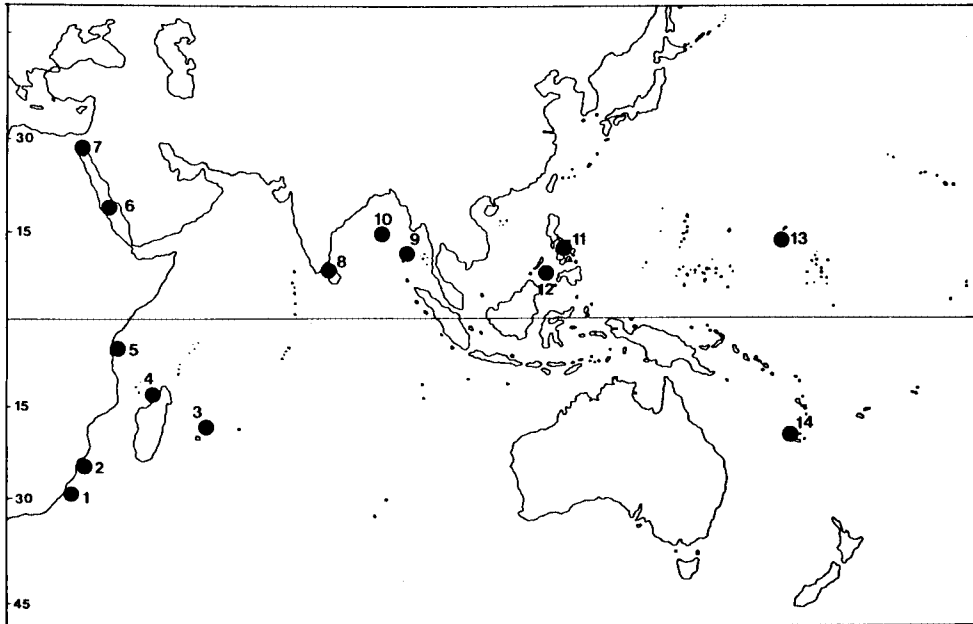


Fig. 7. *Luidia savignyi*, geographical distribution. Explanation of the numbers used: 1, Natal (29° S); 2, Inhaca Island; 3, Mauritius; 4, Madagascar; 5, Zanzibar; 6, Red Sea; 7, Gulfs of Suez and Aqaba; 8, Sri Lanka; 9, Andaman Islands; 10, Bay of Bengal; 11, Philippines; 12, Sulu Islands; 13, Marshall Islands; 14, New Caledonia.

Astropecten monacanthus Sladen, 1883

(figs. 8, 9, table 2)

Astropecten monacanthus Sladen, 1883: 263; 1889:216; Bell, 1899: 136; Koehler, 1905b: 458; 1910a: 37; Döderlein, 1917: 150; Fisher, 1919: 74; McNeill & Livingstone, 1926: 194; Russo, 1929: 5; Macan, 1938: 336; H.L. Clark, 1938: 63; 1946: 76; John, 1948: 491; Endean, 1957: 237; A.M. Clark & Spencer Davies, 1966: 598; McKnight, 1968: 712; A.M. Clark & Rowe, 1971: 46; Domantay, 1972: 66; Marsh, 1974: 100; 1976: 216; Price, 1981: 5; 1982: 522; A.M. Clark, 1982: 487; Price, 1983: 37; Aziz & Jangoux, 1984: 137; Aziz, 1986: 88; Fouda & Hellal, 1987: 15.

? *Astropecten notograptus* Sladen, 1888: 325; Döderlein, 1917: 53; Aziz, 1986: 89.

Astropecten squamosus Sluiter, 1889: 309; Döderlein, 1917:150.

Astropecten granulatus; Jangoux, 1973: 10 [Non: *Astropecten granulatus* Müller & Troschel, 1842].

Material.— 1. 24 specimens from Inhaca Island, Mozambique. AE 5631: one specimen, off Marine Biological Station, 10 m depth, 2.xi.1986, R/r = 17/5 mm; AE 5636: one specimen, between Portinho and Ilha dos Portugueses, 10 m depth, 2.xi.1986, R/r = 15/5 mm; (*) AE 5633 (= RMNH 5778): two specimens, between Ponta Rasa and the Marine Biological Station, 10 m depth, 2.xi.1986, R/r = 18/5 and 16/5 mm; AE5634: two specimens, off Marine Biological Station, 20 m depth, 1.xi.1986, R/r = 20/7 and 15/5 mm; AE 5643: one specimen, off Marine Biological Station, 7-12 m depth, 2-11-1986, R/r = 15/5 mm; AE 5609: one specimen, between Ponta Rasa and Ponta Punduini, littoral sands, 1.viii.1984, R/r = 53/15 mm; AE 5637: one specimen, off Marine Biological Station, 8 m depth, 18.xii.1986, R/r = 22/6 mm; AE 5638: one specimen, between Marine Biological Station and Barreira

Vermelha, 6 m depth, 14.i.1987, R/r = 19/5 mm; AE 5641: one specimen, SW off Ilha dos Portugueses, 14 m depth, 6.ii.1987, R/r = 9/4 mm; AE 5642: three specimens, off Barreira Vermelha, 12 m depth, 19.x.1986, R/r = 15/6, 15/5 and 14/5 mm; AE 5630: seven specimens, on sandy intertidal flat, off Ponta Rasa, 1.xi.1986, R/r = 46/14, 45/14, 40/11, 39/11, 33/9, 31/9 and 30/8 mm; (*) AE 5610 (= RMNH 5779): three specimens, off Ponta Rasa, sandy intertidal flat, 20.i.1982, R/r = 57/15, 47/12 and 28/9 mm. 2. Nine specimens, on sandy tidal flat off Costa do Sol, Maputo, Mozambique. AE 5624: three specimens, 1.x.1983, R/r = 45/13, 34/9 and 24/8 mm; (*) AE 5611 (= RMNH 5780): three specimens, 7.x.1987, R/r = 54/14, 51/14 and 51/14 mm; AE 5602: three specimens, 7.x.1987, R/r = 53/15, 52/14 and 50/14 mm. 3. Six specimens in the British Museum (Natural History). BM(NH) 90.5.7.302-3, type specimens, R/r = 24/6 and 21/6 mm, Challenger Expedition Station 203 (11° 7' N, 123° 7' E, 12-20 fms., mud); BM(NH) 88.12.19 (part), R/r = 27/8 mm, Tuticorin, coll. E. Thurston (label with: *A. notograptus* = *A. monacanthus*); BM(NH) 1937.6.18.52, R/r = 41/12 and 43/13 mm, Ras al Hadd, Arabia, 16-22 m, John Murray Expedition, Sta. 80, 30.xi.1933, T.T. Macan, 1935; BM(NH) 1983.2.15.106, R/r = 43/12 mm, Tai Long Sai Wan, Hong Kong, in sand. 4. 51 specimens from Inhaca Island, Mozambique, 7.viii.1969, in the Tervuren Museum, MRAC RG No. 1270, identified as *A. granulatus*, as listed in Jangoux (1973).

Diagnosis.— An *Astropecten* species with five, evenly tapering rays. Superomarginal plates wider than long, without any spines or with a very small abradial spine. One large, pointed exterior infero-marginal spine with one or two much smaller spines below it. Ventral surface of infero-marginal plates without any enlarged spines, evenly covered by short, squamose spines. Only two ventro-lateral plates on each side of the rays. Two or three very broad and flattened, spatulate spines on the ventral surface of the adambulacral plates.

Description.—The five arms taper evenly to a rather acute tip with a strong terminal plate. The R/r ratio varies from 2.3 in the smallest specimen (R = 9 mm) to 3.9 in the largest (R = 47-54 mm). The arms are about three times as long as wide at their bases. The paxillar areas occupy from one half to two thirds of the arm's width. In the larger specimens, there are about eighteen paxillae between the first superomarginal plates. The paxillae bear from one, in the smallest, to twenty (in the largest specimens) central spinelets, surrounded by a slightly larger number of rather more slender peripheral spinelets. Except for some small specimens, the peripheral spinelets do not extend beyond the central ones. In all specimens, there are about five paxillae to two supero-marginal plates. The centre of the disc may be flat or protruding in a distinct cone, or, rarely, sunk in.

The colour of the specimens preserved in alcohol 70% is whitish. The dorsal surface of some specimens has dark radial stripes, occupying about three series of carinal paxillae. In other specimens there may be an additional dark pentagon around the central protuberance and/or dark lines along the supero-marginal plates, particularly in the proximal half of the arm. Those specimens usually also have darkened terminal plates and dark transverse bands at about the 9-13th superomarginal plates. Rarely, a second band is visible at the 6th supero-marginal plates.

Other, live, specimens have the dorsal face of the supero-marginal plates darkened, in combination with a mid-radial dark stripe, a darkened central area and a large, dark, sometimes distinctly triangular spot in each interradial area. There may be a dark transverse band on the arms at about the 9th-10th supero-marginal plates (table 2). The ventral surface is yellowish white.

The madreporite is inconspicuous, about as large as two surrounding paxillae and, in the larger specimens, separated from the supero-marginal plates by three or four rows of paxillae. The supero-marginal plates are all wider than long, even in the

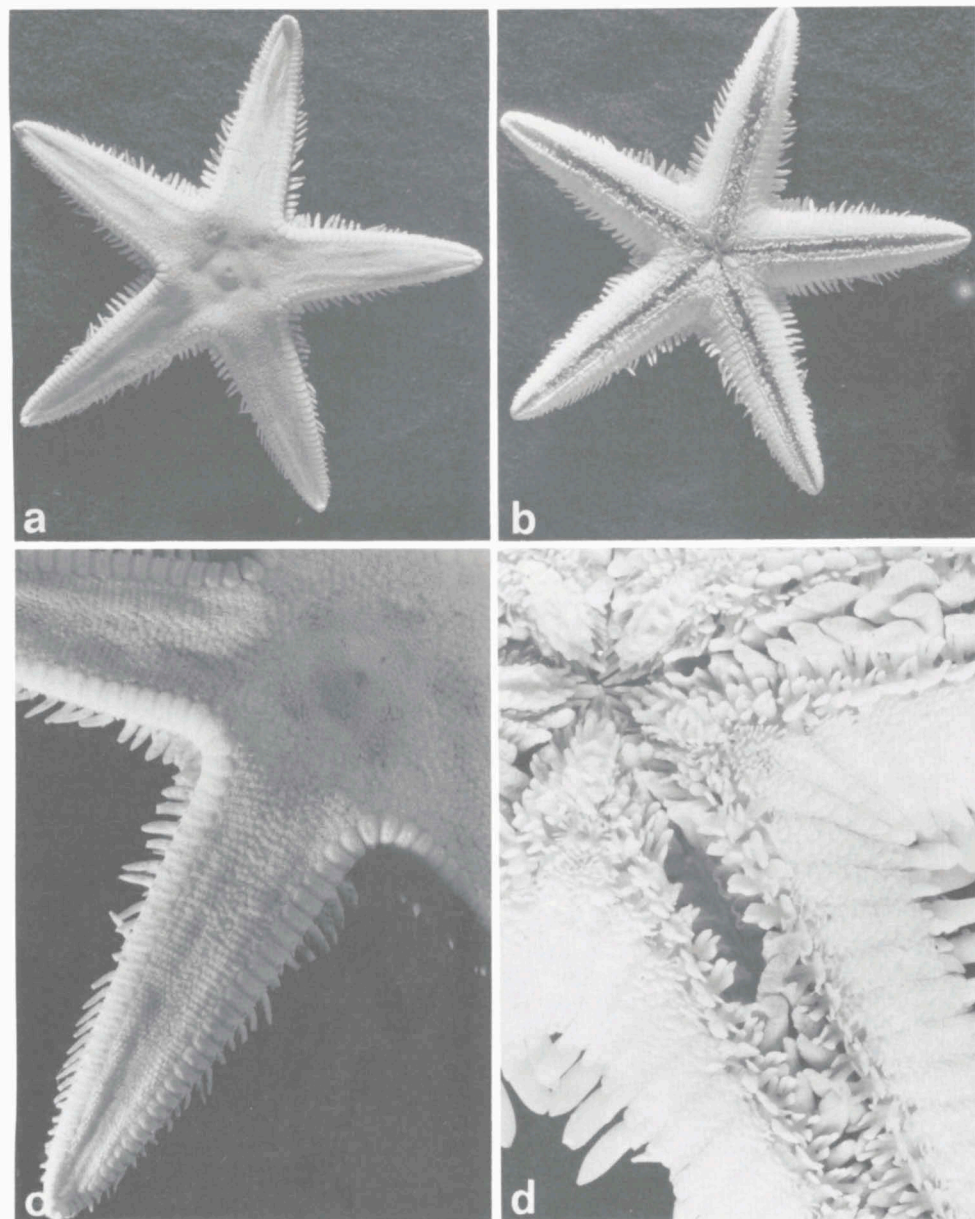


Fig. 8. *Astropecten monacanthus*. AE 5511, R/r = 51/14 mm. a, habitus dorsally; b, habitus ventrally; c, dorsal view of arm; d, ventral view of arm basis.

smallest specimens. They are covered with low, smooth, at times rather angular, granules forming about four irregular transverse rows in the larger specimens. The peripheral spinelets are much finer and have below them, in the grooves between the plates, very thin, needle-like spinelets. In many, larger, specimens one granule, on the outer margin, is slightly enlarged to an inconspicuous spinelet, particularly in the distal part of the arm. These spinelets may be only marginally larger than the sur

Table 2. Comparative measurements on 33 specimens of *Astropecten monacanthus* from southern Mozambique.

Rat. = R/r ratio; CP = maximum number of central paxillar spinelets found in arm bases; AWL = width/length ratio of the arms; PA = width paxillar area in relation to whole arm base; NSM = number of supero-marginal plates; FSMS = first supero-marginal plate bearing a spine(let), - = no enlarged granules; VS = estimated volume of the supero-marginal spines in relation to the surrounding granules; SMWL = width/length ratio of the fifth supero-marginal plate.

Coll.no.	R/r mm	Rat.	CP	AWL	PA	NSM	FSMS	VS	SMWL
AE 5602	53/15		3.5	12	0.3	0.6	31	1-4	4 2.0
	52/14	3.7	13	0.3	0.7	33	1	4	2.3
	50/14	3.6	16	0.3	0.5	32	1	3	2.3
AE 5611	54/14	3.9	14	0.3	0.7	34	1	4	1.8
	51/14	3.6	15	0.3	0.7	31	2-3	3	1.9
	51/14	3.6	23	0.3	0.6	31	-	-	1.8
AE 5624	45/13	3.5	20	0.3	0.6	28	21	2	1.4
	34/9	3.8	10	0.3	0.7	27	3-12	2	1.3
	24/8	3	7	0.3	0.6	23	-	-	2.2
AE 5609	53/15	3.5	16	0.3	0.6	33	6	2	2.1
AE 5610	57/15	3.8	18	0.3	0.7	35	1	3	2.1
	47/12	3.9	16	0.3	0.6	30	12	2	1.6
	28/9	3.1	7	0.3	0.6	18 ^a	-	-	1.6
AE 5642	15/6	2.5	6	0.3	0.6	17 ^b	-	-	1.6
	15/5	3	5	0.4	0.6	17 ^b	-	-	1.3
	15/5	2.8	4	0.4	0.6	16 ^b	-	-	1.6
AE 5634	20/7	2.9	6	0.4	0.6	19 ^c	-	-	1.3
	15/5	3	5	0.3	0.6	16 ^d	-	-	1.2
AE 5630	46/14	3.3	18	0.3	0.7	28	8	4	2.0
	45/14	3.2	23	0.3	0.8	27	1	3	1.3
	40/11	3.6	16	0.3	0.8	27	5	2	1.7
	39/11	3.5	14	0.3	0.8	27	-	-	1.7
	33/9	3.7	12	0.3	0.7	26	7 ^e	2	1.4
	31/9	3.4	17	0.4	0.6	26	9	2	1.8
AE 5631	30/8	3.8	15	0.3	0.7	26	-	-	1.4
AE 5631	17/5	3.4	2 ^f	0.3	0.7	20 ^g	-	-	1.3
AE 5638	19/5	3.8	6	0.3	0.7	20	-	-	1.3
AE 5643	15/5	3	4 ^f	0.3	0.6	18 ^g	-	-	1.5
AE 5633	18/5	3.6	5	0.3	0.7	20 ^h	-	-	1.3
	16/5	3.2	3	0.4	0.6	16 ^c	-	-	1.5
AE 5637	22/6	3.7	8	0.3	0.8	21 ^c	-	-	1.4
AE 5641	9/4	2.3	1	0.4	0.6	14	-	-	1.2
AE 5636	15/5	3	2	0.4	0.5	17	-	-	1.4

Note. a = arm tips regenerated; b = dark transverse band at 10th-13th supero-marginal plates; c = dark transverse band at 9th-11th supero-marginal plates; d = dark transverse band at 6th and at 10th-12th supero-marginal plates; e = on some arms only; f = peripheral spinelets larger than central ones; g = dark transverse band at 11th-13th supero-marginal plates; h = dark transverse bands at 12th-14th supero-marginal.

rounding granules or up to four times as large (table 2). In some specimens, the first supero-marginal plates have up to six such enlarged granules in a transverse row starting near the dorsal paxillae.

The infero-marginal plates have a strong, flattened and pointed exterior spine, almost as long as the plates are wide, followed by a less than half as long secondary spine and, occasionally one to three much smaller spines, which are about twice as long as the short, flat and broad squamose spinelets, which evenly cover the ventral

surface of the plates. The first infero-marginal plates usually have much smaller exterior spines and may show a transverse (interradial) row of enlarged, at times even pointed, squamose spinelets on the ventral surface (fig. 8d).

There are two ventro-lateral plates on each side of the arm, even in the smallest specimens. Their armature resembles that of the infero-marginal plates, although the spinelets are generally only half as wide as the infero-marginal squamules. Near the oral plates, the spinelets are often much more slender.

The adambulacral plates typically have three furrow spines, of which the middle one is the longest and curved. The straight ad- and aboral furrow spines may be broadened distally. On the ventral surface of the adambulacral plates there are one to three series of spines. Near the mouth the plates typically bear two smallish straight spines behind the furrow spines, followed by two flattened and very broad, spatulate spines, of which the aboral one usually is somewhat larger. Half way along the arm, the base of the aboral spine of the second series is in line with the spatulate spines, although it never gets to be as wide as the other two. The adoral spine of the second series either remains present, or becomes smaller or disappears. Abradially to the broad, spatulate spines there may be one or two much more slender spines. The most adoral adambulacral plates have more series of spines. The oral plates have six strong, straight spines in the mouth, followed by about five smaller spines on each side. The ventral surface of the plates bears two to four, rather irregular, interradian series of short, distally broadened spines, with a series of slender peripheral spinelets on the lateral and aboral sides. All specimens are completely devoid of pedicellariae (fig. 8).

Distribution.— From southern Mozambique (Inhaca Island and Maputo Bay; first records), along the East African coast to the Red Sea, Saudi Arabia (Döderlein, 1917; Price, 1981, 1982, 1983), the Maldives (John, 1948), Sri Lanka, Bay of Bengal, the Andaman Islands (A.M. Clark & Rowe, 1971), Indo-Malaysian area (Aziz, 1986), Philippines (Fisher, 1919), China Sea (Döderlein, 1917), northern Australia (Marsh, 1976), Marshall Islands (A.H. Clark, 1952) and Tongatabu, southern Pacific (McKnight, 1968). The Inhaca and Maputo findings appear to be the most southern records for the western Indian Ocean (fig. 9).

Habitat.— The specimens, which were collected with a fine-meshed dredge in shallow (12-20 m) water off Inhaca are all juveniles ($R = < 22$ mm). The larger specimens ($R = 24-57$ mm) were all collected at low tide on intertidal sand flats. Often the sand had fallen dry and the presence of the starfishes, which were buried a few centimeters deep, was denoted by a faint pentagonal outline in the sand.

Discussion.— A.M. Clark & Rowe (1971) synonymized *Astropecten notograptus* Sladen, 1888, with *A. monacanthus* and I agree that the differences listed by Sladen and Döderlein (1917: 53) to distinguish between the two largely fall within the range of variation observed in the Inhaca specimens of *A. monacanthus* (table 2). The single, interior spine on the first supero-marginal plates of the type of *A. notograptus* (Sladen, 1888, pl. 28) is, however, not accounted for by A.M. Clark & Rowe (1971). Döderlein (1917: 151) found the type specimen of *Astropecten squamosus* Sluiter (1889: 309) to belong to *A. monacanthus*. The photograph of Sluiter's type specimen certainly agrees with the Inhaca material of *A. monacanthus*. Sluiter's mentioning of six adambulacral furrow spines may refer to the most adoral plates. Jangoux (1973)

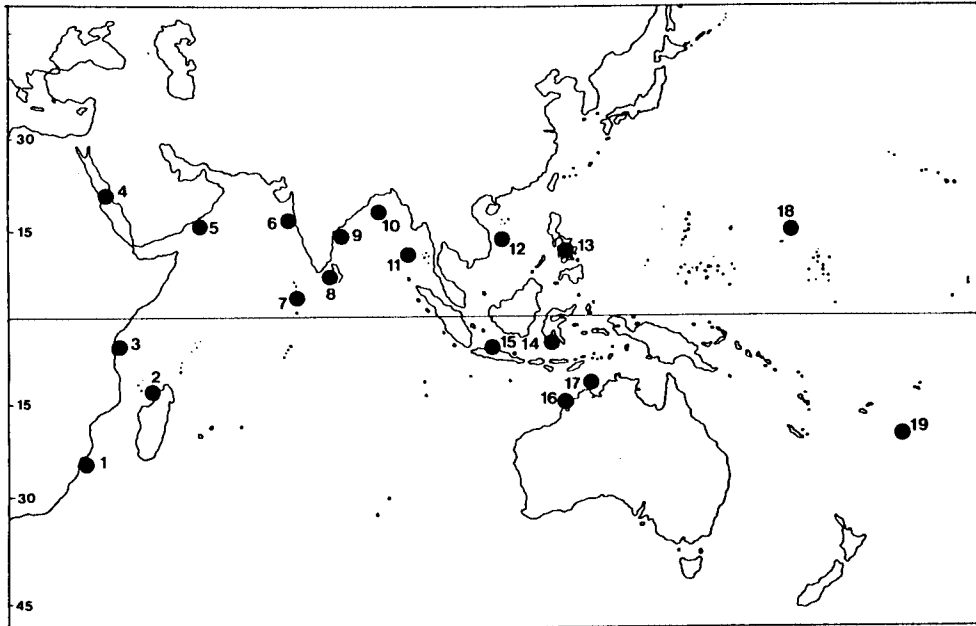


Fig. 9. *Astropecten monacanthus*, geographical distribution. Explanation of the numbers used: 1, Inhaca Island; 2, Madagascar; 3, Zanzibar; 4, Red Sea; 5, SE Arabia; 6, West of India; 7, Maldives; 8, Sri Lanka; 9, East of India; 10, Bay of Bengal; 11, Andaman Islands; 12, China Sea; 13, Philippines; 14, Sulawesi; 15, Java; 16-17, NW Australia; 18, Marshall Islands; 19, Tongatabu.

reported on 51 specimens of *Astropecten* from Inhaca Island, which he identified as *A. granulatus* Müller & Troschel, 1842. The ventral surface of the infero-marginal plates of these specimens is covered by squamose spines, the only larger spines being the large exterior spine with one or two secondary spines. This rather excludes *A. granulatus*, which is characterized by an aboral row of enlarged spines on the ventral surface of the infero-marginal plates (Döderlein, 1896: 306, and Koehler, 1910a: 40). This fact, and an investigation of Jangoux's material in the Tervuren Museum have convinced me that his specimens, which also show the distinctly broadened subambulacral spines, belong to *A. monacanthus* rather than to *A. hemprichii*, as was suggested by A.M. Clark & Courtman-Stock (1976) and Price (1983).

***Astropecten hemprichii* Müller & Troschel, 1842** (figs. 10, 11, table 3)

- Astropecten hemprichii* Müller & Troschel, 1842: 71; Peters, 1852: 178; Dujardin & Hupé, 1862: 419; Martens, 1869: 131; Gray, 1872: 119; Bell, 1884c: 509; Lorient, 1885: 74; Bell, 1888: 384; Sladen, 1888: 324; 1889: 196; Thurston, 1895: 114; Pfeffer, 1896: 47; Ludwig, 1899: 539; Bell, 1903: 244; Herdman & Herdman, 1904: 139; Herdman, 1906: 447; Simpson & Brown, 1910: 48; Goto, 1914: 119; H.L. Clark, 1915: 94; 1923: 250; Mortensen, 1933a: 232; Day & Morgans, 1956: 308;
- Astropecten hemprichi*; Perrier, 1878: 89; Bell, 1909: 19; Döderlein, 1917: 139; A.M. Clark, 1967: 38; A.M. Clark & Rowe, 1971: 45; Day, 1974: 94; A.M. Clark & Courtman-Stock, 1976: 50; Jangoux, 1973: 12; Price, 1981: 5; 1982: 522; 1983: 34; Jangoux & Aziz, 1984: 860; Fouda & Hellal, 1987: 14.
- Astropecten mauritanus*; Möbius, 1880: 50 [?Not: *Astropecten mauritanus* Gray, 1840].

Astropecten tamilicus; Döderlein, 1888: 829; Koehler, 1910a: 41; H.L. Clark, 1915: 94; Jangoux, 1978: 292; Aziz, 1986: 98.

Astropecten hemprichi tamilicus Döderlein, 1917: 140.

? *Astropecten granulatus*; Kalk, 1954: 113; Balinsky, 1958; 1969: 99; Macnae & Kalk, 1962: 114 [Not: *Astropecten granulatus* Müller & Troschel, 1842].

? *Astropecten acanthifera*; Macnae & Kalk, 1962: 115.

Material.— 1. Two specimens from littoral sandy flat off Costa do Sol, Maputo, Mozambique, 17.xi.1986. (*) AE 5802 (= RMNH 5781): R/r = 64/17 mm; AE 5801: R/r = 73/19 mm. 2. Four specimens from Inhaca Island, Mozambique. AE 5628: R/r = 21/6 mm, off Barreira Vermelha, 12 m depth, 19.x.1986; (*) AE 5632 (= RMNH 5782): R/r = 20/6 mm, off Marine Biological Station, 7-12 m depth, 2.xi.1986; (*) AE 5648 (= RMNH 5783): R/r = 4/2 mm, off Barreira Vermelha, 15 m depth, 14.i.1987; AE 5639: R/r = 6/3 mm, off Barreira Vermelha, 17 m depth, 14.i.1987. 3. Three specimens in the British Museum (Natural History). BM(NH) 86.6.26.50, R/r = 51/16 mm, labelled: "*Astropecten hemprichii Tamilicus*, Andaman Islands, Dr. Anderson"; BM(NH) 1955.3.25.35, R/r = 101/23 mm, Morumbene Estuary, Mozambique, Cape Town University Expedition, 16.vii.1954; BM(NH) 1958.11.16.1, R/r = 25/8 mm, Inhaca Island, Dr. W. Macnae, identified by Macnae as *A. granulatus*, by A.M. Clark in 1958 as *A. granulatus natalensis* and in 1972 as *A. hemprichii*. 4. Four specimens from Inhaca Island, Mozambique, in the Tervuren Museum, 7.viii.1969, MRAC-ULB, as listed in Jangoux (1973).

Diagnosis.— Five flat arms tapering to a rather acute tip. Two ventro-lateral plates on each side of the arm. Infero-marginal plates with one large, pointed, flattened spine, followed by a much smaller spine below it, and by an aboral, transverse row of again much smaller spines. Supero-marginal plates, when viewed from above, broader than long, without interior (adradial) spines, but with a rather stout, conical spine on the outer edge of the distal plates. Paxillae with eighteen or less central spinelets.

Description.— The following description is based on the largest specimen (R = 73 mm). The disc and arms are flattened. The five rays taper evenly to rather acute tips. The paxillae are rather small, about fifteen in number between the aboral edges of the first supero-marginal plates. The paxillae bear up to fifteen central spinelets (usually less) and slightly more, very similar peripheral spinelets. The rays are about four times as long as the width of the arm base, the paxillae occupying more than half of the latter. The madreporite is partly hidden by the adjacent paxillae. It has a size of about three paxillae and shows fine, radiating grooves.

The 29 supero-marginal plates along each side of the arm are, when viewed from above, all wider than long. There are no internal (adradial) spines, but every plate, with the exception of the first three, has a short, blunt, conical spine on the outer, abradial margin. On the first spine-bearing plates this spine is merely an enlarged granule, but after the eighth plate the spines are fully developed. The marginal plates have two types of peripheral spinelets: one series of small spinelets, which are quite similar to the paxillar armature, and another, outer series of more slender spinelets. There are two to three irregular transverse rows of coarse central granules on the supero-marginal plates, the largest being bigger than the diameter of the pedicel of the adjacent paxillae. Distally and orally there is an irregular row of smaller granules, forming the transition to the larger peripheral spinelets. A varying number of supero-marginal plates bear a rather small, but distinct exterior spine (table 3).

The infero-marginal plates have one large, flattened and pointed exterior spine, about as long as the plates are wide, with a smaller spine below. This second spine

has one to three much smaller but similar spines adradially and adorally to it. The ventral surface of the infero-marginal plates is covered by short, squamose spines, of which four to six larger and bluntly pointed ones form a transverse aboral row. The exterior spines of the first infero-marginal plates are considerably shorter than the others, and spatulate rather than pointed. In the ventro-lateral areas there are two plates on each side, both densely covered by rather long, slender spinelets.

The adambulacral plates have three furrow spines, the middle one being the longest, followed by two slightly flattened subambulacral spines, of which the aboral one is distinctly stouter. The spines on the ventral surface are smaller, the most abradial ones closely resembling the adjacent ventro-lateral or infero-marginal peripheral spinelets. The oral plates have two parallel interradiial series of blunt, flattened spines, increasing in size adorally. Near the mouth the plates are flanked by five or six slightly longer and less flattened spines. Adorally, there are four strong oral spines. The slightly smaller specimen ($R = 64$ mm) is very similar. The small differences between the two are listed in table 3.

Table 3. Comparative measurements on six specimens of *Astropecten hemprichii* from southern Mozambique.

Rat. = R/r ratio; NSM = number of supero-marginal plates; FSMS = first supero-marginal plate bearing an exterior spine; NP = number of paxillae between the aboral edges of the first supero-marginal plates (arm base); CS = maximum number of central paxillar spinelets found in arm base; AWL = width/length ratio of the arms; SMWL = width/length ratio of the fifth supero-marginal plate; ISWL = width/length ratio of the large infero-marginal spine; PA = width paxillar area in relation to width of the whole arm base; VL = number of ventro-lateral plates on each arm side.

Coll. No.	AE5801	AE5802	AE5628	AE5632	AE5639	AE5648
R/r mm	73/19	64/17	21/6	20/6	6/3	4/2
Rat.	3.8	3.8	3.5	3.3	2	2
NSM	29	30	19	18	10	6
FSMS	4	8-10	5	4-6	2	2
NP	15	13	11	9	6	7
CS	15	15	3	2	1	0
AWL	0.27	0.28	0.36	0.30	0.5	0.5
SMWL	2.5	2.3	2.0	1.8	1.7	1
ISWL	0.15	0.12	0.20	0.22	0.17	0.29
PA	0.7	0.5	0.5	0.47	0.5	0.44
VL	2	2	2	2	1	1

The most remarkable differences between the larger and the two medium-sized specimens ($R = 20$ and 21 mm) are (1) the size and the number of spinelets of the paxillae and (2) the shape of the ventral infero-marginal spinelets, which are slender rather than squamose. Both differences, and those listed in table 3, are easily attributable to the young age of the specimens (cf. also Döderlein, 1917: 26). The smallest specimens ($R = 4$ and 6 mm) are very youthful in appearance, with weakly developed, well spaced, echinose spines and spinelets, and even shorter and relatively broader arms. Yet they undoubtedly belong to the same species (fig. 10).

Distribution.— Indian Ocean, from Natal and southern Mozambique (A.M. Clark & Courtman-Stock, 1976) along the East African coast to the Red Sea and the Gulf of Suez (Gray, 1872; A.M. Clark, 1967; Fouda & Hellal, 1987), Mauritius (Loriol, 1885), Sri Lanka (Döderlein, 1888), Bay of Bengal. Gulf of Thailand (Döderlein, 1917), and

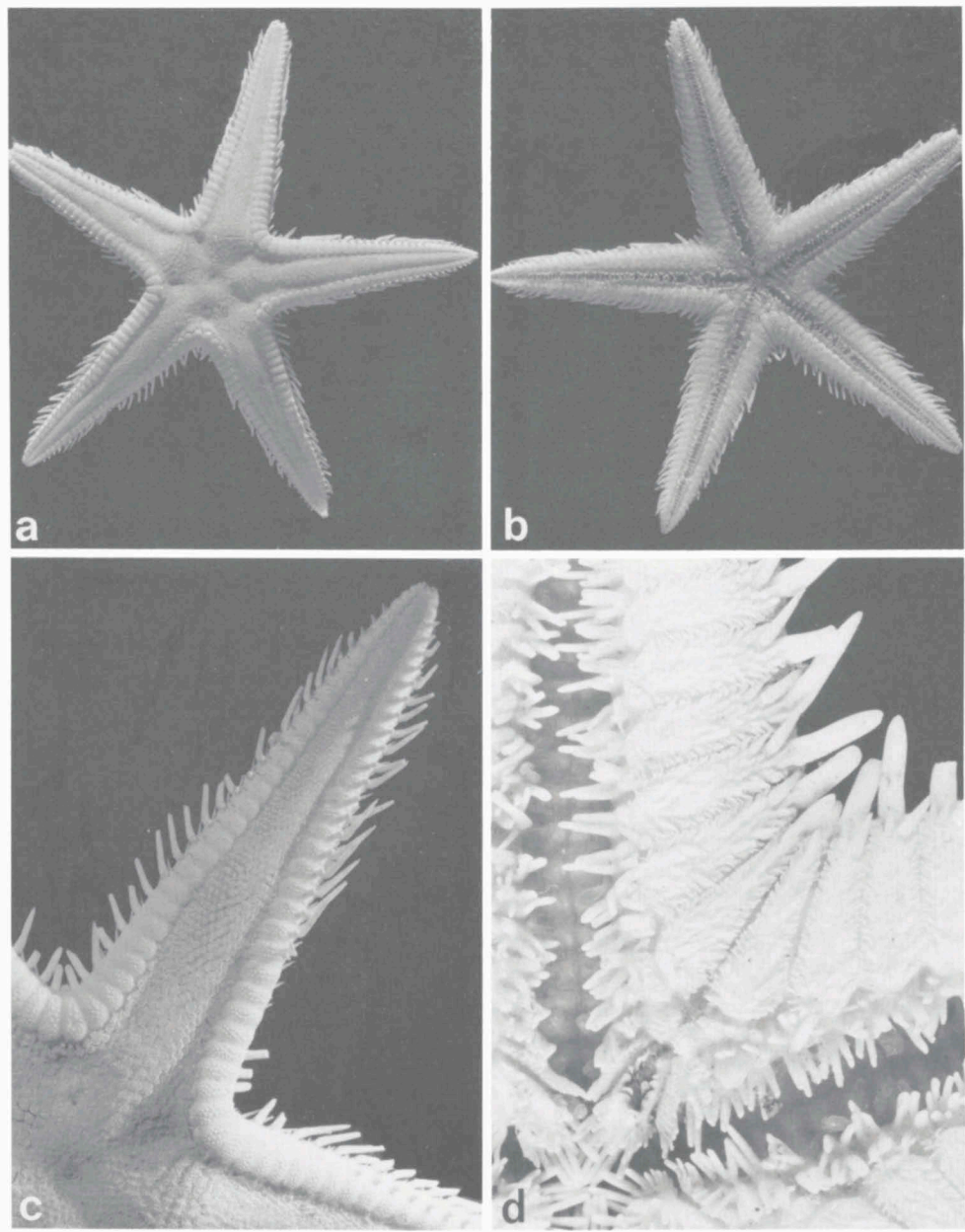


Fig. 10. *Astropecten hemprichii*. AE 5802, R/r = 64/17 mm. a, habitus dorsally; b, habitus ventrally; c, dorsal view of arm; d, ventral view of arm basis.

Timor (fig. 11; Jangoux, 1978). The largest specimens were found on littoral sands; the smaller ones were collected by a fine-meshed bottom trawl at depths of 7-17 m, also on a sandy bottom.

Discussion.— The species was described by Müller & Troschel (1842) as

Astropecten hemprichii. This was later changed to *A. hemprichi* (see synonymy). According to the International Code of Zoological Nomenclature (3rd ed.), Article 33.d, this change constitutes an incorrect subsequent spelling, even if it were made deliberately.

Sladen (1888) considered the specimens from Mauritius, described by Möbius (1880) as *A. mauritianus* Gray, 1840, to be *A. hemprichii*. In 1888, Döderlein described a small *Astropecten* ($R/r = 26/8.7$ mm) from Sri Lanka as *Astropecten tamilicus*, which he later (Döderlein, 1917) reduced to subspecific rank as *A. hemprichi tamilicus*. Subsequent authors either completely synonymized *A. tamilicus* (and *A. h. tamilicus*) with *A. hemprichii* (e.g., A.M. Clark & Rowe, 1971; Jangoux, 1973), or considered it to be a distinct species (e.g., Jangoux, 1978; Aziz, 1986). Döderlein (1917) distinguished *A. h. tamilicus* from the typical *A. hemprichii* by (1) its shorter and wider arms ($R/r = 3-3.5$), (2) the supero-marginal plates, which are less numerous (even in specimens of similar sizes) and little wider than long, and (3) by the large infero-marginal spines, which are flatter and generally wider, particularly the most proximal ones. Jangoux (1978) judged *A. tamilicus* to be a distinct species, in which he was followed by Aziz (1986). According to Jangoux, *A. tamilicus* differs from *A. hemprichii* not only in its geographic distribution and the features mentioned above (Döderlein, 1917), but also by its size (!) and the number and structure of its paxillae.

Having investigated the specimens from southern Mozambique, which range in size from $R = 4$ to $R = 73$ mm (table 3), I strongly suspect that a study of Döderlein's specimens will prove that *A. tamilicus* is a junior synonym of *A. hemprichii* and that the differences indicated by Döderlein (1888; 1917) and Jangoux (1978) are mainly related to the size of the specimens. When not, they fall well within the variability commonly found in species of *Astropecten*. An *Astropecten* specimen in the British Museum (Natural History), labelled as *A. hemprichii Tamilicus*, agrees well with the general description of *A. hemprichii*. In agreement with A.M. Clark & Courtman-Stock (1976), I suspect that the Inhaca record of *A. acanthifera* (sic) by Macnae & Kalk (1962) actually refers to *A. hemprichii*. An investigation of an *Astropecten* specimen from Inhaca Island, collected and identified by W. Macnae as *Astropecten granulatus* (BM(NH) 1958.11.16.1) confirms the suggestion of A.M. Clark & Courtman-Stock (1976) that the Inhaca records of Kalk (1954), Balinsky (1958; 1969) and Macnae & Kalk (1962) probably refer to *A. hemprichii*. Goto (1914) considered *A. hemprichii* (and *A. japonicus* Müller & Troschel, 1842: 73) to be synonyms of *A. scoparius* Müller & Troschel, 1842: 71. Döderlein (1917) synonymized *A. japonicus* with *A. scoparius*, but looked upon *A. hemprichii* as a distinct species.

The specimens of *A. scoparius* in the British Museum (Natural History), BM(NH) 1937.6.7.1-4, show a great resemblance to *A. hemprichii*, but for the ventral surface of the infero-marginal plates, which is more spinose. The type specimen of *A. mauritianus* Gray, 1840, BM(NH) 40.11.27.1, also shows many similarities with *A. scoparius* and *A. hemprichii*, as do the (type) specimens of *A. granulatus natalensis* John, 1948, BM(NH) 1904.4.20.120. The largest ($R/r = 104/28$ mm) of the four specimens from Inhaca, described by Jangoux (1973) as *A. hemprichii*, has 31 supero-marginal plates and could equally well, or better, be named *A. mauritianus*. A revision of the "Scoparius-group" of the genus *Astropecten* from South-East Africa, with a greater number of specimens from more locations than presently have been sampled, could yield interesting results.

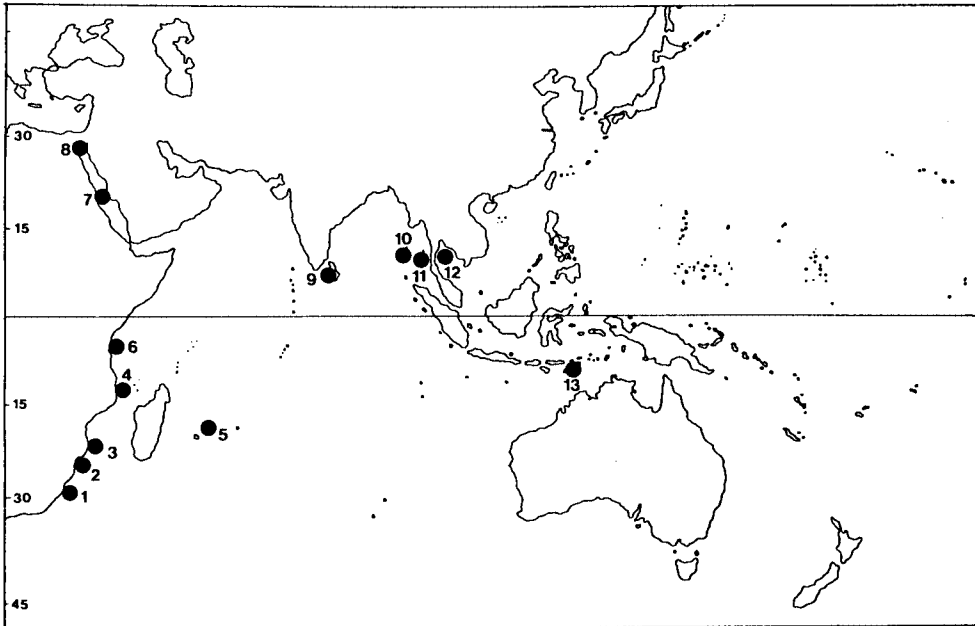


Fig. 11. *Astropecten hemprichii*, geographical distribution. Explanation of the numbers used: 1, Natal (29° S); 2, Inhaca Island; 3, Mozambique (23° S); 4, northern Mozambique; 5, Mauritius; 6, Zanzibar; 7, Red Sea; 8, Gulf of Suez; 9, Sri Lanka; 10, Andaman Islands; 11, Mergui Islands; 12, Gulf of Thailand; 13, Timor.

Archaster angulatus Müller & Troschel, 1842

Archaster angulatus Müller & Troschel, 1842: 66; Sukarno & Jangoux, 1977: 830; Aziz, 1986: 201.

Archaster angulosus (pars) Dujardin & Hupé, 1862: 412.

Archaster mauritianus Martens, 1866: 86.

Archaster typicus; Bell, 1894: 402 [Not: *Archaster typicus* Müller & Troschel, 1840].

Diagnosis.— Tube feet cylindrical and with terminal disc. Mid-radial row of dorsal paxillae distinctly enlarged, but flush with the dorsal surface. Paxillar spinelets cylindrical and round-tipped. Supero-marginal plates vertical in alignment. Infero-marginal plates with two to four enlarged scales at the upper end, but without a large spine.

Remarks.— This widely distributed Indo-West Pacific shallow water species has not been collected by the author, but was reported from Mozambique by Simpson & Brown (1910: 48) and from Inhaca Island by Jangoux (1973: 14). An extensive discussion of the synonymy, a description and an account of the distribution are given by Sukarno & Jangoux (1977: 830) in their revision of the genus *Archaster* Müller & Troschel, 1842. In this revision, the authors also described a new *Archaster* species, viz. *A. lorioli*, which they argued to contain many specimens previously described as *A. angulatus*.

Although in the publication by Sukarno & Jangoux the *Archaster* specimens from

Mozambique (Inhaca Island and Mtundo Bay) figure as *A. lorioli* on the distribution map, they are listed as the "Varité africaine" of *A. angulatus* in the text.

Monachaster sanderi (Meissner, 1892)
(figs. 12-14, table 4)

Goniodiscus sanderi Meissner, 1892: 185; Ludwig, 1899: 539.

Monachaster sanderi; Döderlein, 1916: 412; 1935: 103; A.M. Clark & Rowe, 1971: 48; Tortonese, 1976: 272; 1980: 113.

Monachaster umbonatus Macan, 1938: 399; Tortonese, 1949: 31.

Material.— 1. Two specimens from Inhaca Island, Mozambique. AE 5616: R/r = 30/15 mm, infralittoral off Barreira Vermelha, 8.i.1986; (*) AE 5620 (= RMNH 5784): R/r = 47/22 mm, near coral reef off Marine Biological Station, 1 m depth, 8.i.1982. 2. Nine specimens in the British Museum (Natural History). BM(NH) 63.11.19.19, R/r = 27/14 mm, Mozambique, Dr. Livingstone; BM(NH) 1903.4.2.66, R/r = 37/16 mm, Zanzibar, coll. C. Crossland; BM(NH) 1961.4.12.17, R/r = 37/16 mm, Inhaca Island, Mozambique, coll. Miss M. Kalk, near coral reef; BM(NH) 1979.2.5.111, R/r = 26/15 mm, Watamu, Kenya, Dr. W.F. Humphreys, beneath rock near coral heads next to Whale Island, Turtle Bay, 5.vii.1969; BM(NH) 1903.4.2.57.60, five specimens: R/r = 30/19, 28/13, 25/11, 24/11, 19/10 mm, Zanzibar, Dr. C. Crossland.

Diagnosis.— A goniasterid starfish of which the whole body is covered with densely packed low granules, which on the radial dorsal plates and most supero-marginal plates of the larger specimens are produced in strong tubercles or short conical spines. Granulation of adambulacral plates similar to that of ventro-lateral area. Four, sometimes five, strong, straight adambulacral furrow spines form a single longitudinal series. Valvate pedicellariae on dorsal and ventral surfaces.

Description.— The two specimens from Inhaca Island (R/r = 47/22 and 30/15 mm) are slightly different in general appearance, the larger one being more spinose and more heavily built. The rather flat bodies have five slightly tapering arms ending in a rounded tip. The dorsal surface rises gently towards the anus, reaching a level above the supero-marginal plates. The interradial areas are slightly depressed. The whole surface of the animals is densely covered by a sheath of small granules, interrupted by the dorsal papular pores, anus and madreporite, by enlarged granules and spines, particularly on the dorsal surface, by valvate pedicellariae on both surfaces and by the ambulacral furrow.

The differences between the specimens are mainly found in the armature of the dorsal surface. In the larger specimen, almost all dorsal plates bear a strong, but relatively short conical spine in the centre. In each radius there are 18-21 carinal plates, all bearing at least one spine, except for the bare, most distal 5-7 plates. The principal spine is sometimes accompanied by one or two secondary spines and/or some enlarged granules. There are two series of radial dorsal plates on each side of the carinal series. With exception of some distal plates, each plate bears a short, strong conical spine, often accompanied by a secondary spine and/or some enlarged granules. The spines are slightly shorter than those of the carinal series. About half the adcarinal plates also have a valvate pedicellaria occupying a quarter to half the width of the plate.

The dorsal interradial plates are arranged in two transverse rows: the proximal

row consists of two large plates which may or may not have a small spine or some enlarged granules; the distal row of six interradial plates is spread out and adjacent to the first few supero-marginal plates. The outlines of the plates are obscured by the granular sheath. When this is removed, the dorsal plates show numerous, well-spaced crystal bodies, which are almost twice as large as the covering granules. Although the granulation continues on to the marginal plates, the ones investigated do not have the crystal bodies. These reappear on the most adradial ventro-lateral plates and the adambulacral plates.

Papular pores, which surround all other dorsal plates, are absent between the interradial plates, as well as between the interradial and the supero-marginal plates. The granules around the papular pores are often somewhat elongated. The anal opening is covered by 21 thick, short, pointed spinelets, occupying an almost quadrangular area, surrounded by four spine-bearing plates. The madreporite is very conspicuous, bare, slightly larger than the largest dorsal plate and has fine, radiating grooves. It is surrounded by an estimated eight small plates, of which two bear a short spine. There are nine pairs of tumescent marginal plates on each side of the arm. Marginal and ventro-lateral plates are densely covered with a smooth plastering of flattened, often angular granules. On the central part of the dorsal surface of all supero-marginal plates, several granules are enlarged to form a broad transverse area of strong, irregularly shaped tubercles, spines and/or clusters of very heavy granules. The granules on the edges and between the marginal plates are much smaller, compressed and very regularly arranged (fig. 12a, c).

In dorsal view, the infero-marginal plates extend slightly beyond the supero-marginals. With exception of the most distal two to three plates, which bear one or more short spines, the plates are densely covered by low granules, which are somewhat enlarged on the central area of the exterior face. In some arms there is a small tenth infero-marginal plate, opposite the terminal plate and/or a diminutive tenth supero-marginal plate. The small terminal plates have lost most granules and show many minute crystal bodies around two to four small but relatively strong spines.

The ventro-lateral plates form four, more or less regular chevrons, consisting, in aboral direction, of 44, 15, 10 and 4 plates. The innermost ventro-lateral plates extend to the distal end of the seventh infero-marginal plate, those of the second chevron to the end of the fourth infero-marginal plates, those of the third chevron to the end of the second and those of the outermost chevron extend to the end of the first infero-marginal plates. On the most proximal chevron, there are four to five valvate pedicellariae, about as long as a third of the diameter of the plates. The other ventro-lateral plates lack pedicellariae.

The adambulacral plates have a dense covering of granules, very similar to that of the ventro-lateral plates and even extending upon the abradial side of the four (occasionally five) strong, straight and equal furrow spines. Between the granules, almost all adambulacral plates bear a small, valvate pedicellaria, usually aligned along the furrow and occupying about half the length of the plate. Between the distal three infero-marginal plates, the adambulacral plates lack pedicellariae, but may have one or two subambulacral spines. Proximally, there are about three adambulacral plates to two ventro-lateral plates; distally two. Except for their size and outline, the oral plates are very similar to the adambulacral plates: there are nine to ten similarly shaped furrow spines, the ventral surface is similarly covered with gran-

ules and may have one or two pedicellariae (fig. 13a, c). This specimen is the largest recorded to date.

The smaller specimen has an identical pattern of granulation and about the same number of plates, but is not as heavily built and much less spinose than the larger one. On the dorsal surface, only four of the carinal plates in each radius bear a single, low and smooth tubercle, which is smaller on the more distal plates. The two adacari-

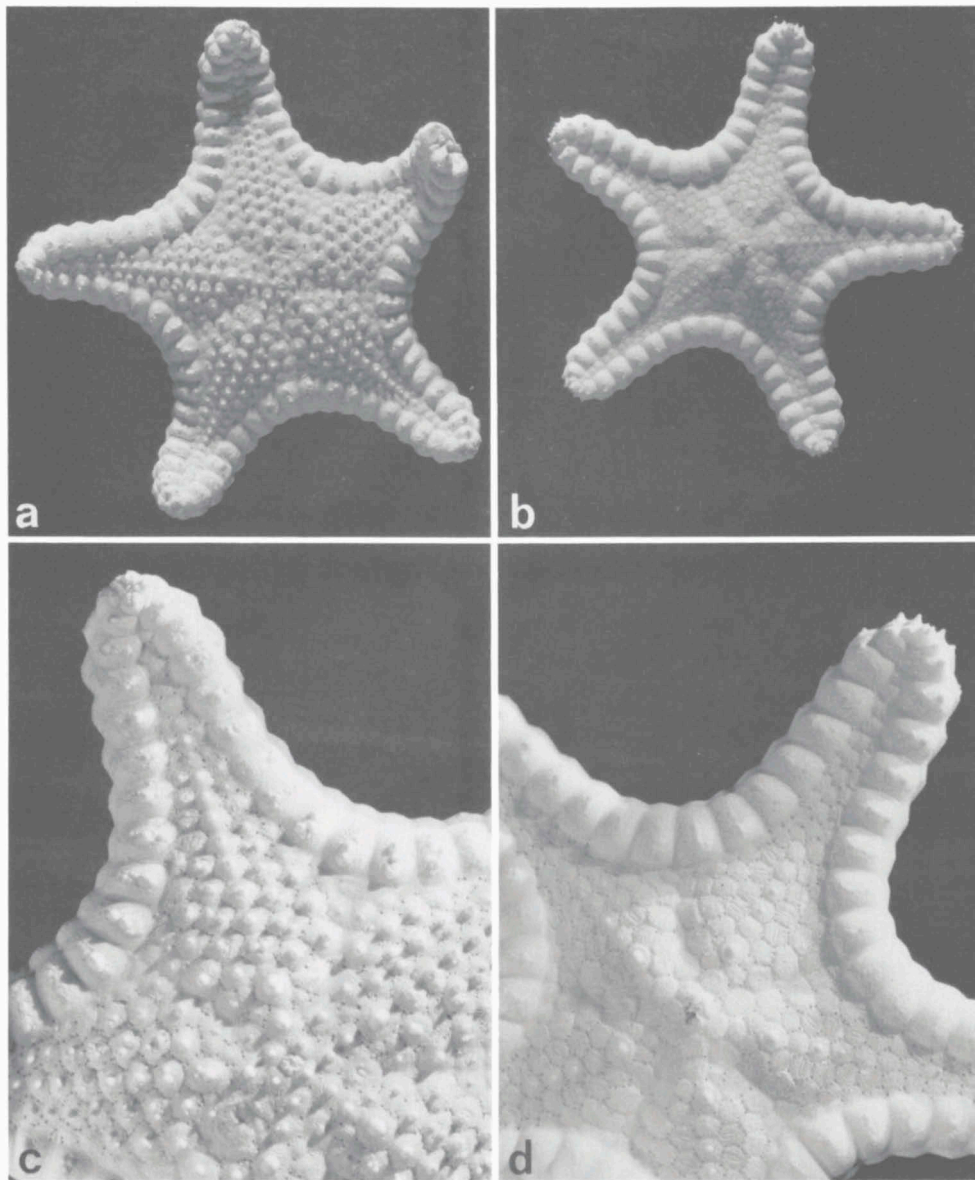


Fig. 12. *Monachaster sanderi*. Dorsal views of the Inhaca specimens. a, habitus larger specimen (AE 5620, R/r = 47/22 mm); b, habitus smaller specimen (AE 5616, R/r = 30/15 mm); c, detail arm basis larger specimen; d, detail arm basis smaller specimen.

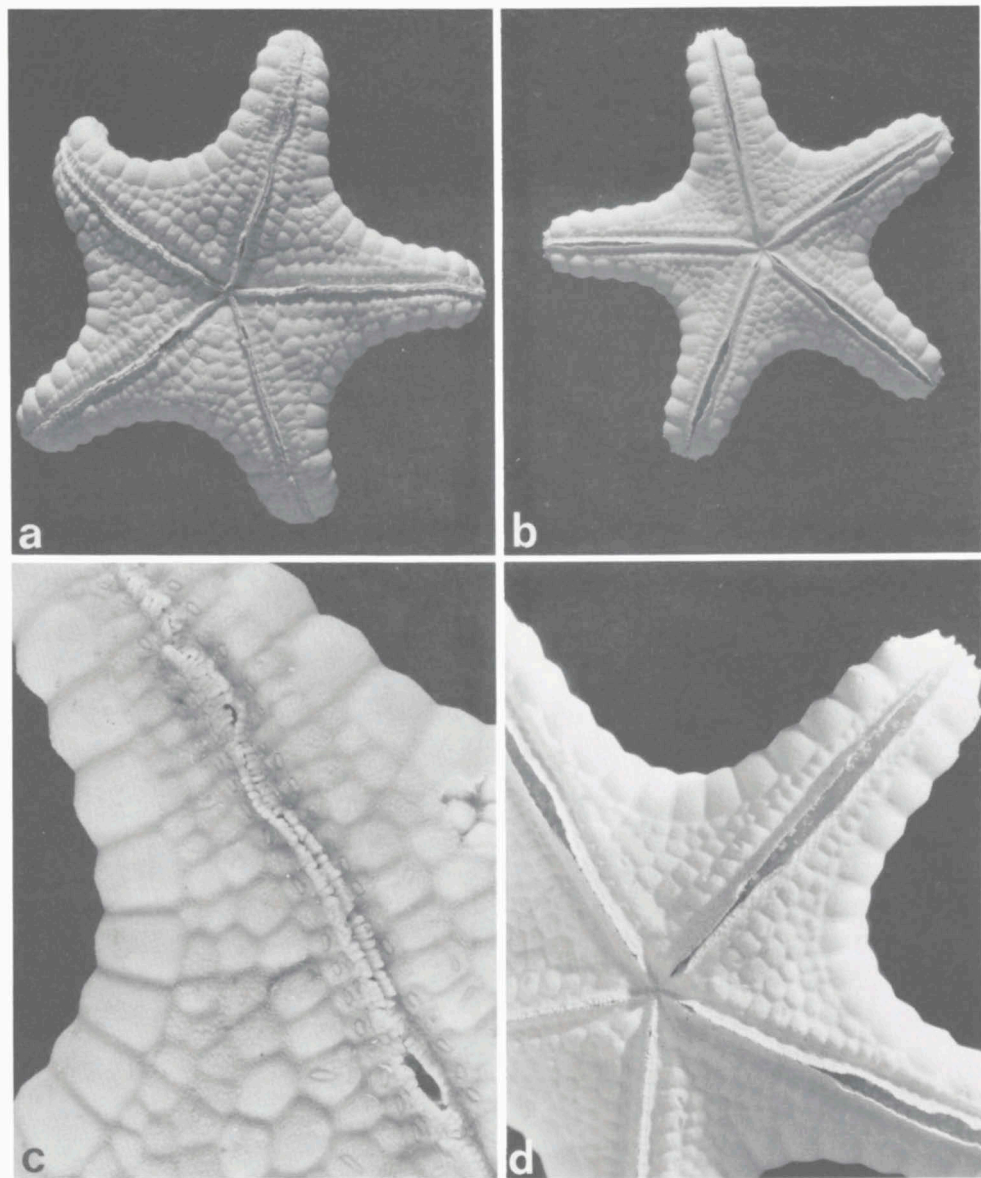


Fig. 13. *Monachaster sanderi*. Ventral views of the Inhaca specimens. a, habitus larger specimen (AE 5620, R/r = 47/22 mm); b, habitus smaller specimen (AE 5616, R/r = 30/15 mm); c, detail arm basis larger specimen; d, detail arm basis smaller specimen.

nal series in each radius are mainly characterized by large valvate pedicellariae, occupying about two thirds of the diameter of the plates. The other adcarinal plates may show one or more enlarged granules. The interradial areas between the adcarinal series consist of six transverse rows of plates: distally a row of ten plates along the six interradial supero-marginal plates, proximally followed by one row of four plates, two of two plates and two of one. With one exception, all interradial plates

are devoid of pedicellariae and spines. The conspicuous, rounded triangular madreporite is two plates removed from the perianal spinelets. The eight to ten swollen supero-marginal plates, of which the tenth, if present, is very small, have a large, transversely lengthened central area with enlarged, usually polygonal granules, of which, particularly in the distal part of the arm, one or two may be produced into a smooth rounded tubercle. The small terminal plates bear four short, conical spines. The granular covering is largely absent and the plates show numerous minute crystal bodies (fig. 12b, d).

The infero-marginal plates have slightly enlarged granules on the central area of the lateral surface, which, in dorsal view, extends beyond the supero-marginal plates. In the distal part of the arm, some of the enlarged granules may be produced in short, conical spines. The small granules of the ventral surface of the infero-marginal plates are slightly higher distally, giving the impression of imbricating.

The whole ventral surface of the animal is almost identical to that of the larger specimen. The four irregular chevrons of the ventro-lateral area consist of 44, 15, 10 and 4 plates. The innermost chevron extends to the end of the sixth infero-marginal plates, the second chevron to the end of the third infero-marginal plates, the third to halfway the second infero-marginals and the outermost chevron extends to the distal end of the first infero-marginal plates. The ventro-lateral pedicellariae are only half as long as the dorsal ones and the adambulacral pedicellariae are even smaller (fig. 13b, d).

The colour in alcohol 70% is pure white in the smallest specimen and beige in the larger one. The colour in life of the larger specimen was dark reddish brown.

Distribution.—Red Sea, Gulf of Suez, 65–68 m depth, soft yellow mud (Macan, 1938); Mogadishu, Somalia (Tortonese, 1949); Sar Uanle, Somalia, in tide pools (Tortonese, 1976); Kenya, Zanzibar (Meissner, 1892); Madagascar (Döderlein, 1935); Inhaca Island, Mozambique, infralittoral (first record); ?New Britain ("Neu Pommern"), western Pacific (Döderlein, 1935) (fig. 14). Döderlein's record from the western Pacific is implicitly doubted by A.M. Clark & Rowe (1971), and by Tortonese (1976; 1980a).

Habitat.—The species apparently occurs from the tidal zone to deeper water (65 m), irrespective of age (Tortonese, 1976: 275). It does not seem to be abundant and does not seem to be very particular as to its substrate.

Discussion.—Meissner (1892) described a small ($R = \text{ca. } 34 \text{ mm}$), four-armed starfish from Zanzibar as a new species, *Goniodiscus sanderi*, which was, hesitantly, placed in the genus *Goniodiscus*. Döderlein (1916) considered the species so different from "real" *Goniodiscus* forms, that he created a new genus, *Monachaster*, which is, in his opinion, easily derived from *Goniodiscus*, and differs from all other Oreasteridae in (1) the single row of adambulacral furrow spines and (2) the similar granulation on the ventral surface of the adambulacral and ventro-lateral plates. In 1935, Döderlein described another two specimens of *Monachaster sanderi* ($R = 32$ and 38 mm) from, respectively, South-West Madagascar and Neu Pommern (= New Britain, Bismarck Archipelago, Papua New Guinea), still including the species in the family Oreasteridae. Macan (1938) described a new species of *Monachaster* Ludwig (*sic*), 1916, viz. *M. umbonatus*, from the Gulf of Suez ($R = 27 \text{ mm}$). He also reported a specimen from Mozambique "close to but not identical with this form, which is in the British Museum bearing the label *Goniodiscus* sp. (yg), 63.11.19.19. Mozambique. Dr.

Livingstone". The specimen, which still is in the British Museum (Natural History), has relatively slender arms with the supero- marginal tubercles produced into short spines, but doubtlessly belongs to *Monachaster sanderi*, and has been correctly labelled as such in recent years. Tortonese (1949; 1976) described a small specimen ($R = 21$ mm) of *M. umbonatus* from Mogadishu, Somalia (1949), and another two ($R = 20$ and 9 mm) from Sar Uanle, also in Somalia.

The position of the genus *Monachaster* has been subject to some discussion. Döderlein (1916; 1935) considered the genus to belong to the family Oreasteridae. A.M. Clark & Rowe (1971) and Tortonese (1976), however, thought the correct place of the genus to be with the Goniasteridae, with which I wholeheartedly agree. A.M. Clark & Rowe (1971) and Tortonese (1976) doubted the specific distinctness of *M. umbonatus*. Macan (1938) listed three diagnostical characters to distinguish between the species: (1) slightly longer arms and more supero-marginal plates in *M. umbonatus*, (2) the supero-marginal plates of *M. umbonatus* have no tubercles such as those of *M. sanderi* and (3) the granules around the papular pores are not enlarged in *M. umbonatus*.

An investigation of all eleven specimens listed above showed *M. sanderi* to be quite variable, particularly in the degree of spinulation and the relative size of the supero-marginal plates. Most of the Zanzibar specimens had supero-marginal plates, which are much less swollen and wide than those of the specimens from Kenya and Mozambique (table 4). Consequently, the arms of those specimens are more slender and taper more evenly to a relatively fine tip. There is also a considerable variation in the number of supero-marginal plates, even within a single specimen (table 4) and in the degree to which the central granules of the plates are produced in tubercles or

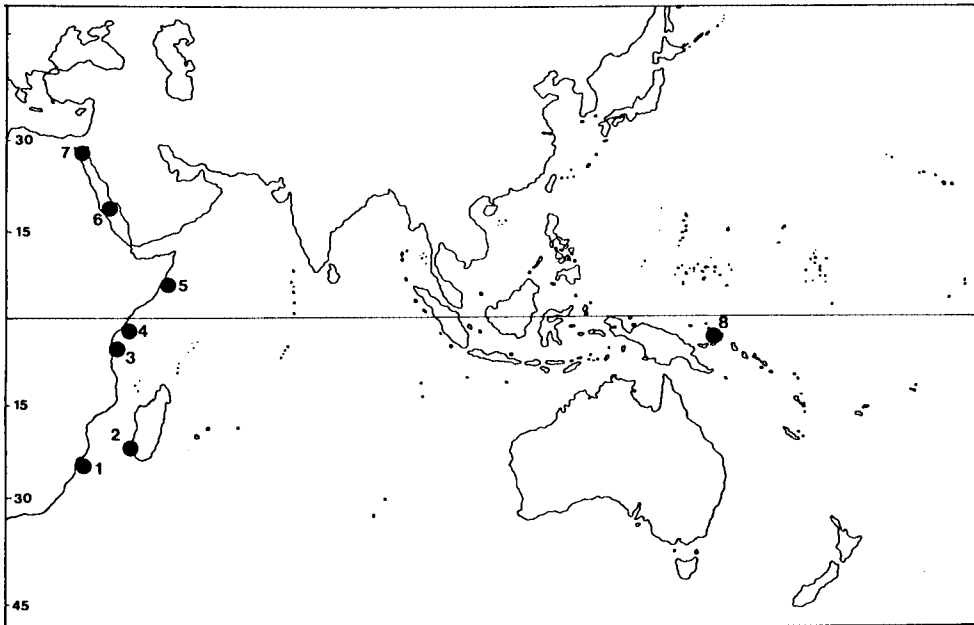


Fig. 14. *Monachaster sanderi*, geographical distribution. Explanation of the numbers used: 1, Inhaca Island; 2, Madagascar; 3, Zanzibar; 4, Kenya; 5, Somalia; 6, Red Sea; 7, Gulf of Suez; 8, New Britain.

even short, blunt, conical but distinct spines. This variation is not always size-related as examination of only the Inhaca specimens would suggest. The size of the granules around the papular pores varies from that of the other granules to slightly longer, even within a single specimen. Despite the range of variation, all specimens undoubtedly belong to the same species, and I have no hesitation to include *M. umbonatus* in the synonymy of *M. sanderi*.

Table 4. Comparative measurements on the arm length and disc diameter (R/r), the number of supero-marginal plates on each side of an arm (NSMP) and width of the fifth supero-marginal plate/width of the whole arm at that point ("Widths") of eighteen specimens of *Monachaster sanderi*. The specimens marked with an asterisk (*) were described as *M. umbonatus*.

Specimen	R/r in mm	R/r ratio	NSMP	Widths
AE 5620	47/22	2.14	9-10	4/13
AE 5616	30/15	2	8-10	3.5/9
Döderlein, 1935	32/16	2	7-8	
	38/18	2.11	8	
Meissner, 1892	34/16	2.13	7-9	
*Macan, 1938	27/12.5	2.16	9	
*Tortonese, 1949	21/12	1.75	7	
Tortonese, 1976	20/11.5	1.74	7	
	9/5.5	1.64	6	
BM(NH) 63.11.19.19	27/14	1.93	8	2/7
1903.4.2.66	37/16	2.31	7-10	2/9
1961.4.12.17	37/16	2.31	9	4/11
1979.2.5.111	26/15	1.73	7	3/8
1903.4.2.57.60	30/19	1.58	8	2.5/8
1903.4.2.57.60	18/13	2.15	8	2/6.5
1903.4.2.57.60	25/11	2.27	8	2/6
1903.4.2.57.60	24/11	2.18	7	2/5
1903.4.2.57.60	19/10	1.9	6	1.5/4

***Stellaster equestris* (Retzius, 1805)**
(figs. 15, 16)

Asterias equestris Retzius, 1805: 12; Lamarck, 1815; 1816: 555; Blainville, 1830: 219; 1834: 238.

Stellaster childreni Gray, 1840: 278; Döderlein, 1935: 95.

Stellaster equestris childreni; Mortensen, 1940: 66.

Stellaster equestris; Müller & Troschel, 1842: 62; Döderlein, 1935: 91; Macan, 1938: 395; A.M. Clark & Spencer Davies, 1966: 598; A.M. Clark, 1967: 39; A.M. Clark & Rowe, 1971: 49; Marsh, 1976: 217; Gibbs et al., 1976: 112; Guille & Jangoux, 1978: 53; Aziz & Jangoux, 1984: 130; Aziz, 1986: 293.

Stellaster incei Gray, 1847: 76; Döderlein, 1935: 97; H.L. Clark, 1938: 94; Domantay & Roxas, 1938: 210; H.L. Clark, 1946: 97; Endean, 1956: 124; 1957: 238; 1961: 291; Domantay, 1972: 81; Jangoux, 1973: 5; Marsh, 1976: 217.

Stellaster belcheri Gray, 1847: 76; Döderlein, 1935: 97.

Material.— Three specimens on the sandy tidal flat of Costa do Sol, Maputo, Mozambique. AE 5621: one specimen, R/r = 34/15 mm, 11.vii.1984; (*) AE 5608 (= RMNH 5785): two specimens, R/r = 34/14 and 26/10 mm, 11.vii.1984.

Diagnosis.— A goniasterid starfish with prominent marginal plates, a large disc and five long, slender arms. Dorsal surface convex. Fine, even granulation of dorsal surface continuous or interrupted to show underlying plates with crystal bodies.

Granules around papular pores not different from other dorsal granules. Infero-marginal plates with one large aboral spine.

Description.— The three specimens from Inhaca Island have a large disc with five, relatively long and slender arms (R/r ratio 2.3-2.6). The specimens were found dead on a sand flat at low tide and are in a rather poor shape: many of the spines, granules and even pedicellariae have been lost. The largest dorsal plates are in the interradial areas. The radial plates are, at the arm base, arranged in three longitudinal series. The second plate of the carinal series bears a thick, short tubercle of which the size is variable, even within a single specimen. The tubercle is often lost, leaving behind a circular depression without crystal bodies. The plates bearing the tubercles are often swollen, particularly in the smallest specimen. The fine granulation of the dorsal plates is largely lost, leaving the slightly wider spaced, and slightly smaller, well embedded crystal bodies uncovered. Many of the radial plates, and some of the interradial areas, have a small, valvate pedicellaria, usually not longer than a fourth of the diameter of the plates.

Papular pores are found between and around the radial plates. The granules surrounding the pores are in no way different from the other dorsal granules. The conspicuous madreporite is bare, with fine, radiating grooves, and about as large as the surrounding dorsal plates. The number of supero-marginal plates increases with the size of the animals: fourteen at $R/r = 34/14$ mm, thirteen at $R/r = 34/15$ mm and twelve at $R/r = 26/10$ mm. The plates are swollen in the arm corners and slightly wider than long. Further along the arm the plates are less tumescent and slightly longer than wide. The fine granulation of the plates has been largely rubbed off, leaving numerous small, shallow pits, but, except some in the distal plates, no crystal bodies. A few plates have a small deep pit, indicating the former presence of pedicellariae. Some larger valvate pedicellariae are found on the, better granulated, lateral sides of the proximal supero-marginal plates.

The height of the margin is, in the arm corners, about four mm in the smallest and about five mm in the larger specimens. The infero-marginal plates are equal in number to the supero-marginals, but, as they extend slightly more distally, the distal plates are not as well aligned with the supero-marginal plates as the proximal ones. The aboral-ventral corner of the lateral side of the plates bears a single, strong, flattened spine, which leaves a very distinct mark when lost. The ventral surface is flat, the granulation has been largely lost, leaving a smooth or slightly pitted surface with an occasional pedicellaria and, in the distal plates, some crystal bodies. Adoral-dorsally to the large spine, there may be a small valvate pedicellaria on the lateral side.

The heart-shaped terminal plates are bare and show many, minute, embedded crystal bodies. The ventro-lateral areas consist of two chevrons of plates and an additional two to four plates in the distal interradial corner. The plates are distinctly smaller than the ventral surface of the proximal infero-marginal plates.

The adoral chevron consists of ca twelve (in the smallest specimen) to sixteen (in the larger specimens) plates and reaches the third or fourth infero-marginal plates. The second chevron has five to six plates and extends towards the distal end of the first (smallest specimen) or second (larger specimens) infero-marginal plates. Where the granulation is intact, the plates are densely and evenly granulated. On each ventro-lateral area there are about two small valvate pedicellariae. Small, shallow pits indicate the former presence of granules; deep pits pedicellariae. The adambulacral

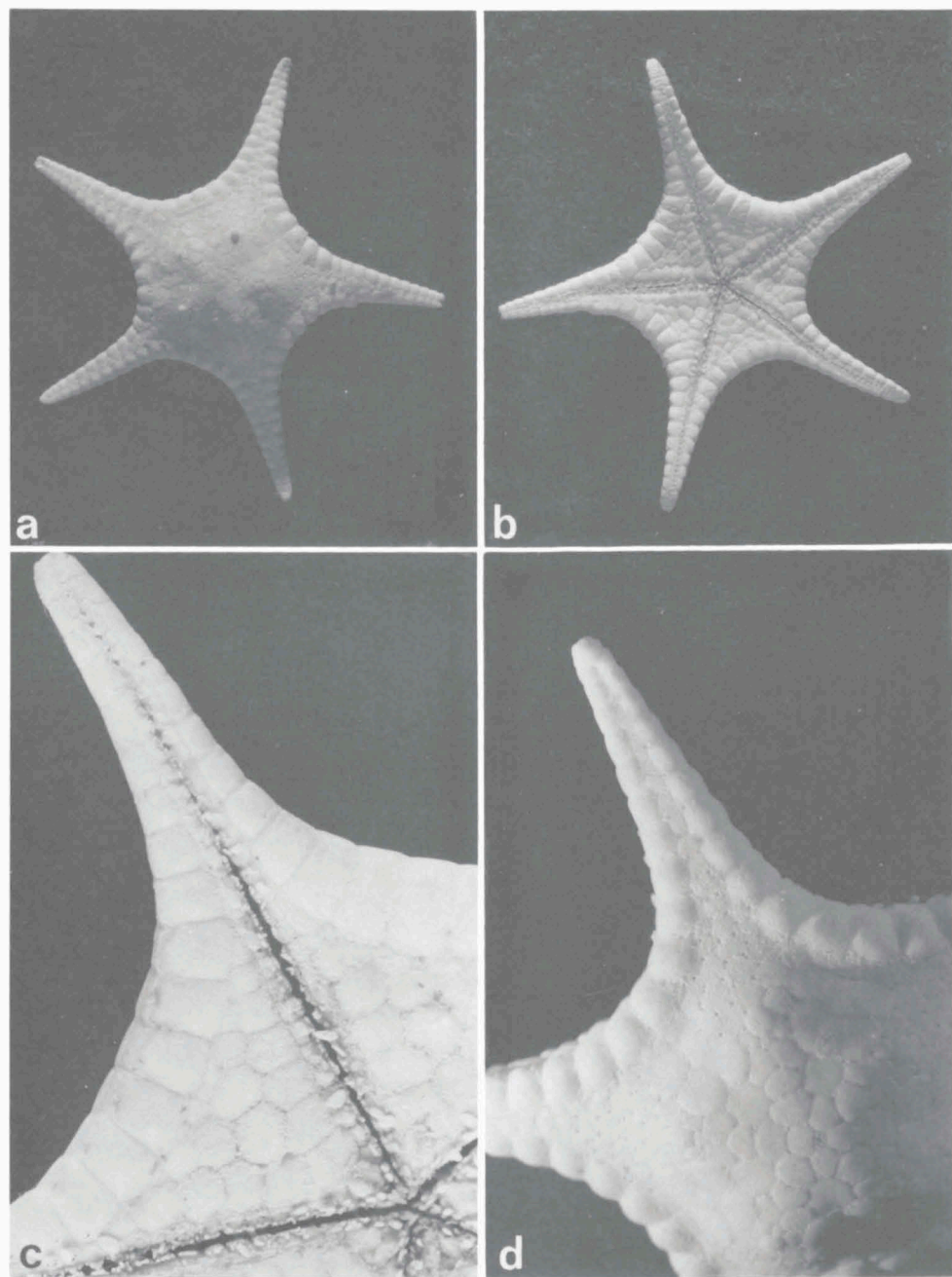


Fig. 15. *Stellaster equestris*. a-b, AE 5608, R/r = 34/14 mm, a, habitus dorsally; b, habitus ventrally; c, AE 5621, R/r = 34/15 mm: ventral view of arm; d, AE 5608, R/r = 26/10 mm: dorsal view of arm.

plates have an almost straight series of about five furrow spines. On the granulated ventral surface, there is one (sometimes two) large, often, particularly distally, very broad spine. In the adoral-adradial corner there is often (the scar of) a simple, *Luidia*-

like pedicellaria. The granulation is slightly coarser and more widely spaced than that of the ventro-lateral plates. The oral plates have, on each side, about six spines along the furrow, increasing in size (length and width) towards the mouth. Behind the furrow spines, there are up to three strong spines, similar to those of the second series of adambulacral spines. The swollen ventral surface of the plates is coarsely granulated. I could not detect any (marks of) pedicellariae (fig. 15).

The colour of all three specimens, preserved in alcohol 70%, is white.

Distribution.— Common, and widely known in the Indo-West Pacific area; not as well known from East Africa: Maputo, southern Mozambique (first record), Kero-Nyuni Bay, northern Mozambique (Simpson & Brown, 1910), Maldives (A.M. Clark & Spencer Davies, 1966), Red Sea (A.M. Clark, 1967), Gulf of Oman, Persian Gulf, Sri Lanka, Bay of Bengal, Mergui Archipelago (Macan, 1938; H.L. Clark, 1915; Koehler, 1910a; Brown, 1910), Indonesia, Malaysia, Philippines (Aziz, 1986), Australia (Marsh, 1976; H.L. Clark, 1946; Gibbs et al., 1976), Japan (Goto, 1914), China Sea (Martens, 1865) (fig. 16). The sand flat at Costa do Sol is very similar to that of Ponta Rasa, Inhaca Island, on the other side of Maputo Bay.

Discussion.— In his report on the Oreasteridae of the Siboga expedition, Döderlein (1935) revised the genus *Stellaster* Gray, 1840. In his opinion, the genus contained six species, of which five (*S. princeps* Sladen, 1889; *S. tuberculosus* Martens, 1865; *S. squamulosus* Studer, 1884; *S. gibbosus* Döderlein, 1916; *S. inspinosus* H.L. Clark, 1916) are known from only a few specimens and (hence) well defined. The sixth species, *S. equestris* (Retzius, 1805), is very abundant and widespread. The dif-

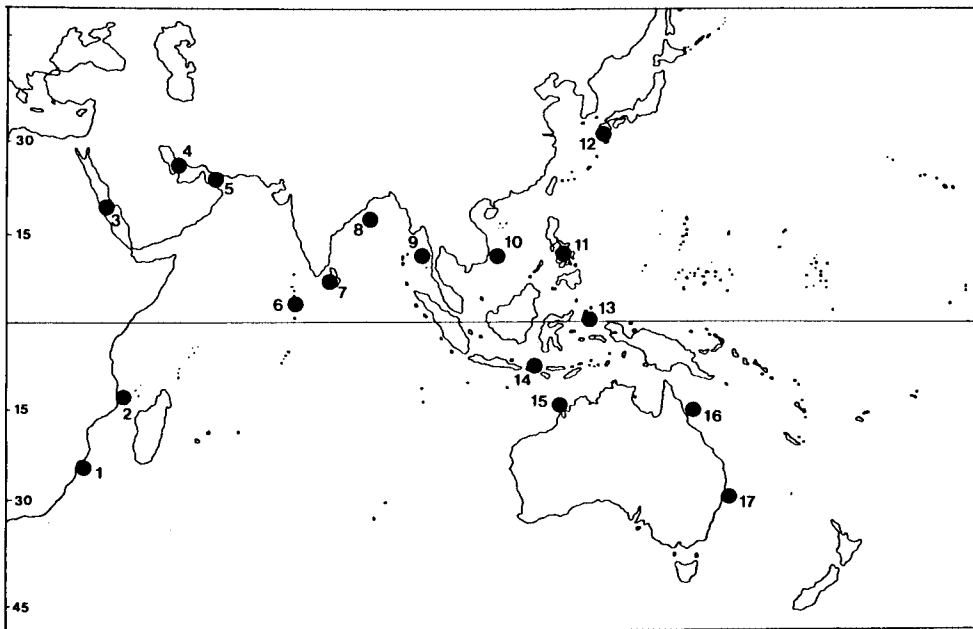


Fig. 16. *Stellaster equestris*, geographical distribution. Explanation of the numbers used: 1, Maputo, southern Mozambique; 2, northern Mozambique; 3, Red Sea; 4, Persian Gulf; 5, Gulf of Oman; 6, Maldives; 7, Sri Lanka; 8, Bay of Bengal; 9, Mergui Islands; 10, China Sea; 11, Philippines; 12, southern Japan; 13, Moluccas; 14, Sunda Islands; 15, NW Australia; 16, NE Australia; 17, northern New South Wales, Australia.

ferent varieties are not well defined. Although a number of principal forms can be distinguished, some of which have been described as separate species, there are so many intermediate forms that even the distinction between varieties becomes doubtful (Döderlein, 1935). The synonymy of the species presented here is derived from Döderlein (1935). The references to the different "species", which were published between the time of original description and Döderlein's revision are omitted here; only references more recent than 1935 are given. The Inhaca Island specimens have a combination of characters, which makes it very difficult to include them in any of the groups, forms or varieties listed by Döderlein (1935).

***Asterodiscides elegans* (Gray, 1847)**
(figs. 17, 18)

Asterodiscus elegans Gray, 1847: 75; 1866: 5; Perrier, 1876: 72; 1878: 81; Viguier, 1878: 188; Sladen, 1889: 353; Thurston, 1895: 114; Bell, 1909: 19; Fisher, 1919: 355; Balinsky, 1958; 1969: 105; A.M. Clark & Rowe, 1971: 53; Domantay, 1972: 90; Jangoux, 1973: 5.

Asterodiscides elegans; A.M. Clark, 1974: 435; A.M. Clark & Courtman-Stock, 1976: 67; A.M. Clark, 1984: 90; Rowe, 1985: 534; Aziz, 1986: 301.

Asterodiscides elegans elegans; Rowe, 1977: 197.

Asteridiscides elegans belli Rowe, 1977: 199; Jangoux & Aziz, 1984: 860.

Asterodiscides belli; Rowe, 1985: 534.

Material.— 1. Two smallish, dried specimens from Inhaca Island, Mozambique; Sandy littoral flat off Barreira Vermelha, 18.x.1986. (*) AE 5646 (= RMNH 5786): R/r = 56/41; AE 5649: R/r = 45/36 mm. 2. Three specimens from the Seychelles, Mahé, "au large de Beau Vallon", R/r = 53/42, 48/36 and 21/16 mm, Musée Royal de l'Afrique Centrale, Tervuren, No. 1356.

Diagnosis.— A stout, dorsally and ventrally flat, rounded-pentagonal (R/r = 1.1-1.5) starfish with five rays. Dorsal, marginal and ventro-lateral plates covered by tubercles surrounded by granules. Marginal plates indiscernible, except for the distal-most supero-marginal plates, which are very conspicuous, bare and oblong. Ventro-lateral tubercles one to six per plate. About four stout adambulacral furrow spines, followed by two, larger, ad- and abradially flattened, round-tipped subambulacral spines.

Description.— Two thick, rounded-pentagonal starfish from Inhaca Island, evenly covered on all sides by strong conical tubercles. R/r = 51/41 and 45/36 mm; R/r ratio's 1.25 and 1.32, respectively. Only the adambulacral, oral, ventro-lateral and the distal-most supero-marginal plates are clearly discernible. The dorsal plates are very numerous, surrounded by small papular pores and, like all other plates, devoid of pedicellariae. The surface of the plates is almost completely occupied by a thick, conical tubercle, ranging in size from, height/diameter, 1.7/1.5 mm to 1.0/0.8 mm. The larger tubercles are completely, the smaller partly surrounded by much smaller granules. The small, but swollen madreporite is clearly visible and about the size of two to four large dorsal plates. The slightly acentrally located anus is largely hidden by stout tubercles and surrounded by a circle of shorter, compressed spines. There is a rather gradual transition from the dorsal to the ventral spinulation.

In undenuded areas, only the distal pair of supero-marginal plates is recognizable. These plates are rounded-oblong, higher than long (8/4.5 mm in the larger and

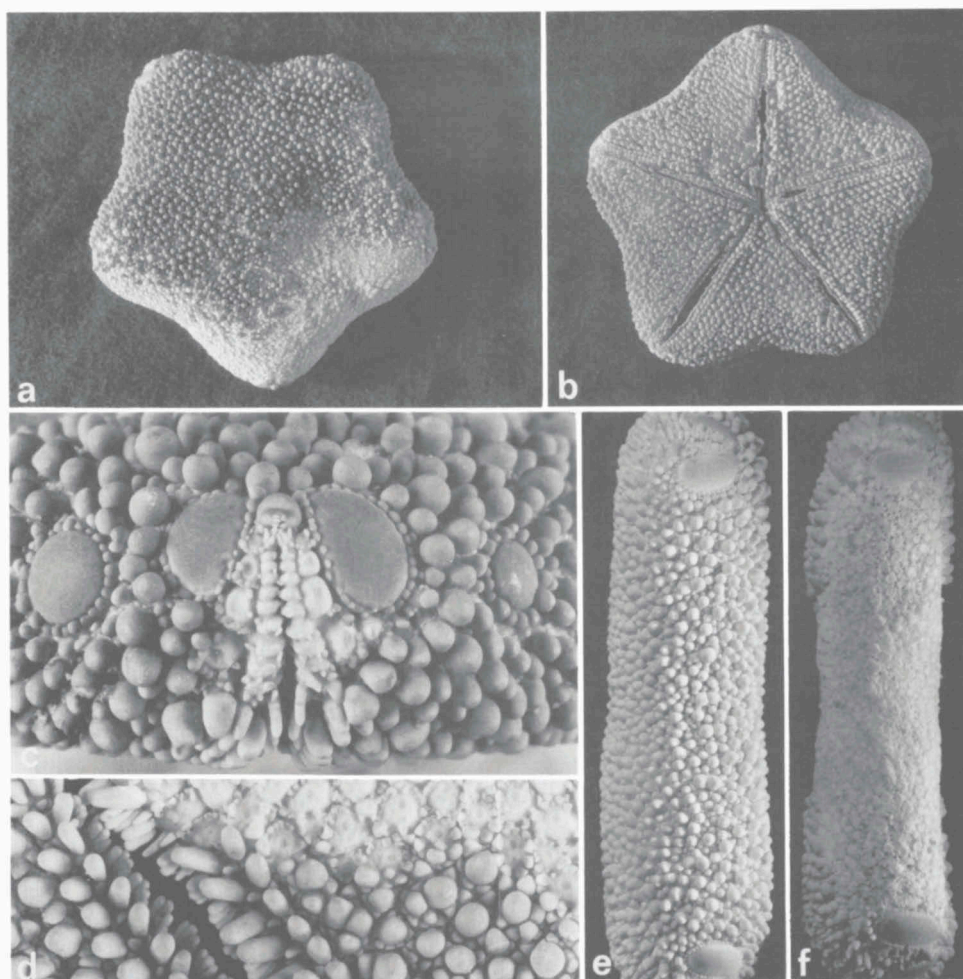


Fig. 17. *Asterodiscides elegans*. a-c, AE 5649: R/r = 45/36 mm: a, habitus dorsally; b, habitus ventrally; c, view of arm tip showing the (exceptional) double terminal supero-marginal plates. d-f, AE 5646: R/r = 51/41 mm: d, detail ventro-lateral area (partly denuded); e, view of arm side, dorsal surface on the right; f, view of denuded arm side, dorsal surface on the right.

6.5/3.5 mm in the smaller specimen), slightly convex and surrounded by a single series of squarish granules. The peripheral granules are (almost) adjacent above the terminal plates. In one arm of the smaller specimen there is an additional pair of smaller, more circular, but otherwise similar supero-marginal plates, separated from the most distal pair by one and three rows of tubercles. The sizes of these plates are 3.5×3.5 mm and 2.5×2 mm (fig. 17c). The other supero-marginal plates are only discernible when the specimens are denuded. On the bared sides of the smaller specimen, there are six slightly enlarged, oblong plates (3×2 mm). These plates are not only larger than the others, but also bear more than one (two to five) large tubercles. In the larger specimen, the proximal supero-marginal plates are hardly or not discernible, even on the denuded body sides (fig. 17f). In none of the specimens, there

are infero-marginal plates recognizable as such.

The ventro-lateral areas extend to the terminal plates, forming a single series between the adambulacral and the conspicuous supero-marginal plates. The plates bear from one to six, large, conical to prismatic tubercles. Where there are more than two tubercles, there are one or two principal spines and a number of much smaller tubercles. The sides where all these spines meet are usually flattened (fig. 17d). On all plates there is a peripheral series of prismatic granules, some of which are often slightly enlarged. The adambulacral plates have one series of four furrow spines, of which the most adoral spine is often smaller than the other three. This series is followed by two series, each of one strong, ad- and abradially flattened, rounded spine, surrounded by prismatic granules, which sometimes may be produced in one or more short spines. In the larger specimen, one of these secondary spines on the adoral edge of the more proximal plates may be quite large. The oral plates are very similar with six to seven furrow spines and about three (two to four) strong, ventral spines on each side (fig. 17).

The colour of the dried specimens is brownish; the colour in life is brick-red.

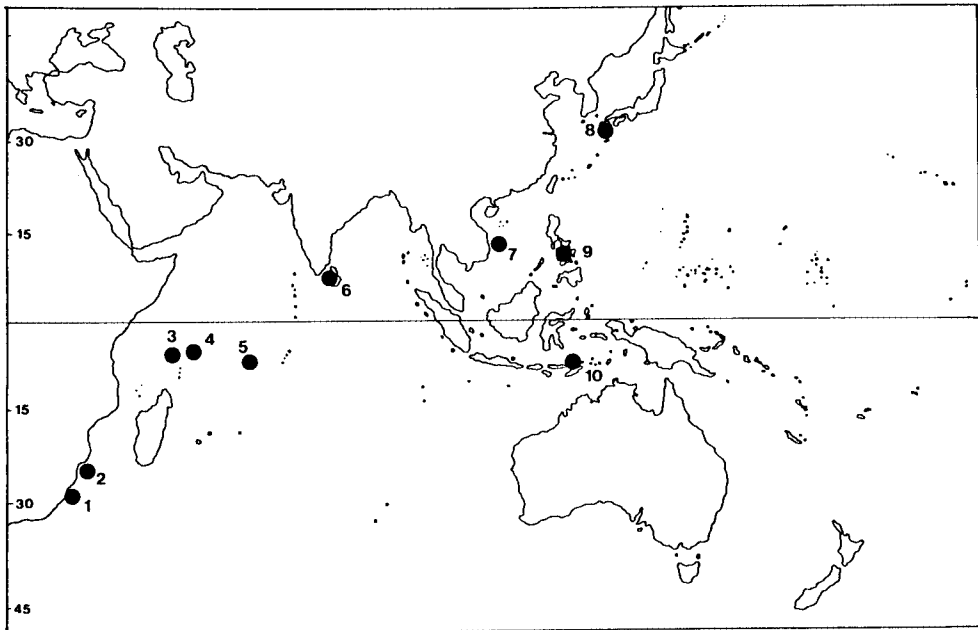


Fig. 18. *Asterodiscides elegans*, geographical distribution. Explanation of the numbers used: 1, Durban; 2, Inhaca Island; 3, Amirante Islands; 4, Seychelles; 5, Saya de Malha; 6, Sri Lanka; 7, South China Sea; 8, southern Japan; 9, Philippines; 10, lesser Sunda Islands.

Distribution.— Off Durban, South Africa (A.M. Clark, 1974; A.M. Clark & Courtman-Stock, 1976); Inhaca Island, Mozambique (Balinsky, 1969); Amirante Islands, Seychelles, Saya de Malha (Rowe, 1977; A.M. Clark, 1984); Sri Lanka (James, 1969); Indo-Malaysian area (Rowe, 1977; Aziz, 1986); Philippines, China Sea and southern Japan (Rowe, 1977) (fig. 18).

Discussion.— A.M. Clark (1974) included the genus *Asterodiscus* in the family Oreasteridae under the new name *Asterodiscides*, because *Asterodiscus* Gray, 1847, is a junior homonym of *Asterodiscus* Ehrenberg, 1839, a genus of Protozoa. Rowe (1977) created a new family, Asterodiscididae, for the genera *Asterodiscides* A.M. Clark, 1974, *Paulia* Gray, 1840, and *Amphiaster* Verrill, 1868. Rowe (1977) distinguished between two subspecies of *A. elegans*, viz. *A. e. elegans* and *A. e. belli*. A.M. Clark (1984) evidently did not accept this subdivision. In 1985, Rowe elevated *A. e. belli* to specific rank. Aziz (1986) found his specimens from the Indo-Malaysian region to fall within the range of variation described by Rowe (1977) for the West Indian subspecies *A. e. belli*, and concluded that Rowe's subspecific characters were better interpreted as due to individual variation. According to Rowe (1977, 1985), *A. belli* differs from *A. elegans* in: (a) the number of adambulacral furrow spines, being 4-5 in *A. elegans* and 3-4 (5) in *A. belli*, (b) the number of tubercles on the ventro-lateral plates, (c) the shape of the pedicellariae, and (d) the geographical distribution.

The specimens from Inhaca Island do not have any pedicellariae. The number of adambulacral furrow spines is four, rarely five in the larger specimen, and rarely three in the smaller. Some of this variation is caused by the varying position of the most adorally placed furrow spine, particularly in the distal part of the arm. The number of tubercles on the ventro-lateral plates ranges from one to six in a single specimen. In the three specimens from the Seychelles, the number of furrow spines is three to four and the number of raised tubercles on the ventro-lateral plates ranges from one to five. The two larger specimens do have pedicellariae, which are widened at the base, but not "bulbous".

The difference in shape between the two forms ($R/r = 1.3-1.5$ in *A. e. elegans* and $1.1-1.3$ in *A. e. belli*), as described by Rowe in 1977, seems no longer to be accepted by this author in 1985. In the last-named publication the R/r ratio of *A. belli* is given to range from 1.1 to 1.4. In his key to the species of *Asterodiscides*, Rowe (1985) mentions two series of two (adradial series) and one (abradial series) spines on the ventral surface of the adambulacral plates in both *A. elegans* and *A. belli*. In his "Diagnosis" of *A. belli*, however, he lists a single inner and a single outer spine. Although the specimens from the Seychelles correspond better with Rowe's description of *A. belli*, I am not convinced of the distinctness of *A. elegans* and *A. belli*, even on a subspecific level.

Culcita schmideliana (Retzius, 1805)

(fig. 19)

Asterias schmideliana Retzius, 1805: 11.

Culcita schmideliana; Gray, 1840: 276; 1847: 74; 1866: 5; Perrier, 1869: 197; 1876: 74; 1878: 81; Viguier, 1878: 192; Bell, 1882a: 168; 1884c: 510; Studer, 1884: 37; Lorient, 1885: 64; Bell, 1887a: 140; 1888: 388; Döderlein, 1888: 827; Sladen, 1889: 351; Sluiter, 1889: 305; Hartlaub, 1892: 65; Döderlein, 1896: 315; Herdman & Herdman, 1904: 143; Koehler, 1910a: 126; Simpson & Brown, 1910: 53; Goto, 1914: 516; H.L. Clark, 1915: 89; 1923: 274; Decary, 1924: 40; Kalk, 1958: 218; 1959: 21; Balinsky, 1958; 1969: 105; A.M. Clark & Spencer Davies, 1966: 598; A.M. Clark & Rowe, 1971: 53; Jangoux, 1973: 18; Marsh, 1974: 100; A.M. Clark & Courtman-Stock, 1976: 67; Marsh, 1976: 218; Sloan et al., 1979: 95; Tortonese, 1980a: 111; A.M. Clark, 1984: 90; Jangoux & Aziz, 1984: 860; Aziz, 1986: 307; Campbell & Morrison, 1988: 374. Not: *Culcita schmideliana*; Sluiter, 1889: 305.

- Asterias discoidea* Lamarck, [1815] 1816: 554; Desjardins, 1830: 177; Dujardin & Hupé, 1862: 371.
Asterias dioscoidea; Blainville, 1830: 218; 1834: 237.
Culcita discoidea; Müller & Troschel, 1840: 323; L. Agassiz, 1835: 192; 1838: 442; Müller & Troschel, 1842: 37; 1843: 127; Michelin, 1845: 22; Peters, 1852: 178; Dujardin & Hupé, 1862: 371; Martens, 1866: 71; 1869: 130; Perrier, 1869: 256.
Culcita schmideliana; Möbius, 1980: 50.
Culcita schmideliana var. *africana* Döderlein, 1896: 315; Ludwig, 1899: 540; Goto, 1914: 516.
Culcita schmideliana africana; Tortonese, 1935: 64.
Culcita schmideliana var. *ceylonica* Döderlein, 1896: 315; Goto, 1914: 516.
Culcita novaeguineae; H.L. Clark, 1923: 273 [Not: *Culcita novaeguineae* Müller & Troschel, 1842: 38].
Culcita coriacea; Studer, 1884: 37; Bell, 1909: 19.

Material.— Three dried specimens from Inhaca Island, Mozambique; between and on corals of Ponta Torres, ca 1 m depth, 14.i.1987. (*) AE 5671 (= RMNH 5787): R/r = 106/71 mm; AE 5672: R/r = 105/77 mm; (*) AE 5673 (= RMNH 5788): R/r = 102/80 mm.

Diagnosis.— Large, cushion-shaped starfishes with dorsal and marginal plates concealed by a thick, granular skin. Some enlarged tubercles on the dorsal surface, particularly radially. Pore-free areas distinct, specially towards the lower surface, at the margins. No spines or spinelets on the pore areas, which are more or less confluent.

Description.— A large, pentagonal, cushion-shaped starfish, which is common on and around the coral reefs of Barreira Vermelha and Ponta Torres. The dried forms are shrunk and may keep their cushion-like appearance or become flat and even concave dorsally. The arm tips are bent over dorsally, so that the adambulacral grooves extend onto the dorsal surface. The dorsal surface is covered by a thick, finely granulated skin, which obscures the outlines of the dorsal and marginal plates. The spinulation of the dorsal surface varies in density (fig. 19a, c). It consists of enlarged granules, tubercles and conical, pointed spines, which are concentrated along the radii, the margin of the disc and around the arm-tips. The papular pore areas are large, about eight per radius, and more or less confluent. The degree of granulation is variable and the granules may be slightly elongated, but the areas are devoid of spines and tubercles. Between the granules there are many small, calcareous rings containing the two valves of a small pedicellaria. The large madreporite has many fine radiating grooves and is very conspicuous, particularly in dried specimens.

The anus is a distinct hole in the middle of the disc or somewhat acentral, and may be surrounded by strong dorsal spines. The ventro-lateral areas are very large and consist of regular, at times interrupted, rows of elongated hexagonal or pentagonal plates which are densely granulated with distinct granules of various sizes. Some larger granules may be produced in low tubercles or short blunt spines, which may be rounded or angular in cross-section. The armature further consists of many small pedicellariae, which look like split granules; the edges of the valves are often slightly serrated. The number of granules that are raised in short, blunt spines, as well as the length of the spines, are variable. In the three Inhaca specimens, the ventral armature was least developed in the specimen with the most dorsal spines (AE 5674) and vice versa (fig. 19).

The adambulacral plates bear straight furrow spines, of which the central ones are often somewhat widened distally. The number of furrow spines varies from four to seven, being largest in the specimen with the least dorsal spines (AE 5671). There

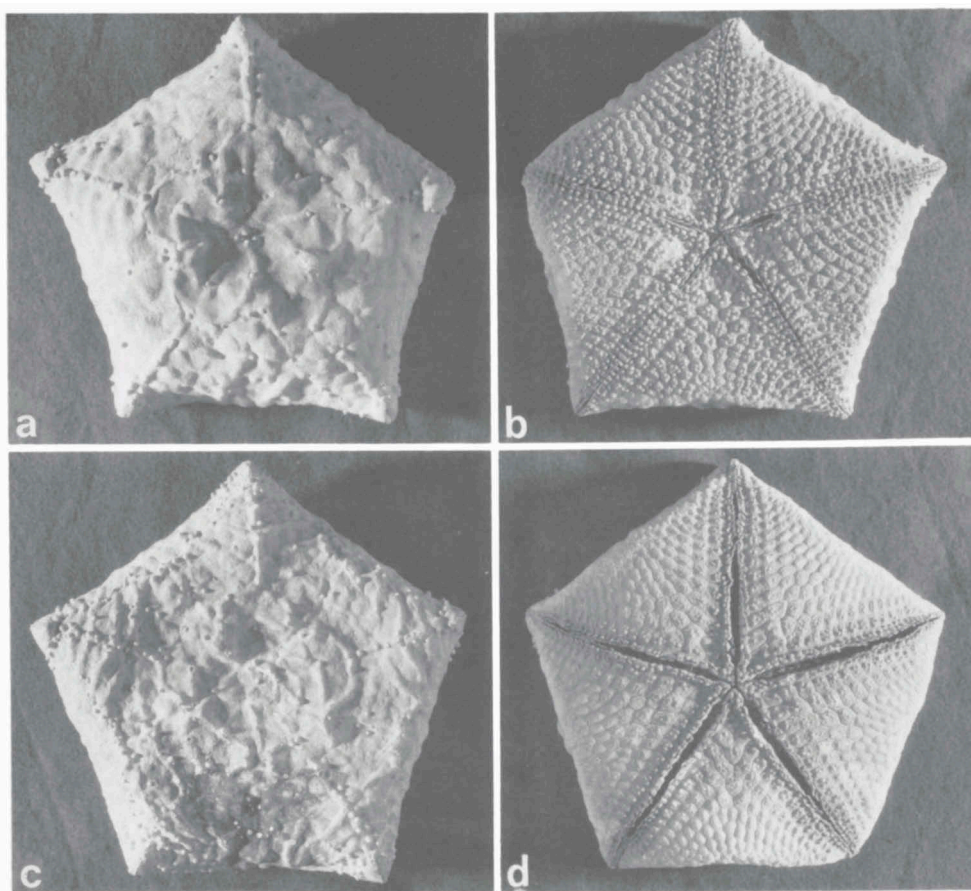


Fig. 19. *Culcita schmideliana*. a-b: AE 5672, R/r = 105/77 mm; a, habitus dorsally; b, habitus ventrally. c-d: AE 5671, R/r = 106/71 mm; c, habitus dorsally; d, habitus ventrally.

is one strong subambulacral spine with one or two (much) smaller secondary spines. The ventral surface of the plates is densely granulated and has some small pedicellariae. The oral plates are very similar to the adambulacral plates. The second of the about six furrow spines is decidedly stronger than the other ones and has about the same diameter as the two or three suboral spines. The small ventral surface of the plates has granules and pedicellariae like the adambulacral plates.

The colour in life is yellowish-brown with darker papular areas.

Distribution.— From Inhaca Island, southern Mozambique (Balinsky, 1958; 1969), north to Dar-es-Salaam (Döderlein, 1896) and SE Arabia (Campbell & Morrison, 1988), Mauritius, Madagascar and the Seychelles (Döderlein, 1896; Perrier, 1876), Maldives (A.M. Clark & Spencer Davies, 1966), Sri Lanka (H.L. Clark, 1915), Andaman Islands, Bay of Bengal, Indonesia: Moluccas (Martens, 1866), NW Australia (Marsh, 1976). See map in Jangoux (1973: 19).

Discussion.— Döderlein (1896) distinguished two varieties of *Culcita schmideliana*, viz. *ceylonica* from Sri Lanka, with small and roundish, well separated pore areas and numerous rather small, thorny dorsal spines, and *africana* from East

Africa, Mauritius and the Seychelles, with large, more or less confluent pore areas and very large, wart-like dorsal spines, (which are rarely thorny), numerous to almost lacking. Koehler (1910a), however, reported his large (R = 190 mm) specimen from the Andaman Islands to be more similar to the African forms of the species than to the variety *ceylonica* of Döderlein and most later authors have not taken up Döderlein's distinction. Lorient (1885) considered both *Culcita coriacea* and *Culcita discoidea* to be synonymous with *C. schmideliana*. Later authors, however, maintained *C. coriacea* as a distinct species. A.M. Clark & Courtman-Stock (1976) considered the specimen from Mozambique, identified by H.L. Clark (1923) as *C. novaeguineae* Müller & Troschel, 1842, to be *C. schmideliana*. A.M. Clark & Rowe (1971) identified the specimen of *C. coriacea* of Bell (1909) from the Seychelles as *C. schmideliana*. According to Aziz (1986), the specimen from the Red Sea, which Sluiter (1889) had identified as *C. schmideliana* is in fact *C. novaeguineae*.

The juvenile forms of this genus, which have not as yet been observed in Inhaca waters, are very different in appearance from the adults and have often been described in different genera (e.g., *Goniodiscus* Müller & Troschel and *Randasia* Gray). The development of *Culcita* and the resulting synonymy has yet to be fully resolved for the East African species.

Pentacaster mammillatus (Audouin, 1826)

(figs. 20, 21)

Asterias mammillata Audouin, 1826: 209, pl. 5.

Oreaster mammillatus; Müller & Troschel, 1842: 48; 1843: 126; Michelin, 1845: 22; Dujardin & Hupé, 1862: 383; Perrier, 1869: 268; Bell, 1884a: 67; 1889a: 6; H.L. Clark, 1915: 89; 1923: 273; Mortensen, 1933a: 220; Lopes, 1939: 83.

Pentaceros mammillatus; Perrier, 1876: 62; 1878: 21; Viguier, 1878: 194; (?) Koehler, 1895: 396; Sladen, 1889: 760;

Pentaceros mammillatus var. *tuberculatus*; Koehler, 1910a: 108.

Pentacaster mammillatus; Döderlein, 1916: 424; 1926: 9; 1936: 341; Tortonese, 1935: 68; 1936: 211; Mortensen, 1940: 66; Tortonese, 1949: 35; 1953: 27; Kalk, 1954: 113; 1959: 21; Tortonese, 1960: 17; Macnae & Kalk, 1962: 108; A.M. Clark, 1967: 38; Balinsky, 1958; 1969: 102; Day, 1969: 182; A.M. Clark & Rowe, 1971: 56; Jangoux, 1973: 20; A.M. Clark & Courtman-Stock, 1976: 68; Tortonese, 1980a: 110; Price, 1981: 5; 1983: 42; Aziz, 1986: 312; Fouda & Hellal, 1987: 31.

Pentaceros hiuculus Gray, 1840: 276.

Oreaster hiulcus; Perrier, 1869: 267; 1876: 59 [Not: *Oreaster hiulcus* Müller & Troschel, 1842: 48 (= *Pentaceros hiuculus* Gray, 1840: 276)].

Pentaceros hiulcus; Perrier, 1876: 59; 1878: 83; Ludwig, 1899: 540.

Oreaster tuberculatus; Peters, 1852: 178 [Not: *O. tuberculatus* Müller & Troschel, 1842].

Material.— Six dried specimens from Inhaca Island, Mozambique; sea-grass beds off Barreira Vermelha. a. 31.viii.1985: AE 5702: R/r = 71/27 mm; AE 5703: R/r = 58/23 mm; AE 5704: R/r = 61/24 mm. b. 30.viii.1986: (*) AE 5710 (= RMNH 5789): R/r = 51/22 mm; (*) AE 5711 (= RMNH 5790): R/r = 59/26 mm; (*) AE 5712 (= RMNH 5791): R/r = 50/22 mm

Diagnosis.— A rather larger oreasterid starfish with well-developed arms. Dorso-lateral areas reticulate. Only the primary plates with knobs forming regular longitudinal series. Some proximal infero-marginal plates with tubercles or spines.

Description.— This species is very similar, in habitat and abundance, to

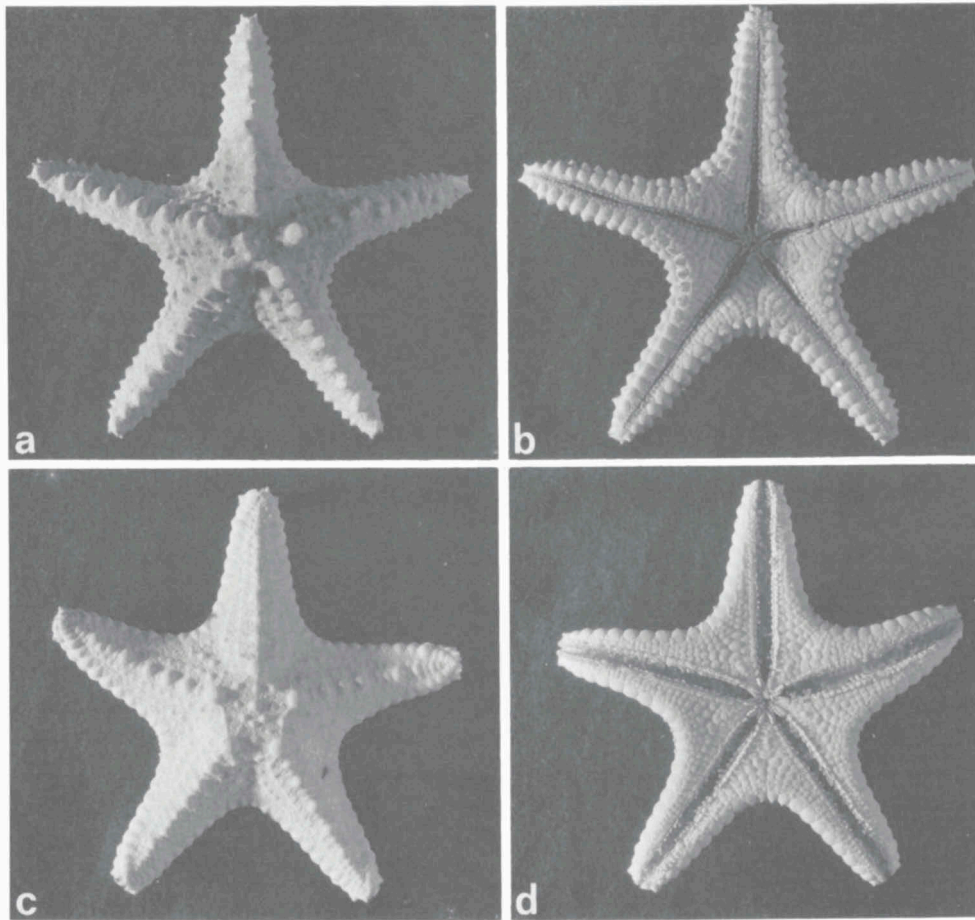


Fig. 20. *Pentaceraster mammillatus*. a-b: AE 5702, R/r = 71/27 mm; a, habitus dorsally; b, habitus ventrally. c-d: AE 5712, R/r = 50/22 mm; c, habitus dorsally; d, habitus ventrally.

Protoreaster linkii. In the field, it is easily distinguished, however, by its rather uniform coloration and the presence of infero-marginal spines in the interradial arc. The armature and the coloration are highly variable. In the most spinose specimens, every other (distally every third) carinal plate is produced into a very prominent, basally constricted "spine" with a tubercle at the tip. On the sides of the arms, the primary plates form regular longitudinal series, of which, proximally, up to five plates may be swollen and be bearing a terminal tubercle. These plates are, however, always distinctly smaller than those of the carinal series. The granules on the primary plates are flatter and more polygonal, and harbour long, valvate pedicellariae, whereas the remaining dorsal surface bears small, rounded granules and many spatulate pedicellariae. In the less spinose specimens the primary plates are not raised as high and rarely have a terminal tubercle. The carinal plates are still raised higher than the lateral plates, which are only slightly swollen and usually bear a large valvate pedicellaria.

In some specimens, the supero- and infero-marginal plates are very similar and extend equally, whereas in others the supero-marginal plates are much more swollen to form the sole border of the body. All marginal plates are densely covered with flat, polygonal or rounded granules. In the larger, more spinose specimens, the supero-marginal plates are almost all highly raised and the terminal granule is enlarged to form a distinct tubercle. Distally, three or more plates are small, flat and without tubercle. The less spinose specimens have the supero-marginal plates only slightly swollen. A low tubercle may be present on some of the proximal plates.

Valvate pedicellariae are common. The infero-marginal plates are usually largely shifted to the ventral surface. The proximal plates invariably have one or more central granules produced into a bluntly pointed tubercle. Distally, again, a few plates generally have a prominent tubercle. Pedicellariae are rare or absent. In two specimens (AE 5710 and AE 5712) there is, interradially, a series of about ten small plates inserted between the supero- and infero-marginal plates.

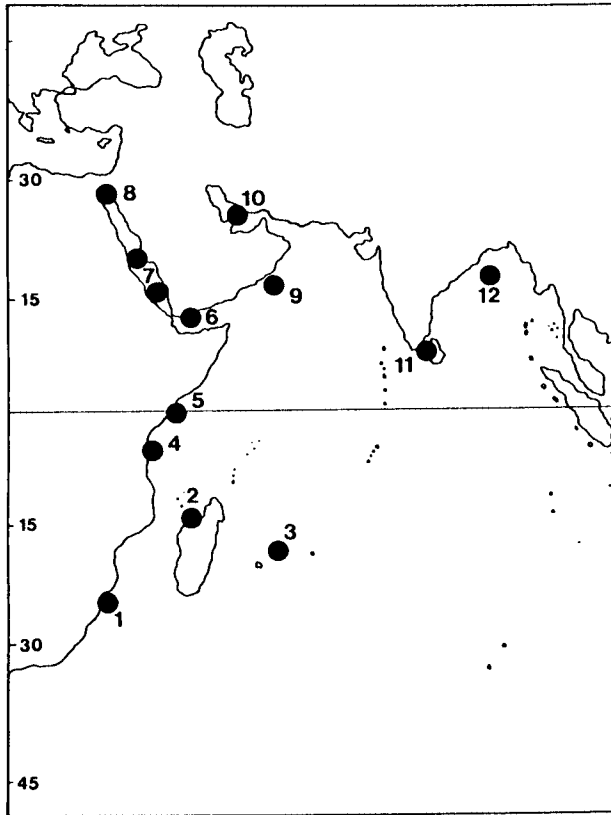


Fig. 21. *Pentaceraster mammillatus*, geographical distribution. Explanation of the numbers used: 1, Inhaca Island; 2, Madagascar; 3, Mauritius; 4, Zanzibar; 5, Somalia; 6, Aden; 7, Red Sea; 8, Gulfs of Suez and Aqaba; 9, SE Arabia; 10, Persian Gulf; 11, Sri Lanka; 12, Bay of Bengal.

The ventral surface is very similar to that of *Protoreaster linkii*. The ventro-lateral areas extend towards the tips of the arms. The granulation is similar to that of the infero-marginals, but for the enlarged and slightly raised central granules and the presence of valvate pedicellariae. The abundance and size of the pedicellariae are variable, both between specimens and in a single individual. The more adradial plates have more and larger pedicellariae. The adambulacral plates bear about eight slender furrow spines, increasing in length towards the centre, and two or three (distally one), flattened, bluntly tipped subambulacral spines of usually unequal lengths. Between the series, on the adoral edge of the plate, there generally is a rather long, simple pedicellaria. The plates have a marginal series of polygonal granules, decreasing in size adradially, and may bear

two to four short, flattened spines and/or some additional granules on the ventral surface. The oral plates have about twelve furrow spines, rapidly increasing in size towards

the mouth, and three or four large and strong subambulacral spines. The armature of the ventral surface of the oral plates is very similar to that of the adjacent ventro-lateral plates, and may also comprise pedicellariae, varying from large valvate (AE 5704) to simple and spatulate (AE 5702) (fig. 20).

Distribution.— From Inhaca Island (Balinsky, 1958; 1969) to the Red Sea and the Persian Gulf, including Madagascar and Mauritius (A.M. Clark & Rowe, 1971), Sri Lanka (H.L. Clark, 1915) and the Bay of Bengal (Bell, 1884a) (fig. 21).

Discussion.— I tend to agree with A.M. Clark & Courtman-Stock (1976) that the record of H.L. Clark (1923) is extremely unlikely, despite it has been often quoted (Mortensen, 1933a; Day, 1969; Jangoux, 1973) Mossel Bay (Cape Province, South Africa). A.M. Clark & Courtman-Stock (1976) considered the specimens described by Peters (1852) as *Oreaster tuberculatus* Müller & Troschel, 1842 (p. 46), to be *Pentacaster mammillatus*. Döderlein (1936) judged specimens described by Perrier (1876) as *Oreaster hiulcus* and *Pentaceros hiulcus*, respectively, to be *Pentacaster mammillatus*. Döderlein (1936) considered the specimens identified as *Oreaster hiulcus* Müller & Troschel, 1842 (p. 48; = *Pentaceros hiuculus* Gray, 1840) to be synonymous with *Protoreaster nodosus* (L., 1758). Aziz (1986) doubted the correctness of Koehler's 1895 record of this species from the Sunda Islands, and suggested that the specimens belong to *Pentacaster alveolatus* (Perrier, 1875).

Protoreaster linkii (Blainville, 1830)
(fig. 22)

Asterias linkii Blainville, 1830: 219; 1834: 238.

Oreaster linckii; Lütken, 1864: 156; Goto, 1914: 516; H.L. Clark, 1915: 89; 1923: 273; Lopes, 1939: 83; Satyamurti, 1967: 87.

Oreaster lincki; Bell, 1884a: 72; 1884c: 510; 1887b: 647; 1888: 384; Goto, 1914: 493.

Pentaceros lincki; Bell, 1899: 136; 1903: 244; Crossland, 1907: 9; Bell, 1909: 19; Brown, 1910: 32; Simpson & Brown, 1910: 51.

Protoreaster lincki; Döderlein, 1916: 423; 1936: 328; Tortonese, 1949: 33; Kalk, 1954: 113; Macnae & Kalk, 1962: 108; Balinsky, 1958; 1969: 105; Kalk, 1958: 215; 1959: 21; Day, 1969: 182; James, 1969: 60; A.M. Clark & Rowe, 1971: 54; Jangoux, 1973: 23; A.M. Clark & Courtman-Stock, 1976: 68; Marsh, 1976: 218; Julka & Das, 1978: 346; Sloan *et al.*, 1979: 96; Aziz, 1979: 722; Ebert, 1979: 71; Tortonese, 1980a: 111; Aziz, 1981: 48; Aziz & Jangoux, 1984: 137; A.M. Clark, 1984: 90; Jangoux & Aziz, 1984: 860; Aziz, 1986: 323.

Pentaceros muricatus Gray, 1840: 277; Dujardin & Hupé, 1862: 382; Gray, 1866: 6; Perrier, 1876: 55; 1878: 22; Viguier, 1878: 197; Sladen, 1889: 760; Meissner, 1892: 187; Russo, 1894: 162; Sluiter, 1895: 56; Thurston, 1895: 114; Pfeffer, 1896: 47; Ludwig, 1899: 540; Koehler, 1905a: 185; Kalk, 1959: 6.

Oreaster muricatus; Dujardin & Hupé, 1862: 383; Martens, 1866: 77; 1869: 130; Perrier, 1869: 266.

Oreaster reinhardti Lütken, 1864: 159; Bell, 1884a: 74.

Pentaceros reinhardti; Perrier, 1878: 24; Sluiter, 1895: 56; Koehler, 1910a: 101.

Material.— Four dried specimens from Inhaca Island, Mozambique. sea-grass beds, off Barreira Vermelha, 31.vii.1985. AE 5701: R/r = 81/30 mm; AE 5705: R/r = 111/36 mm; (*) AE 5706 (= RMNH 5792): R/r = 96/34 mm; (*) AE 5707 (= RMNH 5793): R/r = 118/44 mm.

Diagnosis.— A common shallow water oreasterid starfish with five well-developed arms and a prominently raised dorsal surface. Marginal and dorsal plates densely covered by small, flattened granules. Some distal supero-marginal plates

with conspicuous lateral knobs or spines. Inframarginal plates without spines. In life this species has a distinct pattern of red lines on a greyish or yellowish background.

Description.— A rather large oreasterid starfish with a large disc and five well developed arms. The species is very conspicuous and common, particularly on the sea-grass beds of the western shores. The ventral surface is flat, or, in dried specimens, concave; the dorsal surface is highly raised and many of the dorsal plates are produced in heavy, blunt, conical "spines". Two of the four specimens have a central "spine" next to the anus. The number of spine-like carinal plates varies between six and twelve. In most specimens the distinction between raised and flat carinal plates is very clear; in others (e.g. AE 5705) most carinal plates are raised to a varying degree. One to three of the proximal adcarinal plates are highly raised, the most proximal ones being tallest, and several more distal plates are usually slightly swollen. All dorsal and marginal plates, whether raised in a "spine" or not, are

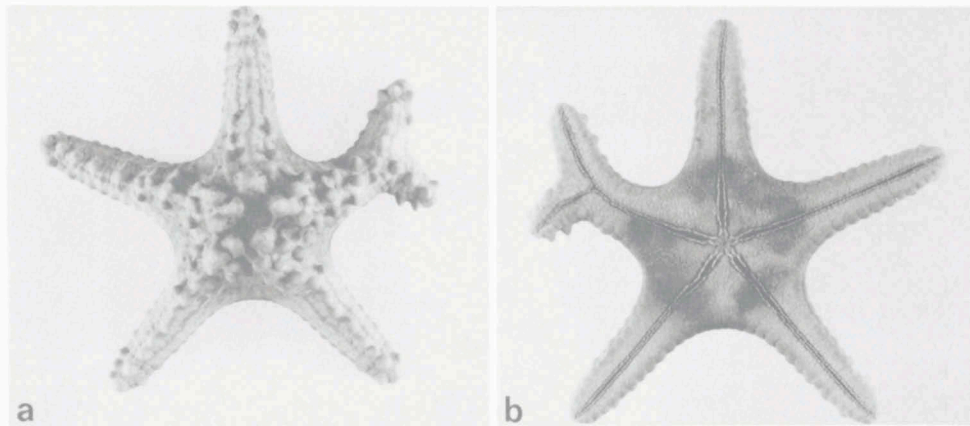


Fig. 22. *Protoreaster linkii*. AE 5707, R/r = 118/44 mm. a, habitus dorsally; b, habitus ventrally.

densely covered by a smooth plastering of polygonal, flat granules, which increase in size towards the centre of the plates; there, on the raised plates, they are often confluent. In one specimen (AE 5701), the tip of most "spines" shows a flat scar and a few supero-marginal plates have retained a blunt, conical tubercle. The large papular areas between the dorsal plates have small, rounded, and/or slightly larger and polygonal granules and small, spatulate pedicellariae around the pores. The papular pore areas are largely confluent, at least with regard to the yellowish-grey coloration and granular armature.

The madreporite lying between and distally to the largest, most proximal carinal "spines" is bare and conspicuous. The anus lies between the most proximal carinal plates, slightly acentrally, even when the central dorsal plate is not produced. A varying number of distal supero-marginal plates, which may be adjacent or separat-

ed by one or two low plates, are produced in strong, blunt, conical "spines", which may bear a terminal tubercle. The proximal supero-marginal plates and all infero-marginal plates are slightly swollen, but never highly raised to form a knob or a spine. The carinal, adcarinal and marginal plates are bright red, as well as the transverse rows of granules connecting about one in three carinal plates with the adjacent adcarinal plates. A red line of varying length descends from the first adcarinal plates. The arm tips are all red, including the granulation of one or two pore areas. The ventral surface may be all red, or be lighter, orange or yellowish in colour.

The ventro-lateral areas extend towards the tip of the arms. The plates are granulated similarly to the infero-marginal plates, but most plates have the central granules enlarged and raised to varying degrees forming low tubercles. Many plates, particularly the series adjacent to the adambulacral plates, have one or two long, valvate pedicellariae. The adambulacral plates bear six or seven small, slender spines, increasing in length towards the centre, deep in the furrow. There are two or three chisel-like subambulacral spines. Between the two series, on the adoral edge of the plate, there usually is a simple pedicellaria of intermediate length. The ad- and aboral and abradial margins of the plates have a series of small, polygonal granules, decreasing in size towards the furrow. In some specimens, several subambulacral spines have grooves on the tip and (part of) the abradial side.

On the oral plates there is a series of about ten furrow spines, of which the distal six are slender and the proximal two to four are as strong as the suboral spines. The oral most furrow spine is smaller than the adjacent ones. The two to five strong suboral spines are wedged, distally, against the series of compressed large furrow spines, sometimes seemingly forming a continuous series. On the abradial side and the tip of all large spines on the oral plates there are grooves and ridges, which may be straight or convoluted or even replaced by granules. The armature of the ventral surface of the oral plates is similar to that of the adjacent ventro-lateral plates (fig. 22), showing an unusual specimen with one, partly divided arm.

Distribution.— From southern Mozambique (Inhaca Island; Balinsky, 1958; 1969) along the coast of East Africa and the islands of the western Indian Ocean to the Red Sea, Sri Lanka and the Gulf of Bengal (Kalk, 1958; Döderlein, 1936; Bell, 1887b; 1888; 1909; Tortonese, 1980a). Also Indo-Malysian region (see review by Aziz, 1986) and North-West Australia (Marsh, 1976). See map in Jangoux (1973: 24).

Discussion.— Although Blainville (1830; 1834) referred to J.H. Linck (1733) for the specific name *linkii*, he consistently spells that name as Link. *A. linkii*, therefore, does not constitute an incorrect original spelling. The specific names *linckii* and *linc-ki* are, according to Article 33b of the International Code of Zoological Nomenclature (3rd ed., 1985), unjustified emendations.

Döderlein (1936) in his revision of the subfamily Oreasterinae synonymized *Pentaceros muricatus* and *Oreaster reinhardti* with *Protoreaster linkii*.

***Fromia milleporella* (Lamarck, 1815)**
(figs. 23, 24, table 5)

Asterias milleporella Lamarck, [1815] 1816: 564.

Fromia milleporella; Gray, 1840: 286; Gray, 1866:14; Hoffmann, 1874: 54; Perrier, 1875: 437; 1878: 71;

Viguiier, 1878: 168; Möbius, 1880: 50; Bell, 1882b: 220; Studer, 1884: 30; Loriol, 1885: 44; Bell, 1887b: 647; 1888: 388; Döderlein, 1888: 826; Sladen, 1889: 400; Sluiter, 1889: 300; Bell, 1894: 396; Sluiter, 1895: 60; Bell, 1899: 138; 1902: 227; Brown, 1910: 34; H.L. Clark, 1915: 95; Fisher, 1919: 378; H.L. Clark, 1921: 40; Decary, 1924: 40; H.L. Clark, 1926: 185; Livingstone, 1932: 252; Tortonese, 1935: 70; Engel, 1938b: 10; Hayashi, 1938c: 205; H.L. Clark, 1946: 112; A.H. Clark, 1954: 255; Endean, 1956: 124; 1957: 239; A.M. Clark & Spencer Davies, 1966: 598; James, 1969: 53; A.M. Clark & Rowe, 1971: 63; Domantay, 1972: 97; Marsh, 1974: 90; 1977: 257; Jangoux, 1978: 288; Guille & Jangoux, 1978: 56; Aziz, 1979: 722; Sloan *et al.*, 1979: 96; Celis, 1980: 41; Tortonese, 1980a: 114; Aziz, 1981: 48; Aziz & Jangoux, 1984: 138; Jangoux & Aziz, 1984: 860; Jangoux, 1984: 280; Aziz, 1986: 344; Jangoux, 1986: 130; Fouda & Hellal, 1987: 44.

Linckia milleporella; Müller & Troschel, 1840: 322; Martens, 1866: 69; 1869: 130.

Scytaster milleporellus; Müller & Troschel, 1842: 35; 1843: 126; Michelin, 1845: 22; Dujardin & Hupé, 1862: 366; Perrier, 1869: 254.

Fromia milleporella (sic); Perrier, 1875: 437.

Asterias sebae Blainville, 1830: 219; 1834: 238.

Scytaster pistorius Müller & Troschel, 1842: 35; Dujardin & Hupé, 1862: 367; Perrier, 1869: 254.

Linckia (*Scytaster*) *pistorius*; Martens, 1866: 85.

Linckia pistoria; Martens, 1869: 139.

Fromia pistoria; Perrier, 1878: 17.

Material.— 1. One specimen from the corals north of Ilha dos Portugueses, Inhaca Island, Mozambique, AE 5617: R/r = 47/11 mm, 1 m depth, 9.iii.1986. 2. Six specimens from Indonesia and Mauritius in the Nationaal Natuurhistorisch Museum, Leiden. RMNH 3068: one specimen, R/r = 31/7.5 mm, small island near Menado, 25.ix.1930, Snellius Expedition; RMNH 3067: three specimens, R/r = 24/7, 24/8 and 31/9 mm, Sissie, near Misool, beach and reef, 6.x.1929, Snellius Expedition; RMNH 617: one specimen, R/r = 43/11 mm, Mauritius, Frank; RMNH 616: one specimen, R/r = 32/10 mm, Indian Ocean, C.G.C. Reinwardt.

Diagnosis.— Dorsal surface rather flat; dorsal plates irregular in size, prominence and arrangement; no distinct carinal or other series. Dorsal, marginal and ventro-lateral plates evenly covered with fine granules over similar crystal bodies. No enlarged granules, spines or pedicellariae. At arm base, more than five dorsal plates and more than three series of ventro-lateral plates. Large, single papular pores between dorsal, marginal and ventro-lateral plates. Supero-marginal plates large and swollen, with intermittent smaller, more squarish and flatter plates. Adambulacral plates with 3-4 furrow spines and 2-3 subambulacral spines.

Description.— A rather flat starfish with five arms tapering to a round tip. R/r = 47/11 mm; the arm width at the base is 14 mm. The dorsal plates are of unequal size, contours and prominence. There are no spines, tubercles or pedicellariae, and the plates are not arranged in any regular rows or series. All dorsal, marginal and ventro-lateral plates are evenly covered by fine, slightly angular granules. Where these are removed, similarly sized, but much lower, crystal bodies are present. Rather large papular pores are found between all dorsal plates and between the dorsal and supero-marginal plates, with exception of the distal interradiial dorsal plates. The granules around the papular pores may be marginally enlarged. There are two anal apertures, separated by two dorsal plates and each surrounded by enlarged granules (fig. 23c). The single madreporite is bare and prominent, about the size of four dorsal plates, and with fine, radiating grooves. It is separated from the marginal plates by three dorsal plates. There are about eight dorsal plates at the arm base between the first supero-marginal plates.

The are 18-23 supero-marginal plates on each arm side. The plates may form a clear border or be almost indistinguishable from the adjacent dorsal plates. The supero-marginal plates vary in size and prominence. Along one arm side most plates are large and rather swollen. The number of distinctly smaller plates varies between one and seven; the number of plates which are merely flatter is larger. The large supero-marginal plates do not markedly decrease in size towards the arm tip. The (pen)ultimate plates are often larger than the more proximal ones. Particularly distally, some of the central granules of the dorsal, marginal and ventro-lateral plates are somewhat enlarged.

Papular pores are very rarely found between the supero-marginal plates and between the infero-marginal plates, but one pore (or occasionally two) is usually present in the corner between two supero- and two infero-marginal plates. The infero-

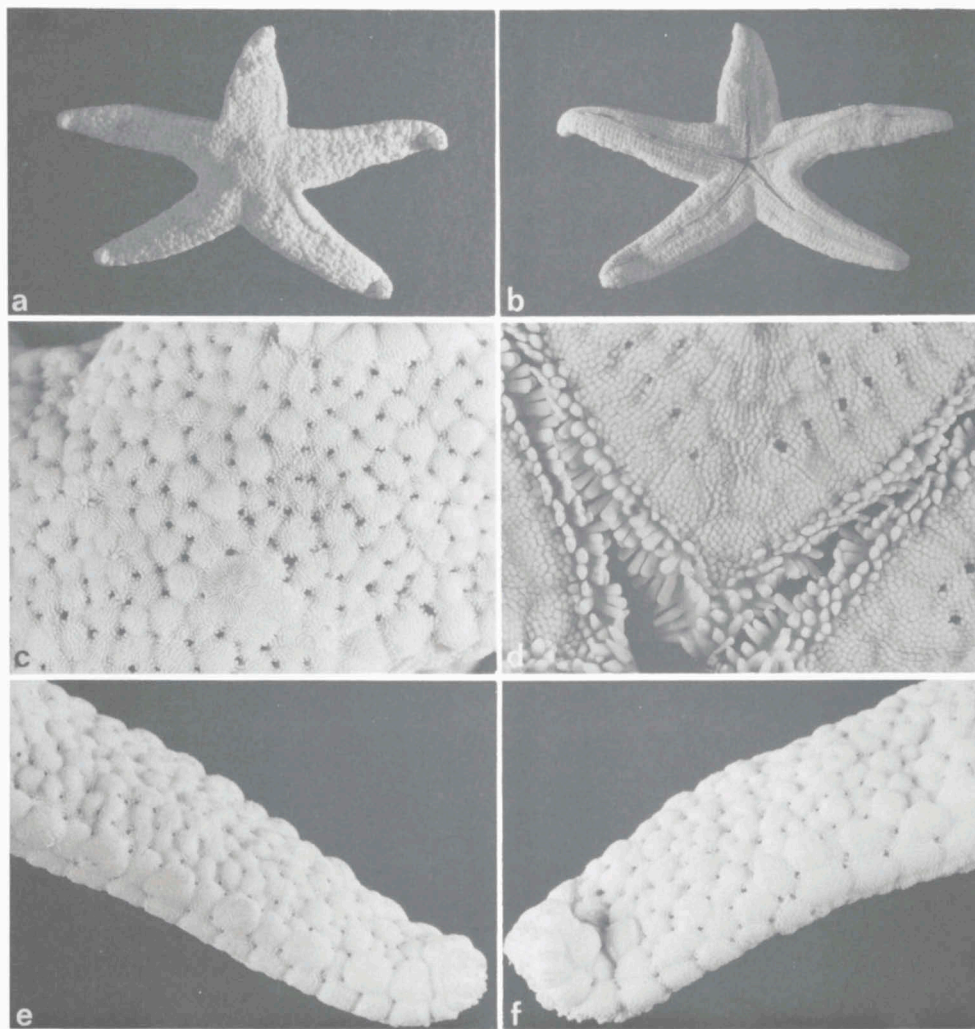


Fig. 23. *Fromia milleporella*. AE 5617, R/r = 47/11 mm. a, habitus dorsally; b, habitus ventrally; c, dorsal view of disk; d, detail of ventro-lateral area; e-f, dorso-lateral views of arms.

marginal plates are more regularly arranged and vary hardly in prominence or size.

There are about six series of ventro-lateral plates in the arm corners; half way along the arm there are about three series, and one persists towards the tip. Papular pores are absent between the two interradial rows, but otherwise regularly present between most ventro-lateral plates.

The adambulacral plates are small, well spaced and set deeply in the ambulacral furrow, so that their longish spines are almost flush with the ventral surface of the arm. There are three to four furrow spines, ad- and aborally flattened and slightly widened at the tip. The spines form small fans, of which the adoral part of the more distal plate covers the aboral part of the fan proximal to it. There are usually two, sometimes three, subambulacral spines, shorter and thicker than the furrow spines. Two large granules form the transition to the ventro-lateral granular covering. On each side of the oral plates there are six or seven furrow spines, followed by two series of five and four subambulacral spines. Between the most aboral chevron of subambulacral spines and the distal edge of the plates there is about a dozen, rather stout, angular granules (fig. 23).

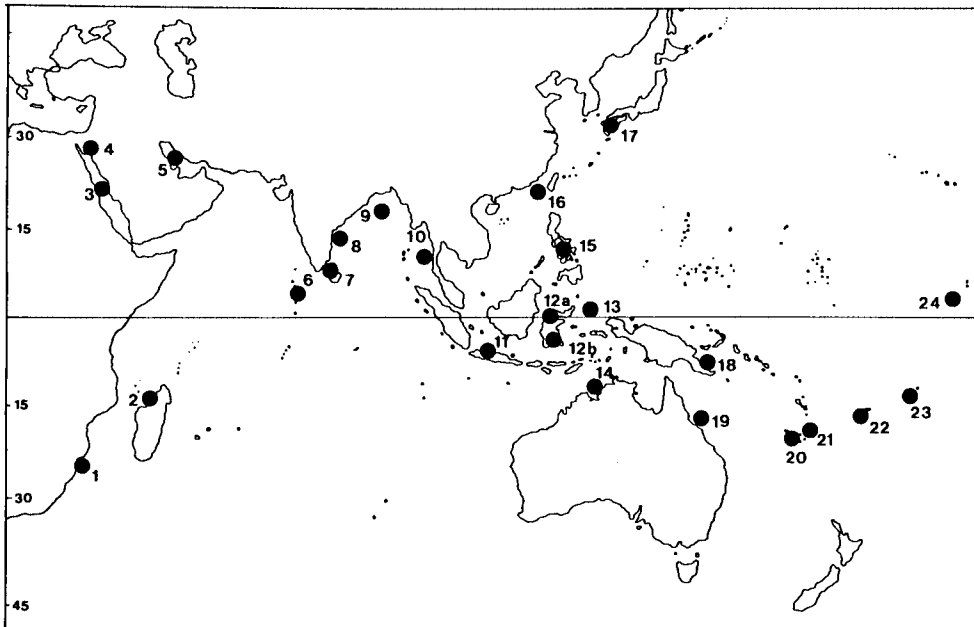


Fig. 24. *Fromia milleporella*, geographical distribution. Explanation of the numbers used: 1, Inhaca Island; 2, Madagascar; 3, Red Sea; 4, Gulf of Aqaba; 5, Persian Gulf; 6, Maldives; 7, Sri Lanka; 8, East India; 9, Bay of Bengal; 10, Mergui Islands; 11, Java; 12a, b, N. and S. Sulawesi; 13, Moluccas; 14, northern Australia; 15, Philippines; 16, China; 17, southern Japan; 18, New Guinea; 19, NE Australia; 20, New Caledonia; 21, Loyalty Islands; 22, Fiji; 23, Samoa; 24, Palmyra Island.

The colour, in alcohol 70%, is creamy white.

Distribution.— Indo-West Pacific region from southern Mozambique (Inhaca Island; first record) along the East African coast and the islands of the western Indian Ocean to the Red Sea (Hoffmann, 1874; Decary, 1924; Fouda & Hellal, 1987), the Persian Gulf, Sri Lanka and the Gulf of Bengal (Brown, 1910). In addition Indo-Malaysian area (Aziz, 1986), Philippines (Fisher, 1919), southern Japan (H.L. Clark,

1946), NE Australia (Eudean, 1957) and New Guinea. New Caledonia (Jangoux, 1984), Fiji and Samoa Islands (H.L. Clark, 1946), Loyalty Islands (Bell, 1899). and Palmyra Island (Marsh, 1974) (fig. 24).

Table 5. Comparative measurements of ten specimens of *Fromia milleporella*. L/W = length/width-at-base ratio of the arms; VL(1-3) = number of series of ventro-lateral plates in the arm corner (1), at half the arm's length (2) and at the tip if the arm (3). The first two rows of measurements are taken from the descriptions of Müller & Troschel (1842) and the last two from the drawings in Seba (1761, vol. 3, tab. 8, figs. 10a-b).

	R/r	L/W	VL(1)	VL(2)	VL(3)
<i>S. milleporellus</i> M. & T.	4.5	< 4	2	1	0
<i>S. pistorius</i> M. & T.	3	2	2	-	1
AE 5617	4.3	3.4	6	3	1
RMNH 3067 (a)	3.4	3	3	1-2	0
(b)	3	3	3	1	0
(c)	3.4	2.8	3	1	0
RMNH 3068	4.1	3.9	3/4	2	1
RMNH 617	3.9	3.6	5	3	1
RMNH 618	3.2	3.6	4	2	1
Seba (dorsal)	3	2.6	?	?	?
(ventral)	2.7	2.2	?	?	?

Discussion.— Lamarck (1815) and Lamarck (1816) are completely identical works with exception of the title page, which differs in the year of publication. Gray (1840) identified his *Fromia milleporella* with *Asterias milleporella* Lamarck and *Asterias sebae* Blainville, the latter being based on a drawing in Seba (1761) of a small starfish from "Batava, onze kust" (Seba, 1761, tab. 8, figs. 10a-b). Gray mentioned three varieties, with five to six, six, and seven rays, from Isle de France (= Mauritius), the Indian Ocean and the Red Sea, but did not give a description. Müller & Troschel (1842) described *Scytaster pistorius*, which they found to be identical with both Seba's drawings and *Fromia milleporella* Gray. Müller & Troschel (1842) also described a specimen from the Red Sea as *Scytaster milleporellus*, which they identified with *Asterias milleporella* Lamarck. In 1866, Gray included both *Asterias sebae* Blainville and *Scytaster posterius* (sic) Müller & Troschel, 1842, in the synonymy of *Fromia milleporella*, without mentioning, however, either *Asterias milleporella* Lamarck or *Scytaster milleporellus* Müller & Troschel. Martens (1866: 69) described a specimen of *Linckia milleporella* from Ambon (R/r = 4, R = 29 mm), which he identified with both *Asterias milleporella* Lamarck and *Scytaster milleporellus* Müller & Troschel. Martens (1866: 85) also reported, without description, a "*Linckia* (*Scytaster*) *pistorius* Mll Tr. = *Fromia milleporella* Gray" from the Moluccas in the "Amsterdamer Sammlung (A)".

Perrier (1875) found Gray's specimens of *Fromia milleporella* to belong to the same species as *Asterias milleporella* Lamarck and the latter to agree perfectly with *Scytaster pistorius* Müller & Troschel. Although Perrier did find specimens indicating that *Scytaster milleporellus* and *Scytaster pistorius* Müller & Troschel are not specifically distinct, in his final conclusions he considered *Scytaster milleporellus* to be a different species, which he named *Fromia monilis*. Studer (1884) and Lorient (1885) synonymized *Scytaster pistorius* Müller & Troschel, 1842 with *Fromia milleporella*. Müller

& Troschel distinguished between their *Scytaster milleporellus* and *S. pistorius* on the basis of differing (1) R/r ratio's, (2) relative arm widths, (3) lengths of the series of ventro-lateral plates and (4) the presence of smaller supero-marginal plates between the primary ones in *S. milleporellus* (table 5). In the seven specimens examined here, the R/r ratio ranges from 3 to 4.3 and the arms are between 3 and 3.9 times as long as wide at the basis. The number of (series of) ventro-lateral plates is also quite variable (table 5), as is the (un)evenness of the supero-marginal series, even in the single Inhaca specimen (fig. 23). I am therefore inclined to consider both *Scytaster milleporellus* and *S. pistorius* Müller & Troschel as synonyms of *Fromia milleporella*.

Linckia laevigata (Linnaeus, 1758)
(fig. 25)

Asterias laevigata Linnaeus, 1758: 662; Lamarck, 1815; 1816: 566; Desjardins, 1830: 178.

Ophidiaster laevigata; Müller & Troschel, 1840: 322.

Ophidiaster laevigatus; Lütken, 1864: 165.

Linckia laevigata; Nardo, 1834: 717; Lütken, 1871: 266; Bell, 1884b: 124; 1844c: 510; 1887a: 140; 1887b: 646; 1888: 384; 1902: 226; Fisher, 1906: 1086; H.L. Clark, 1908: 282; Bell, 1909: 18; H.L. Clark, 1915: 89; Fisher, 1919: 400; H.L. Clark, 1921: 64; 1923: 276; Fisher, 1925: 76; McNeill & Livingstone, 1926: 194; Stephenson *et al.*, 1931: 75; Livingstone, 1932: 254; Mortensen, 1934: 4; Boone, 1935: 243; Tortonese, 1935: 75; H.L. Clark, 1938: 560; Domantay & Roxas, 1938: 221; Engel, 1938a: 2; 1938b: 15; Hayashi, 1938b: 434; Ely, 1942: 20; Engel, 1942: 273; H.L. Clark, 1946: 117; A.H. Clark & Bayer, 1948: 144; A.H. Clark, 1949: 75; 1952: 289; 1954: 258; Hayasaka, 1949: 16; Endean, 1953: 54; 1956: 125; 1957: 239; Kalk, 1958: 206; Balinsky, 1958; 1969: 105; A.M. Clark & Spencer Davies, 1966: 598; McKnight, 1968: 712; James, 1969: 53; A.M. Clark & Rowe, 1971: 62; Domantay, 1972: 109; McKnight, 1972: 42; Jangoux, 1973: 29; Hayashi & Hirohito, 1973: 68; Marsh, 1974: 86; A.M. Clark & Courtman-Stock, 1976: 72; Marsh, 1976: 219; 1977: 260; Gibbs *et al.*, 1976: 113; Marsh, 1977: 260; Rowe & Pawson, 1977: 346; Yamaguchi, 1977: 13; Guille & Jangoux, 1978: 56; Jangoux, 1978: 288; Julka & Das, 1978: 347; Aziz, 1979: 722; Sloan *et al.*, 1979: 96; Celis, 1980: 41; Aziz, 1981: 48; A.M. Clark, 1982: 487; Aziz & Jangoux, 1984: 138; A.M. Clark, 1984: 92; Jangoux, 1984: 281; Jangoux & Aziz, 1984: 861; Aziz, 1986: 354; Jangoux, 1986: 138.

Linckia laevigata var. *hondurae* Domantay & Roxas, 1938: 221.

Linckia typus Nardo, 1834: 717; Gray, 1840: 284; Peters, 1852: 177; Gray, 1872: 118.

Linckia brownii Gray, 1840: 285; Peters, 1852: 177.

Linckia crassa Gray, 1840: 284; 1866: 14; Viguier, 1878: 150.

Ophidiaster miliaris Müller & Troschel, 1842: 30; Peters, 1852: 177; Dujardin & Hupé, 1862: 360; Perrier, 1869: 251.

Linckia miliaris; Martens, 1866: 64; 1869: 125; Perrier, 1875: 401; 1878: 17; Viguier, 1878: 148; Möbius, 1880: 50; Studer, 1884: 27; Loriol, 1885: 36; Martens, 1889: 183; Sladen, 1889: 410; Sluiter, 1889: 298; Loriol, 1893: 385; Russo, 1894: 162; Leipoldt, 1895: 648; Sluiter, 1895: 60; Thurston, 1895: 114; Döderlein, 1896: 319; Ludwig, 1899: 542; Pfeffer, 1900: 83; Ludwig, 1905: 157; Koehler, 1910a: 154; Russo, 1929: 7.

Ophidiaster clathrata Grube, 1864: 51.

Linckia rosenbergi Martens, 1866: 63.

Ophidiaster propinquus Livingstone, 1932: 255.

Linckia guildingii; Jangoux, 1973: 40 [Not: *Linckia guildingii* Gray, 1840].

Material.— 1. Eight dried specimens from Inhaca Island, Mozambique. a. Three on corals off Barreira Vermelha: (*) AE 5680 (= RMNH 5794), blue, R/r = 167/19 mm, 27.vii.1984; (*) AE 5681 (= RMNH 5795), blue, R/r = 155/18 mm, 27.v.1984; (*) AE 5684 (= RMNH 5796), 1 m depth, R/r = 182/19 mm, 13.iv.1987. b. Two specimens off Barreira Vermelha: (*) AE 5686 (= RMNH 5797), 4 m depth,

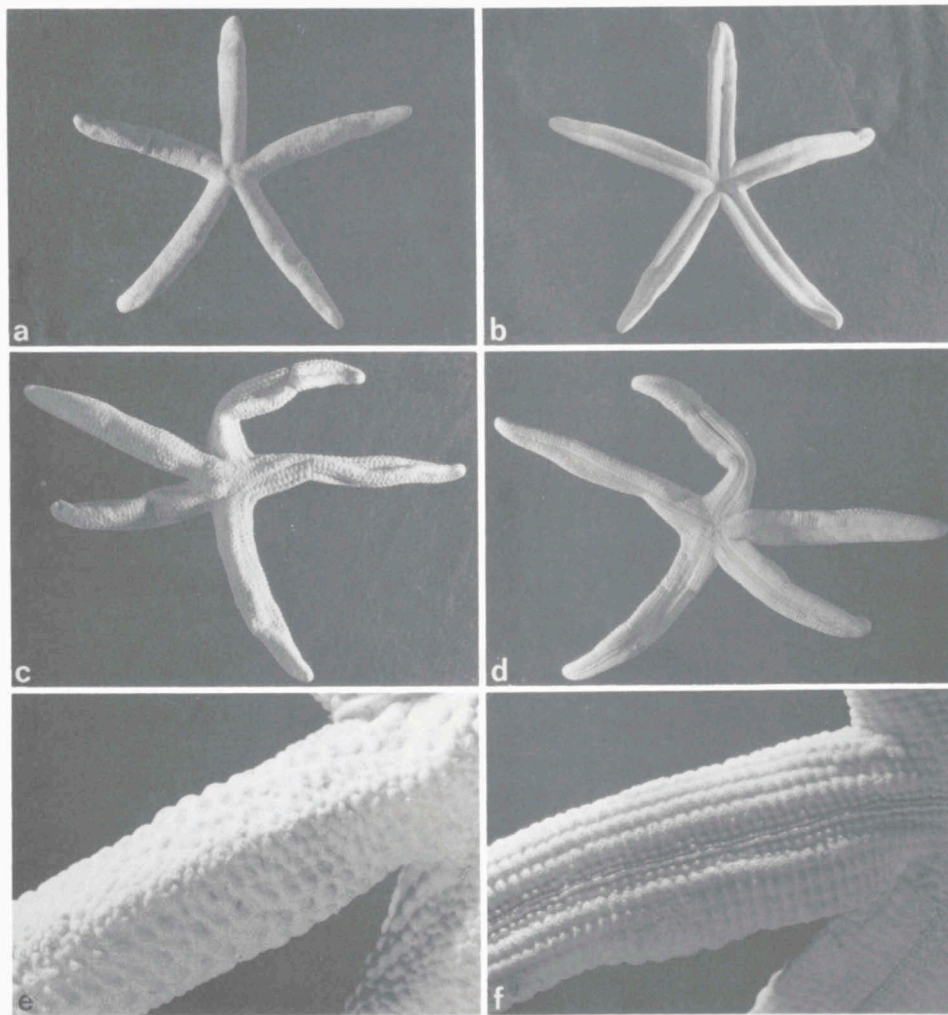


Fig. 25. *Linckia laevigata*. a-b: AE 5683, R/r = 141/18 mm; a, habitus dorsally; b, habitus ventrally. c-f: AE 5686, R/r = 93/14 mm; c, habitus dorsally; d, habitus ventrally; e, dorsal view of arm basis; f, ventral view of arm basis.

17.ii.1986, R/r = 93/14 mm; (*) AE 5651 (= RMNH 5798), R/r = 32/5 mm, 2 m depth, 16.v.1987, colour variegated. c. Two specimens on corals of Ponta Torres: AE 5682, blue, R/r = 111/15 mm, 15.x.1985; AE 5683, R/r = 141/18 mm, 7.i.1982. d. Two specimens on corals of Ilha dos Portugueses: AE 5685, R/r = 151/18 mm, 2 m depth, 9.xii.1984; AE 5687, R/r = 161/18 mm, 2 m depth, four arms, 24-11-1984. 2. One specimen from Ponta de Ouro, southern Mozambique, littoral rocks, preserved in alcohol 70 %: AE 5601, R/r = 53/9 mm, 20.vi.1982. 3. Five specimens from Inhaca Island in the Musée Royal de l'Afrique Centrale, Tervuren and labelled *Linckia guildingii*, MRAC No. 1345, 7.viii.1969: R/r = 160/19 mm (four arms), 165/18, 112/16, 107/14 and 161/18 mm.

Diagnosis.— A large ophiasterid starfish with a small disc and five long, fairly stout arms, which are cylindrical or somewhat triangular in cross section. All plates and papular areas covered by small granules. Low subambulacral tubercles separated from the furrow spines (and each other) by several series of granules. Granules

between the furrow spines. Invariably one madreporite. Colour in life a uniform blue or orange.

Description.— A large ophiasterid starfish, which is common on all coral reefs around Inhaca Island, occurring in the colour varieties blue and orange-yellow.

The five long arms are rounded-triangular in cross section and may be slightly constricted near the small disc. The R/r ratio varies from 5.9 in the smallest to 9.6 in the largest specimen. The width/length ratio of the arms varies from 0.09 in the largest to 0.16 in the smallest specimen. Except for the madreporite, the whole body is densely covered by small granules, which even extend unto and beyond the adambulacral furrow spines. On the dorsal side the plates are slightly swollen and have larger and more angular granules than the depressions between the plates. The papular pore areas have even smaller, relatively longer and often flattened granules. The mid-dorsal plates are smaller, rounder and more irregularly arranged than the lateral plates and have few or no interspersed papular areas. Between the longitudinal series of supero- and infero-marginal plates and the less regular two series of lateral plates, relatively large pore areas, slightly larger than the surrounding plates, are arranged with corresponding regularity. The dorso-lateral plates are in irregular series and so are the pore areas. Pore areas are lacking below the infero-marginal plates, as well as from the mid-dorsal region. At least proximally, there are usually small plates connecting the adjacent supero- and infero-marginal plates and partly delimiting the pore areas. The madreporite is large, round and bare with radiating grooves.

The central anus is an inconspicuous hole surrounded by granules. Along the arms there are four or five regular longitudinal series of ventro-lateral plates, densely covered by small, rounded or slightly angular granules, which near the mouth become more squamiform and imbricating. The adambulacral plates are shorter and slightly more numerous than the adjacent ventro-lateral plates. The armature consists of densely packed, slightly squamiform granules, which extend to between and even beyond the furrow spines. Each plate bears two strong, bluntly tipped furrow spines of unequal lengths and one or two short, blunt subambulacral spines. The furrow spines are separated by two or three series of about three granules, and between the subambulacral and furrow spines there are about six series of granules. In one specimen (AE 5686), most adambulacral plates have a second, usually lower, subambulacral spine on the abradial edge. In others the single subambulacral spine is hardly longer, although much heavier, than the granules. The oral plates are very similar in armature to the adambulacral plates. They bear, on each side, about four furrow spines and, between the granules one subambulacral spine (fig. 25).

There appear to be no morphological differences between the two colour varieties.

Distribution.— From southern Mozambique: Inhaca Island (Balinsky, 1958; 1969) and Ponta de Ouro (first record), along the East African coast and the islands of the western Indian Ocean to the Red Sea, the Persian Gulf, Sri Lanka and the Gulf of Bengal (review by Jangoux, 1973). Indo-Malysian area, Philippines, Hong Kong, New Guinea and northern Australia. Southern, western and central Pacific to Hawaii, Marquesas, Tonga and Society Islands (A.H. Clark, 1954; McKnight, 1968; review by Aziz, 1986, and map in Jangoux, 1973: 31).

Habitat.— In Inhaca waters *Linckia laevigata* is found on and around all three

coral reefs, whereas *L. multifora* occurs between the sea-grasses and rocks in very shallow water. The most southern record of the species is from Ponta de Ouro, Mozambique, where a small specimen rather surprisingly occurred on the exposed littoral rocks.

Discussion.— The small specimens of *Linckia laevigata* (AE 5651 and AE 5601) differ from the adult ones by their variegated coloration and the virtual absence of furrow granules, which are recorded to be “especially numerous in large specimens” (Clark & Rowe, 1971). H.L. Clark (1921) synonymized *Linckia typus* Nardo, 1834, *L. brownii* Gray, 1840, *Ophidiaster miliaris* Müller & Troschel, 1842 and *O. clathrata* Grube, 1864, with *Linckia laevigata*. Engel (1942) considered *L. rosenbergi* Martens, 1866, to be synonymous with *L. laevigata*, and Rowe & Pawson (1977) synonymized *Ophidiaster propinquus* Livingstone, 1932, with the same species. *Linckia crassa* was synonymized with *L. laevigata* by Sladen (1889: 410). With regard to Jangoux’s record of *Linckia guildingii* from Inhaca Island, see “Notes” on p. 9.

Linckia multifora (Lamarck, 1815)

(fig. 26)

Asterias multifora Lamarck, 1815; 1816: 565.

Ophidiaster multiforis; Müller & Troschel, 1840: 322; 1842: 31; 1843: 126; Michelin, 1845: 20; Peters, 1852: 177; Dujardin & Hupé, 1862: 362; Lütken, 1864: 165; Perrier, 1869: 251.

Linckia multiforis; Martens, 1866: 65; Perrier, 1875: 413; 1878: 71; Bell, 1884c: 510; Studer, 1884: 28; Döderlein, 1888: 826; Martens, 1889: 183; ?Meissner, 1892: 185; Pfeffer, 1896: 47; Bell, 1899: 138; Pfeffer, 1900: 83; Bell, 1902: 226; Koehler, 1905b: 459; Bell, 1909: 18.

Linckia multiforas; Gray, 1866: 14.

Linckia multifora; Lütken, 1871: 271; Hoffmann, 1874: 47; Perrier, 1875: 413; 1878: 17; Smith, 1879: 567; Möbius, 1880: 50; Studer, 1884: 28; Lorient, 1885: 27; Sarasin & Sarasin, 1887: 674; Sladen, 1889: 409; Sluiter, 1889: 299; 1895: 57; Döderlein, 1896: 319; Ludwig, 1899: 542; Fisher, 1906: 1085; Ludwig, 1905: 158; H.L. Clark, 1908: 283; Fisher, 1919: 400; H.L. Clark, 1921: 66; 1923: 277; Decary, 1924: 39; Fisher, 1925: 67; Holly, 1932: 6; Edmonson, 1935: 4; Tortonese, 1935: 76; 1936: 214; Domantay, 1936: 395; Domantay & Roxas, 1938: 222; Engel, 1938b: 16; Hayashi, 1938a: 66; 1938b: 435; Macan, 1938: 410; Lopes, 1939: 77; Mortensen, 1940: 67; Ely, 1942: 19; Gibson-Hill, 1947: 24; A.H. Clark & Bayer, 1948: 144; A.H. Clark, 1949: 76; 1952: 287; 1954: 257; A.M. Clark, 1952: 203; Tortonese, 1953: 28; Kalk, 1954: 113; Balinsky, 1958: 99; Kalk, 1959: 6; Tortonese, 1960: 19; Macnae & Kalk, 1962: 118; A.M. Clark & Spencer Davies, 1966: 598; A.M. Clark, 1967: 39; Davis, 1967: 343; James, 1969: 53; Balinsky, 1969: 99; James & Pearse, 1969: 83; A.M. Clark & Rowe, 1971: 62; Domantay, 1972: 110; Hayashi & Hirohito, 1973: 68; Jangoux, 1973: 32; Marsh, 1974: 86; A.M. Clark & Courtman-Stock, 1976: 72; Marsh, 1976: 219; 1977: 261; Guille & Jangoux, 1978: 56; Jangoux, 1978: 288; Julka & Das, 1978: 347; Rideout, 1978: 287; Aziz, 1979: 722; Sloan *et al.*, 1979: 96; Tortonese, 1979: 318; 1980a: 113; Celis, 1980: 41; Price, 1981: 5; 1982: 522; 1983: 45; A.M. Clark, 1984: 92; Jangoux, 1984: 281; Jangoux & Aziz, 1984: 861; Aziz, 1986: 355; Jangoux, 1986: 138; Fouda & Hellal, 1987: 41; Campbell & Morrison, 1988: 374.

Linckia multiflora; McKnight, 1968: 713; 1972: 43.

Linckia costae Russo, 1894: 163.

Material.— 1. Six dried specimens from Inhaca Island Mozambique; sea-grass beds off Barreira Vermelha, 13.vi.1985. (*) AE 5690 (= RMNH 5799): R/r = 86/8 mm; (*) AE 5691 (= RMNH 5800): R/r = 94/7 mm; (*) AE 5692 (= RMNH 5801): R/r = 75/10 mm; (*) AE 5693 (= RMNH 5802): R/r = 75/8 mm (six arms); (*) AE 5694 (= RMNH 5803): R/r = 79/9 mm; (*) AE 5695 (= RMNH 5804): R/r = 66/10 mm. 2. Ten specimens from Inhaca Island, Mozambique, littoral flat off Barreira Vermelha; in

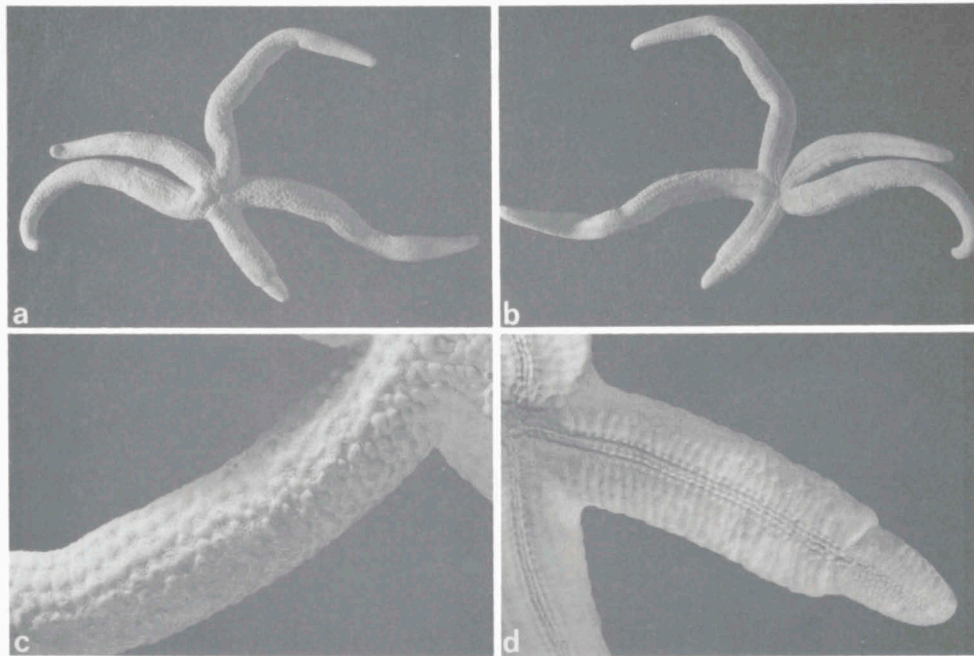


Fig. 26. *Linckia multifora*. AE 5690, R/r = 86/8 mm. a, habitus dorsally; b, habitus ventrally; c, dorsal view arm basis; d, ventral view arm basis.

alcohol 70%. (*) AE 5650 (= RMNH 5805): two specimens, R/r = 25/3 and 15/2 mm, 30.viii.1984; AE 5612: one specimen, R/r = 70/6 mm, 25.ix.1984; AE 5603: two specimens, R/r = 63/5 and 54/5 mm, 7.viii.1983; (*) AE 5645 (= RMNH 5806): two specimens, R/r = 70/5 and 66/7 mm, 14.i.1987; (*) AE 5606 (= RMNH 5807): one specimen ("comet"), R = 60 mm, 12.vi.1982; AE 5614: one specimen, R/r = 105/10 mm, 11.vii.1982; AE 5644: one specimen, R/r = 71/7 mm, 14.i.1987.

Diagnosis.— Very similar to *Linckia laevigata* from which species it differs by having more slender and more finely tipped arms, usually of unequal length, generally two madreporites and a variegated colouration, never uniformly blue or orange.

Description.— Although in the field the two species are easily distinguished by the variegated coloration and the more slender arms of unequal length of *Linckia multifora*, the species is very similar to *L. laevigata*. The R/r ratio varies between 6.6 and 14, and the width/length ratio of the arms between 0.09 and 0.17, both quite irrespectively of the size of the animal. The whole body is covered with rounded granules, which tend to be smaller on the edges of the slightly swollen plates and on the pore areas, but are otherwise all very similar. The papulae-free mid-dorsal area is relatively narrow, about three plates wide. Only the marginal plates and one or two series of lateral plates are more or less regularly arranged. The pore areas contain ten to twenty pores and are distinctly larger than the adjacent plates. Pore areas are present between the series of contiguous infero-marginal plates and the mid-dorsal plates. The ventral side is devoid of papulae.

All specimens investigated have two large, bare, but inconspicuous madreporites

with convoluted, radiating grooves, blending in with the surrounding granules. The central anus is usually hard to find between the small granules of the disc-centre, but may be surrounded by a small circle of slightly enlarged granules. Along the arms, there are about three regular longitudinal series of densely granulated, flattish ventro-lateral plates. Particularly towards the adambulacral furrow, the granules may appear to be slightly squamiform and imbricating. The adambulacral armature is similar to that of *Linckia laevigata*, i.e. small, slightly squamiform granules separating the two furrow spines of unequal lengths, and setting the single, low, tubercle-like subambulacral spines well apart both from each other and from the furrow spines. The oral plates have, on each side, about four furrow spines, well separated by granules, and between the ventral granules one, low, rounded tubercle.

The colour in life is usually variegated grey and greyish-blue on both surfaces. Mottled brownish specimens were also, but more rarely, found in Inhaca Island waters.

In the smallest specimens (AE 5650), which also have arms of unequal lengths, few if any granules are found between the adambulacral furrow spines, and the squamiform subambulacral spines are separated from each other and the furrow spines by only one or two granules. The number of arm plates is much smaller than in the adults and even the dorsal plates are, at least proximally, arranged in more or less regular series. The pore areas are scarcer too and contain only one to five pores. The small madreporites are still very simple with only a few ridges and short grooves. The smallest specimen (R = 15 mm) has three madreporites, of which two in one interradial area; the larger specimen has two, slightly more intricate madreporites (fig. 26).

Distribution.— East Africa; Inhaca Island (Balinsky, 1958; 1969) to the Red Sea. Madagascar, Mauritius, Rodrigues, Zanzibar, Seychelles. Oman (Campbell & Morrison, 1988), Maldives, Laccadives (Jangoux, 1973), Sri Lanka (Döderlein, 1888). Indo-Malysian area (Aziz, 1986), Philippines (Fisher, 1919). Japan (Clark, 1921; Hayashi, 1938a), Pacific Islands: Tonga (McKnight, 1968: 713), Marshall Islands, Gilbert Islands, Tuamotu, Canton Island (A.H. Clark, 1954), Hawaii, Samoa and Tahiti. See map in Jangoux (1973: 34).

Discussion.— H.L. Clark (1921) synonymized *Linckia costae* Russo, 1894, with *L. multifora*. According to A.M. Clark & Courtman-Stock (1976), Meissner's record of "*Linckia multiforis*" from Cape Town "must be an error of either identity or locality".

***Ophidiaster hemprichii* Müller & Troschel, 1842**

(figs. 27-29)

Asterias cylindrica Lamarck, 1815; 1816: 567 (in part).

Ophidiaster hemprichii Müller & Troschel, 1842: 29; 1843: 126; Dujardin & Hupé, 1862: 359; Perrier, 1878: 80; Tortonese, 1953: 28.

Linckia hemprichii; Martens, 1869: 130.

Ophidiaster hemprichii; Döderlein, 1926: 14; A.M. Clark, 1967: 39; A.M. Clark & Rowe, 1971: 61; Guille & Jangoux, 1978: 57; Julka & Das, 1978: 348; Jangoux, 1978: 289; Aziz, 1979: 722; Sloan *et al.*, 1979: 98; Jangoux, 1984: 281; Jangoux & Aziz, 1984: 861; Aziz, 1986: 371; Jangoux, 1986: 142.

Linckia pustulata Martens, 1866: 62; 1889: 183.

Ophidiaster pustulatus; Perrier, 1878: 18; Studer, 1884: 28; Döderlein, 1896: 317; Ludwig, 1899: 541;

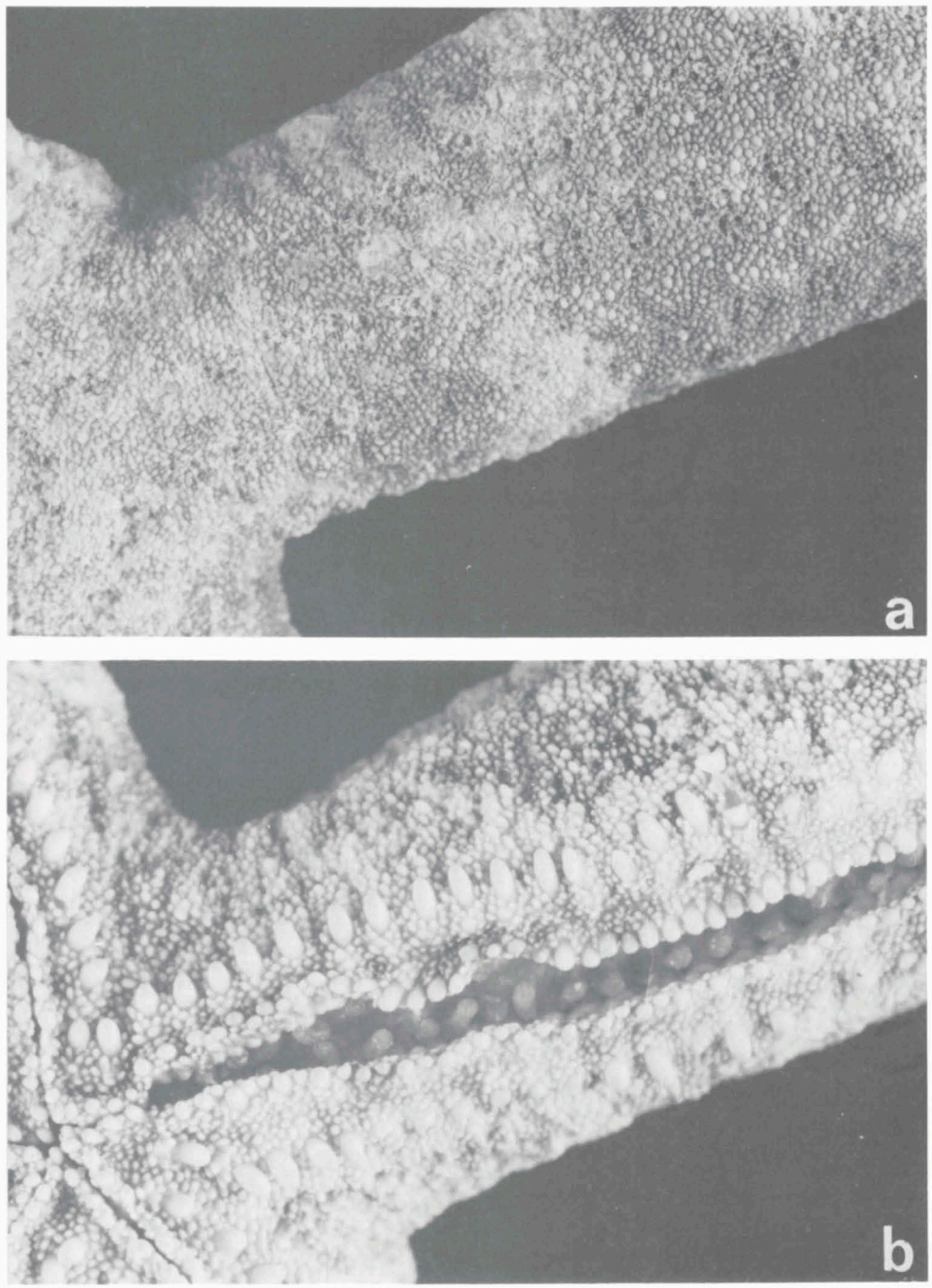


Fig. 27. *Ophidiaster hemprichii*. AE 5623, R/r = 71/6 mm. a, dorsal view of arm basis; b, ventral view of arm basis.

Hayashi, 1938: 213; A.H. Clark, 1949: 76; 1954: 256.

Ophidiaster purpureus Perrier, 1869: 253; 1875: 391; 1878: 17; Lorient, 1885: 22; 1893: 385; Sladen, 1889: 402; Sluiter, 1895: 60; Tortonese, 1935: 80; Macan, 1938: 410.

Ophidiaster squameus Fisher, 1906: 1079; Holly, 1932: 6; Domantay & Roxas, 1938: 223; Ely, 1942: 21; Gibson-Hill, 1947: 24; A.H. Clark, 1952: 287; Endean, 1957: 239; Domantay, 1972: 46; Marsh, 1974: 101; Aziz, 1986: 367; Fouda & Hellal, 1987: 37.

Material.— One specimen, infralittoral off Barreira Vermelha, AE 5623: R/r = 71/6 mm, 8.i.1986.

Diagnosis.— An ophidiasterid starfish with five long, cylindrical arms. Arm plates arranged in regular series along the length of the arm. Whole body densely covered by granules and an inconspicuous skin. Granulation often uneven, some granules being larger and squamiform. Papular pore areas in eight longitudinal series, one of which, on each side, below the infero-marginal plates. Granules and spinelets between the large adambulacral furrow spines. One series of thick, blunt subambulacral spines. Madreporite single.

Description.— The body consists of a small disc and five long, almost cylindrical arms, which are slightly constricted at their base. Three of the five arms were lost. R/r = 71/6 mm; R/r ratio: 11.8; maximum arm width 8 mm.

The arm plates are arranged in regular longitudinal series. The plates and interspersed papular areas are densely covered by rounded granules. On the plates, several of these granules are enlarged and flattened. On the disc and two remaining arms there is one, conspicuous, spatulate pedicellaria. When the granules are removed, the shape and configuration of the plates becomes visible. The plates are roughly rhomboid; the distal plates imbricate over their proximal neighbours. All plates, with the exception of the (ad)ambulacral series, are densely covered with very small crystal bodies, much smaller than the overlying granules.

There is one series of carinal plates and, on each side, one lateral series, one supero-marginal, one infero-marginal and, at least proximally, two series of ventro-lateral plates. Papular areas, each with about ten pores, are found between the carinal and lateral series, between the laterals and supero-marginals and between the supero- and infero-marginal plates, each area being enclosed by four plates. The most ventral series of pore areas is found below the infero-marginal plates. The dorsal series of ventro-lateral plates consists of alternating plates and pore areas. These

most ventral pore areas are enclosed by five or six plates: two infero-marginal plates (dorsally), two, dorsal, ventro-lateral plates (ad- and aborally), and one or two ventral ventro-lateral plates (ventrally). Under the granules, each pore area contains several platelets (fig. 28).

The number of adambulacral plates generally agrees with that of the ventral ventro-lateral plates, but where the latter are large and imbricating, the former are much shorter and more widely spaced. The ventral surface of the adambulacral plates, bearing,

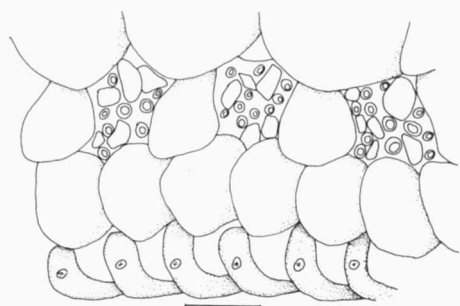


Fig. 28. *Ophidiaster hemprichii*. AE 5623, R/r = 71/6 mm. Some denuded proximal ventro-lateral and adambulacral plates. Scale bar = 1 mm.

besides the granules, one large, thick, bluntly tipped subambulacral spine, is perpendicular to the ambulacral furrow. Where the subambulacral spine is removed, a small pit remains. The vertical half of the plates bends sharply in aboral direction (fig. 28). There are two large furrow spines, in ventral view generally separated by a few granules in an irregular, single transverse row, which is a continuation of the overall ventral granulation. Viewed from the furrow, there are usually one to four shorter and more slender spinelets squeezed between the large furrow spines; in ventral view, these spinelets are either invisible or appear as granules. The oral plates have a very similar armature with, on each side, about five large furrow spines and one subambulacral spine, surrounded by close granulation. The single madreporite is large, bare and conspicuous with radiating grooves. The central anal opening, separated from the madreporite by three dorsal plates, is surrounded by low, but very heavy, enlarged granules (fig. 27).

The colour, even in alcohol 70%, is mottled brick-red and white. Dorsally, red dominates, but the ventral surface, particularly distally, is mostly white with red blotches.

Distribution.— East African coast from Inhaca Island (first record) to the Red Sea (Müller & Troschel, 1842). Islands of the western Indian Ocean (Sloan *et al.*, 1979; Jangoux & Aziz, 1984; A.M. Clark & Rowe, 1971). Indo-Malaysian area and the Philippines (Aziz, 1986), northern Australia (A.M. Clark & Rowe, 1971), southern

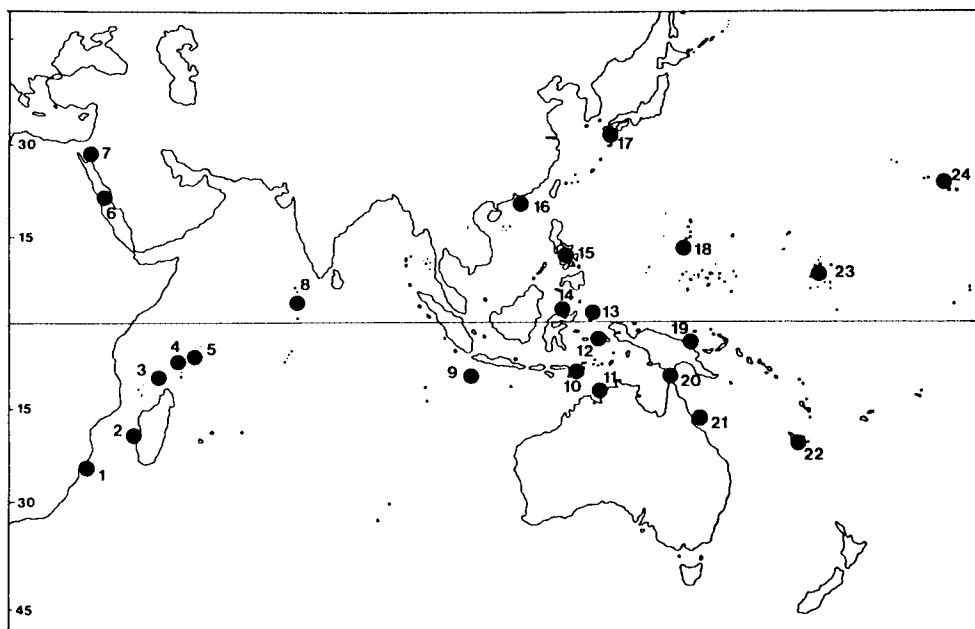


Fig. 29. *Ophidiaster hemprichii*, geographical distribution. Explanation of the numbers used: 1, Inhaca Island; 2, Madagascar; 3, Aldabra; 4, Amirante Islands; 5, Seychelles; 6, Red Sea; 7, Gulf of Aqaba; 8, Maldives; 9, Christmas Island; 10, Timor; 11, northern Australia; 12, S. Moluccas (Ambon, Seram, Banda); 13, N. Moluccas (Halmaheira); 14, Sulawesi; 15, Philippines; 16, southern China; 17, southern Japan; 18, Guam; 19, New Guinea; 20, Torres Strait; 21, Queensland; 22, New Caledonia; 23, Marquesas; 24, Hawaii.

Japan (Hayashi, 1938c), Guam (A.H. Clark, 1954), New Caledonia (Jangoux, 1984) and Hawaii (Aziz, 1986) (fig. 29).

Discussion.— Perrier (1869) judged part of the specimens of *Asterias cylindrica* Lamarck, 1816, to be specifically distinct and named them *Ophidiaster purpureus*. Döderlein (1896) synonymized *O. purpureus* with *Linckia pustulata* Martens, 1866. The number of pedicellariae apparently varies from nil to very great. In 1926, Döderlein investigated typical specimens of *Ophidiaster pustulata* (Martens, 1866), and considered the name to be synonymous with *Ophidiaster hemprichii* Müller & Troschel, 1842. A.M. Clark & Rowe (1971) argued the probability of *Ophidiaster squameus* Fisher, 1906, being synonymous with *O. hemprichii*. On the basis of descriptions of *O. squameus* by Fisher (1906) and subsequent authors (see synonymy) and the known variation in *O. hemprichii*, I tend to agree with A.M. Clark & Rowe.

The change from the original spelling of *Ophidiaster hemprichii* to *O. hemprichi* constitutes an incorrect subsequent spelling, according to Article 33d of the International Code of Zoological Nomenclature (3rd ed., 1985).

Asterina burtonii Gray, 1840

(figs. 30, 31)

- Asterina burtonii* Gray, 1840: 289; 1866: 16; 1872: 118; Perrier, 1878: 86; H.L. Clark, 1921: 96; 1923: 283; Mortensen, 1926: 121; Smith, 1927: 641; Tortonese, 1935: 85; 1936: 215; H.L. Clark, 1938: 144; 1946: 133; A.M. Clark, 1952: 207; Edean, 1953: 54; 1957: 240; Tortonese, 1960: 20; James, 1969: 54;
- Asterina burtoni*; Bell, 1888: 388; Balinsky, 1958: 105; Kalk, 1959: 21; A.M. Clark & Spencer Davies, 1966: 599; A.M. Clark, 1967: 39; Achituv, 1969a: 119; 1969b: 329; Balinsky, 1969: 105; Day, 1969: 182; James & Pearce, 1969: 84; A.M. Clark & Rowe, 1971: 68; James, 1972: 883; Jangoux, 1973: 35; A.M. Clark, 1974: 437; Day, 1974: 55; Marsh, 1974: 91; A.M. Clark & Courtman-Stock, 1976: 77; Tortonese, 1977: 281; Guille & Jangoux, 1978: 58; Jangoux, 1978: 289; Aziz, 1979: 721; Sloan *et al.*, 1979: 98; Tortonese, 1979: 318; 1980a: 114; 1980b: 142; Aziz, 1981: 48; Guille & Ribes, 1981: 75; Price, 1981: 6; 1982: 522; 1983: 47; A.M. Clark, 1983: 367; 1984: 91; Jangoux, 1984: 281; Aziz & Jangoux, 1984: 138; Jangoux & Aziz, 1984: 861; Aziz, 1986: 423; Jangoux, 1986: 144; Fouda & Hellal, 1987: 50; Campbell & Morrison, 1988: 374.
- Asterinides burtoni*; Verrill, 1913: 482.
- Asteriscus cepheus* Müller & Troschel, 1842: 41; 1843: 126; Peters, 1852: 178; Dujardin & Hupé, 1862: 375.
- Asterina cepheus*; Martens, 1866: 85; Bell, 1884b: 131; Studer, 1884: 41; Bell, 1888: 384; Sladen, 1888: 330; 1889: 393; Meissner, 1892: 187; Lorient, 1893: 383; Bell, 1894: 396; Thurston, 1895: 114; Döderlein, 1896: 316; Pfeffer, 1896: 47; Ludwig, 1899: 541; Pfeffer, 1900: 83; Bell, 1902: 227; 1903: 245; Ludwig, 1905: 157; H.L. Clark, 1908: 282; Bell, 1909: 19; H.L. Clark, 1915: 95; Fisher, 1919: 411; 1925: 67; Döderlein, 1926: 19; A.H. Clark & Bayer, 1948: 144; Tortonese, 1949: 36; Marsh, 1976: 219.
- Asterina cephea*; Perrier, 1875: 315; 1876: 235; 1878: 71; Möbius, 1880: 50; Lorient, 1885: 69; Döderlein, 1888: 825; Russo, 1894: 162; Sluiter, 1889: 307; 1895: 59; Koehler, 1905b: 458; 1910a: 128; Decary, 1924: 40; Gravely, 1927: 169; A.H. Clark, 1949: 76; 1952: 287; 1954: 258.
- Asterina cephea* var. *iranica* Mortensen, 1940: 65.
- Asterina burtoni cepheus*; A.M. Clark & Rowe, 1971: 69; Julka & Das, 1978: 349. *Asterina gibbosa*; Martens, 1866: 72 [Not: *Asterina gibbosa* (Pennant, 1777)].
- Asteriscus wega*; Perrier, 1869: 294.
- Asterina wega*; Perrier, 1876: 238; 1878: 29; Tortonese, 1936: 215; Achituv, 1969a: 119; 1969b: 329.
- Asterinides wega*; Verrill, 1913: 482.
- ? *Asterina anomala* H.L. Clark, 1921: 95; 1938: 143; 1946: 133; A.H. Clark, 1952: 289; Ely, 1942: 25; Edean, 1957: 240; McKnight, 1972: 38; Yamaguchi, 1975: 20; Marsh, 1974: 92; 1976: 219; 1977: 270; Oguro, 1983: 222.

Asterina coronata; Kalk, 1958: 215 (?); Jangoux, 1973: 38 [Not: *Asterina coronata* Martens, 1866].

Material.— 1. Sixteen specimens from Inhaca Island, Mozambique, on the underside of dead coral rocks on the west coast. AE 5649: one specimen, R/r = 10/6 mm, off Barreira Vermelha, 13.iv.1987; AE 5604: one specimen, R/r = 15/8 mm, off Marine Biological Station, 1 m depth, 8.i.1982; AE 5619: one specimen, R/r = 27/12 mm, off Barreira Vermelha, 1 m depth, 7.v.1982; (*) AE 5620 (= RMNH 5808): four specimens, R/r = 29/15, 22/11, 19/10 and 15/7 mm, infralittoral off Barreira Vermelha, 8.i.1986; AE 5652: nine specimens, R/r = 26/14, 27/13, 24/12, 24/11, 23/13, 19/9, 17/8, 17/8 and 13/6 mm, off Barreira Vermelha, 1 m depth, 16.v.1987. 2. Eleven specimens in the British Muséum (Natural History). BM(NH) 40.3.23.54, type specimen, R/r = 10/4 mm, Red Sea, "Designated type, see Smith, Ann. Mag. nat. Hist., (9) 19: 641", five arms, one madreporite; BM(NH) 40.3.23.55, R/r = 7/4 mm, six arms, five madreporites; BM(NH) 89.3.11.7-9, three specimens, R/r = 12/7, 13/8, 12/8 mm, Mauritius, de Robillard, labelled: *Asterina burtonii? cepheus*; BM(NH) 85.8.3.2, R/r = 6/3.5 mm, Suakim, labelled: *Asterina wega*; BM(NH) 1974.11.25.3, R/r = 16/10 mm, Gun Island, Houtman, Abrolhos, W. Australia, N. Coleman, labelled: *Asterina burtonii cepheus*; BM(NH) 1978.6.26.49., R/r = 11/6 mm, Heron Island, Southern Great Barrier Reef, Queensland, Miss A.M. Clark, 1978; BM(NH) 1973.10.1.1-3, three specimens, R/r = 8/3, 7/3, 6/3 mm, Merizo, Guam, M. Yamagushi, labelled: *Asterina anomala*. 3. Two speci-

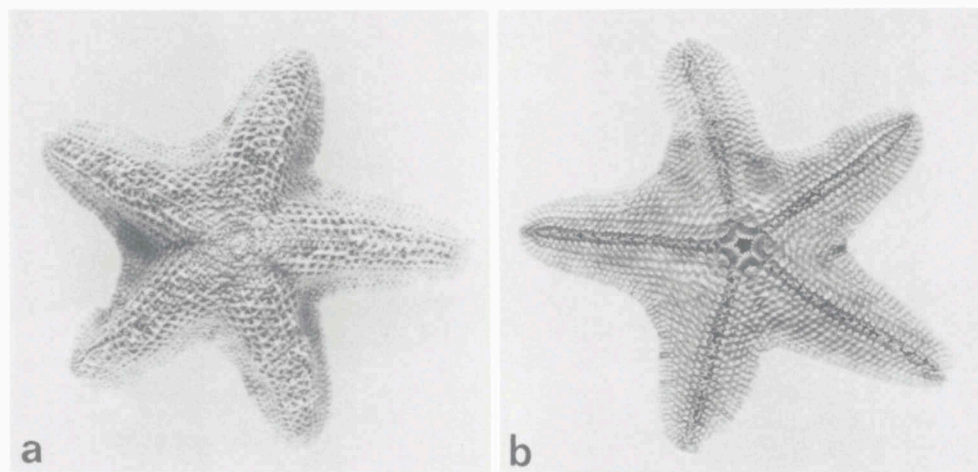


Fig. 30. *Asterina burtonii*. AE 5652, R/r = 23/13 mm. a, habitus dorsally; b, habitus ventrally.

mens from Inhaca Island, Mozambique in the Musée Royal de l'Afrique Centrale, Tervuren, MRAC RG No. 1283, R/r = 34/16 and 30/14 mm, identified by Jangoux as *Asterina coronata*.

Diagnosis.— Small, stellate body (R < 30 mm; R/r ratio about 2), with high, swollen radii and a thin margin. Dorsal spinulation fairly uniform, on proximal part of notched plates. Ventro-lateral plates in neat chevrons and transverse rows, each usually with three to six spinelets, often arranged in one or two combs. Adambulacral plates with a fan of five to seven, webbed furrow spines and about four spines, in a similar fan, on the ventral surface.

Description.— The small, stellate body has five high and swollen rays. A thin marginal fringe stretches from the interradial arc to the tip of the arms. The dorsal plates intricate: the distal and abradial ones over the more proximal and adradial plates. The plates are shield- or heart-shaped with two (proximal carinal plates) or one (most other plates) notches to accommodate the papulae. The plates have very numerous, crowded, minute crystal bodies and bear, on the proximal half, five to 22

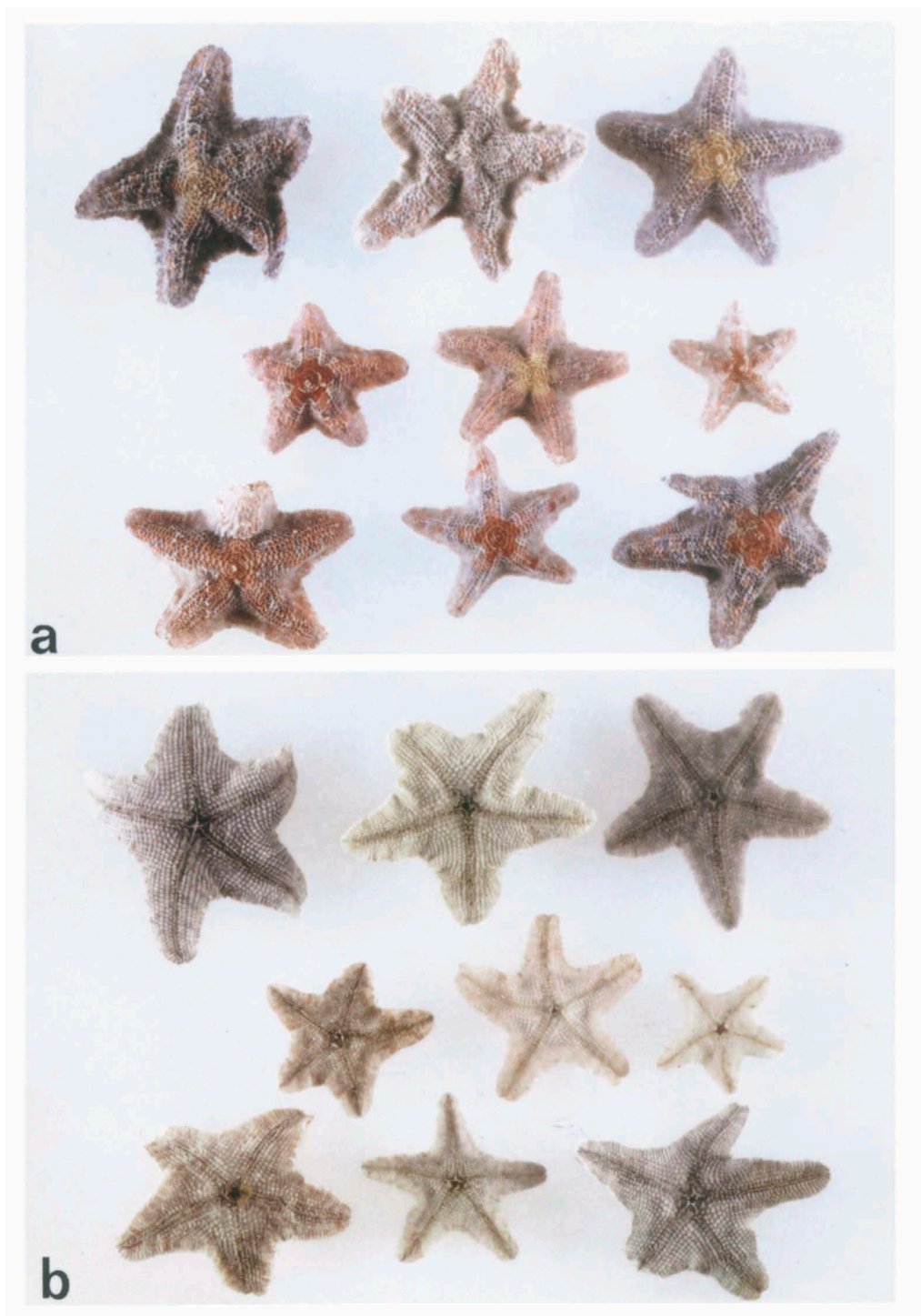


Fig. 31. *Asterina burtonii*. AE 5652: Nine specimens showing variation in colour. a, dorsal view; b, ventral view.

tapering spinelets, which may be more than four times longer than wide, but also much shorter and squatter, even in a single specimen; hyaline flanges are occasionally present on the spinelets. The dorsal plates of the interradial areas are swollen near the proximal edge, where they bear a crown of slender, tapering spinelets. In the smaller specimens, the spines are slightly less numerous and frailer, predominantly tapering and much longer than wide. The distal half to three quarters of the dorsal plates are usually bare, showing the crystal bodies. Except for one large specimen (AE 5620, R/r = 29/15 mm) with three madreporites, all Inhaca specimens investigated have only one. The central anal opening is surrounded by spinelets similar to those of the raised, surrounding dorsal plates.

The marginal plates form a distinct fringe to the disc and the arms, bearing a dense cluster of usually slender, more or less tapering spinelets on the distal margin.

The ventro-lateral plates are arranged in regular chevrons and more variably regular transverse rows. The proximal three chevrons almost reach the tip of the arm. The plates bear three to seven slender, tapering spinelets, often arranged in one or two webbed combs. The remaining surface of the plates shows the crystal bodies to be similar to those of the dorsal and marginal plates. The adambulacral plates bear a curved comb of about seven rather long, webbed furrow spines, of which the central three to five spines are much larger and placed deeper in the furrow than the remaining ad- and aboral spinelets. On the ventral surface of the plates, there is a similar comb of five to six spines, of which the central two or three spines are strong and the ad- and aborally placed spinelets tend to be minute. The oral plates have, on each side, about seven webbed furrow spines, followed by three to five spines on the ventral surface.

The colour in life is very variable, the species being able to adapt its colour to the surroundings and appearing perfectly camouflaged between the encrustations of the dead coral rocks. Nine specimens (AE 5652) were preserved in buffered formalin and maintained their original colour patterns. In five of these specimens the central dorsal area is brick to pinkish red; in two others it is bright yellow; in one yellow mixed with white, and in one grayish-white. The dorsal surface of the arms is pinkish or blueish, interrupted with small, darker and/or lighter areas. The sides of the arms are generally more uniformly coloured. The ventral side may be mottled, or may be uniformly greyish, whitish, or bluish (figs. 30-31).

Distribution.— Along the East African coast from southern Mozambique (Balinsky, 1969; A.M. Clark & Courtman-Stock, 1976) to the Red Sea (A.M. Clark & Rowe, 1971; Fouda & Hellal, 1987) and the eastern Mediterranean (Tortonese, 1966; Achituv, 1969b; Tortonese, 1980b). Indian Ocean: Mauritius, Madagascar, Zanzibar, Saya de Malha and the Seychelles, Maldives, Laccadives (Bell, 1903a-b). Persian Gulf (Mortensen, 1940a), Sri Lanka and Bay of Bengal (H.L. Clark, 1915; Sladen, 1889). Indo-Malaysian area (Aziz, 1986), Philippines (Fisher, 1919). West and North Australia (H.L. Clark, 1921; 1946). New Guinea (Studer, 1884). Pacific Ocean: Wake Island, New Caledonia, Society Islands, Marshall Islands and Hawaii (Fisher, 1925; A.H. Clark, 1952; Ely, 1942). See map in Jangoux (1973: 37).

Discussion.— The change from the original spelling by Gray (1840), *Asterina burtonii*, to *A. burtoni* constitutes an incorrect subsequent spelling, according to Article 33d of the International Code of Zoological Nomenclature (3rd ed., 1985).

The one specimen with three madreporites is in no other way different from the

other ones from Inhaca Island, thus supporting the suggestion of A.M. Clark & Rowe (1971) that the species contains both fissiparous and non-fissiparous forms (see also Fouda & Hellal, 1987). Achituv (1969b) argued convincingly against the hypothesis put forward by A.M. Clark (1952) and Tortonese (1960), who judged the fissiparous forms of *A. burtonii* to be young specimens of the same species; his assumption, however, that the two forms constitute different species, remains debatable. Fissiparity seems to occur mainly in the outlying parts of the distribution area: the Red Sea and the Mediterranean, tropical Australia, Japan and the Marshall Islands.

Asterina burtonii and *A. cepheus* (also, erroneously, called *A. cephea*) are now generally considered to be synonyms. Most fissiparous specimens, described as *A. wega* or *A. anomala* also are most probably *A. burtonii* (A.M. Clark & Rowe, 1971), although recent authors like Yamagushi (1975), Marsh (1974, 1976, 1977) and Oguro (1983), consider *A. anomala* to be distinct. As the shape of the dorsal spines of the Inhaca Island specimens of *A. burtonii* is quite variable, even within a single specimen, I would hesitate to follow authors, who distinguish between forms, on a sub-specific level, on the basis of the predominance of a certain kind of spinelet (e.g., A.M. Clark & Rowe, 1971). The number and the arrangement of the ventro-lateral and suboral spinelets are also highly variable, thus supporting the conclusion of A.M. Clark & Rowe (1971) that these characters can not be correlated with locality.

Asterina coronata Martens, 1866, the distinctness of which has been doubted by some authors (e.g., Sladen, 1889), has been reported from Inhaca Island by (1) Kalk (1958), albeit with a question mark and not in the final table, wherein only *A. burtonii* is recorded from western rocks, and by (2) Jangoux (1973), who wrote that it differed from *A. burtonii* by "raised dorsal plates with sometimes more than five spines". An inspection of Jangoux's specimens of *A. coronata* in the Musée Royal de l'Afrique Centrale, Tervuren, showed them to be *A. burtonii* with the numbers and sizes of the spines being similar to those of the other specimens. A.M. Clark & Courtman-Stock (1976) also considered both records to refer to *A. burtonii*.

Patiriella exigua (Lamarck, 1815)

(figs. 32, 33)

Asterias exigua Lamarck, 1815, 1816: 554 (pars?).

Asterina exigua; Perrier, 1876: ;1878: 86 (pars); Sladen, 1889: 392 (pars); Döderlein, 1910: 250; Koehler, 1914: 171; H.L. Clark, 1923: 285; 1926: 186; Stephenson, Stephenson & du Toit, 1937: 358; Bright, 1938: 76; Stephenson, Stephenson & Bright, 1938: 10; Eyre & Stephenson, 1938: 38; Eyre, Broekhuysen & Crichton, 1938: 96; Eyre, 1939: 298; Stephenson, Stephenson & Day, 1939: 357; Stephenson, 1944: 286; Day, Millard & Harrison, 1952: 389; Kalk, 1954: 112; Day & Morgans, 1956: 308; Macnae, 1957: 362; Balinsky, 1958: 105; Kalk, 1958: 237 (pars); Day, 1959: 544; Morgans, 1959: 398; 1962: 327 (*Asterina spec.*); Balinsky, 1969: 105; Day, 1969: 182; Penrith & Kensley, 1970: 201. [Not: *Asterina exigua*; Koehler, 1910a: 129; Studer, 1884: 41; Sladen, 1889: 392 (pars); Loriol, 1893: 384; Koehler, 1895: 388; Sluiter, 1895: 59; Bell, 1899: 137; Pfeffer, 1900: 83; H.L. Clark, 1908: 282; Koehler, 1910a: 129; H.L. Clark, 1921: 97].

Patiriella exigua; Verrill, 1913: 484 (pars); Döderlein, 1927: 296; Livingstone, 1932: 262 (pars); H.L. Clark, 1938: 163; Fisher, 1940: 272; H.L. Clark, 1946: 136 (pars); Edean, 1953: 54 (pars); 1956: 125 (pars); 1961: 291; Shepherd, 1968: 746; Dartnall, 1970: 73; 1971: 40; A.M. Clark & Rowe, 1971: 67 (pars); A.M. Clark, 1976: 250; A.M. Clark & Courtman-Stock, 1976: 81; Lawson-Kerr & Anderson, 1978: 45; Zeidler & Shepherd, 1982: 412; A.M. Clark, 1983: 367; Aziz, 1986: 434. [Not: *Patiriella exigua*;

- Fisher, 1919: 416; Hayashi, 1938b: 439; A.H. Clark, 1949: 77; 1954: 258; Domantay & Acosta, 1970: 59; Domantay, 1972: 56; Guille & Jangoux, 1978: 58; Jangoux, 1978: 289; Aziz, 1979: 721; Celis, 1980: 53; Aziz, 1981: 49].
- Asterina (Patriella) exigua*; Mortensen, 1921: 188; 1933a: 252; 1933b: 432; Macnae & Kalk, 1958; 1969: 129; Day, Field & Penrith, 1970: 79 (pars). [Not: *Asterina (Patriella) exigua*; Stephenson *et al.*, 1931: 75; Domantay, 1936: 396; Domantay & Roxas, 1938: 227; Engel, 1938a: 2; 1938b: 20].
- Patinella exigua*; Jackson, 1976: 36.
- Asterina kraussii* Gray, 1840: 289; 1866: 16; Martens, 1869: 130.
- Asteriscus kraussii*; Müller & Troschel, 1842: 42 (pars); 1843: 125 (pars); Dujardin & Hupé, 1862: 376 (in part).
- Asteriscus pentagonus* Müller & Troschel, 1843: 125 (pars). [Not: *Asteriscus pentagonus* Müller & Troschel, 1842: 42; Dujardin & Hupé, 1862: 376].
- Asterina calcarata*; Koehler, 1908: 632; H.L. Clark, 1923: 285 [Possibly: *Asteriscus calcarata* Gay, 1854: 427].
- [Not: *Asterias minuta* Linnaeus, 1767: 1099; Gmelin, 1791: 3162; Blainville, 1830: 219; 1834: 238].
- [Not: *Asterina minuta*; L. Agassiz, 1835: 192; 1838: 442; Gray, 1840: 289; 1866: 16].
- [Not: *Asteriscus minutus*; Müller & Troschel, 1842: 41; Gray, 1872: 118].
- [Not: *Asterina pentagona*; Martens, 1866: 74; 1869: 130].

Material.— 1. Eight specimens from Inhaca Island, Mozambique, on the exposed littoral rocks of Cabo da Inhaca. AE 5605: six specimens, R/r = 6/4, 6/4, 5/4, 4/2.5, 3/2, 2.5/2 mm, 2.viii.1982; (*) AE 5607 (= RMNH 5809): two specimens, R/r = 5/3 and 5/3 mm, 12-3-1983. 2. From the collection in the Nationaal Natuurhistorisch Museum (Rijksmuseum van Natuurlijke Historie), Leiden. a. Eighteen specimens from St. Helena. RMNH 5720, four specimens from James Bay, Sta. 5, NW coast, R/r = 11/8, 10/8, 8/6 and 4.5/3 mm, 4+7.vi.1983, J.C. den Hartog; RMNH 5721, Sta. 6, seven specimens from Rupert's Bay, NW coast, R/r = 11/9, 11/8, 10/7, 9/7, 8/6, 8/6, 7/6 mm, 5+9.vi.1983, J.C. den Hartog; RMNH 5722, Sta. 12, seven specimens from Lot's Wife Ponds, south coast, R/r = 11/9, 11/8, 10/8, 10/7, 10/7, 7/5 and 6/5 mm, 11.vi.1983, J.C. den Hartog. b. Ten specimens from Knysna Lagoon, South Africa (RMNH 1345), R/r = 9/8, 9/7, 9/7, 11/7, 7/5.5, 8/6, 9/6 mm, 18.ix.1938, L.D. Brongersma. c. Three specimens from Dassen Island, South Africa (RMNH 2214), R/r = 7/5.5, 7/5, 10/8 mm, 5.xii.1946, W. Vervoort. d. Five specimens from Camp Bay, South Africa (RMNH 1347), R/r = 11/8, 9/7, 10/7, 11/7, 8/5 mm, 27.ix.1916, P. Buitendijk. e. Two specimens from East London, South Africa (RMNH 2577), R/r = 11/7 and 6/5 mm, 1.ii.1961, A.C. van Bruggen.

Diagnosis.—A small ($R < 15$ mm), cushion-shaped asterinid with an R/r ratio of about 1.5 and generally five rays. Notched dorsal plates with short, bluntly tipped spinelets. Ventro-lateral plates with none, one or (distally) two short, tapering spines. Gonopores between the ventro-lateral plates. Adambulacral plates with one or two furrow spines and one subambulacral spine.

Description.—The Inhaca specimens are all small with $R = 6$ mm or less. The number of rays is invariably five.

The dorsal side is high, giving the starfish the appearance of a small cushion. The dorsal plates are of a complex shape, W- or heart-shaped, notched to accommodate the large, single papular pores. Smaller, secondary plates are found between the primary plates. Proximal dorsal plates with up to ten short, squat, bluntly tipped, echinose spines. When the spines are removed, the very numerous, minute, closely packed crystal bodies become visible. In the interradial areas the dorsal plates are not notched and bear one to four spines on the raised central area. The large, single madreporite is bare and conspicuous with radiating grooves. The central anal opening is surrounded by about seven spinelets, which are slightly smaller than the spines on the surrounding, raised dorsal plates. The marginal plates form a distinct fringe around the body with five or six rather long, projecting spines.

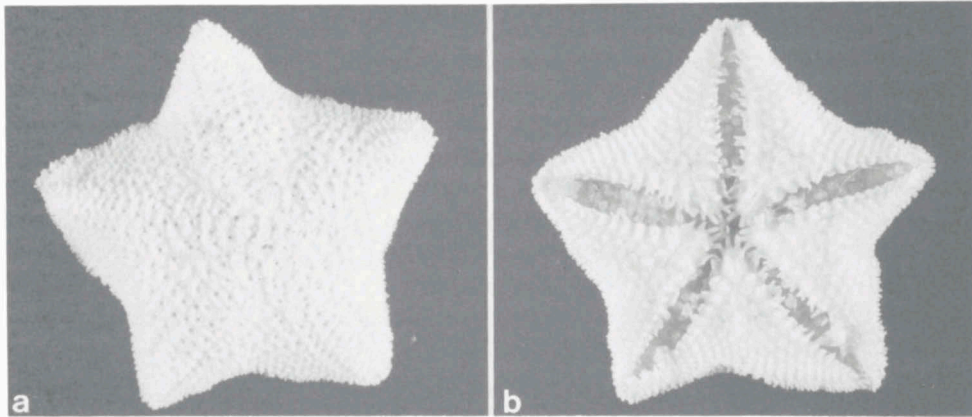


Fig. 32. *Patiriella exigua*. AE 5605, R/r = 6/4 mm. a, habitus dorsally; b, habitus ventrally, showing the gonopores.

The ventro-lateral plates are arranged in chevrons and transverse rows of variable regularity. The most adoral chevron, which reaches to the tip of the arm, is usually devoid of spines, as are a variable number of proximal ventro-lateral plates. The other plates bear one, distally often two, stout, tapering spines. Separated from the oral plates by a few ventro-lateral plates, one or two gonopores may be visible in the larger specimens. The spinulation of the ventral plates is rather variable: in some specimens virtually all ventro-lateral plates, except for the adradial chevron, bear one or two spines; in others the proximal half or two thirds are bare. In some specimens, again irrespective of size, only a few of the distal-most interradial plates have two spines, in others the plates in up to three aboral rows have two spines. The adambulacral plates bear two (proximally) or one (distally), slightly curved, if two webbed, furrow spines, and one, even stronger, subambulacral spine. The oral plates have, on each side, two strong spines in the mouth, two to four spines along the furrow and one subambulacral spine (fig. 32). The colour in life is variable; the colour in alcohol 70% is white.

Distribution.— St. Helena, southern Atlantic Ocean (Mortensen, 1933b). South Africa, from Lüderitz Bay to Natal, and southern Mozambique (A.M. Clark & Courtman-Stock, 1976). St. Paul and Amsterdam Islands (A.M. Clark, 1976). Australia, from Port Lincoln around Tasmania to northern New South Wales (Dartnall, 1971; Zeidler & Shepherd, 1982). Possibly Chile (Gay, 1854) (fig. 33).

Discussion.— Lamarck (1815, 1816) included *Asterias minuta* Gmelin, 1767, with a question mark in the synonymy of his *Asterias exigua*, which was identified with *Pentaceros plicatus et concavus* Linck, 1733 (p. 25, tab. 3, no. 20), and with *Stellulae marinae, minutissimae americanae* of Seba, 1761 (tab. 5, figs. 13, 14 & 15). Blainville (1830, 1834) listed an *Asterias minuta* based on Gmelin, 1791 (p. 3162). Gmelin, however, had identified his *Asterias minuta* with the same species of Linnaeus (1767) and O. Fabricius (1780), who reported it from the Norwegian Sea and Greenland, which makes its identity with *Patiriella exigua* highly unlikely. Gray (1840) considered *Asterias exigua* Lamarck as a junior synonym of *Asterias minuta* Gmelin. Gray gave a brief description of *Asterias minuta*, reported from St. Vincent, West Indies, and distinguished two varieties differing in size and the number of spines on the ventro-lateral plates.

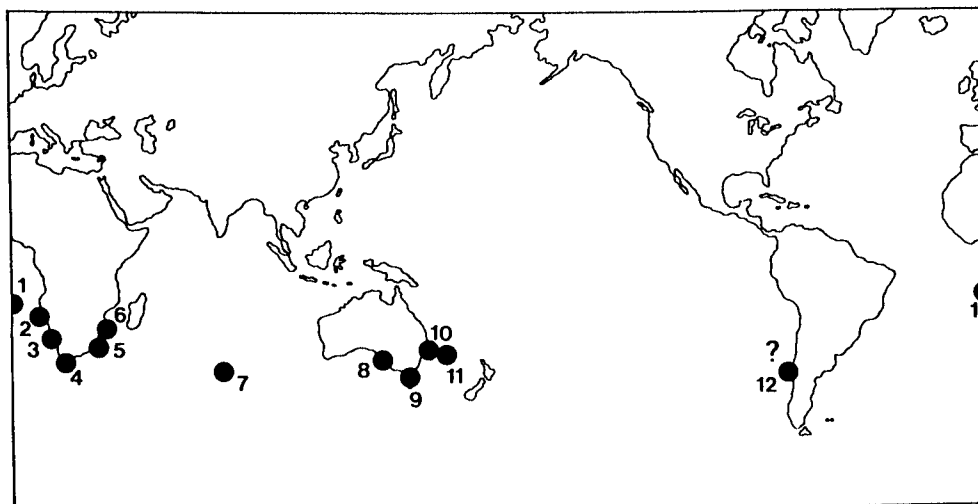


Fig. 33. *Patiriella exigua*, geographical distribution. Explanation of the numbers used: 1, St. Helena; 2, Lüderitz Bay; 3, Lambert's Bay; 4, Cape of Good Hope; 5, Natal; 6, Inhaca Island; 7, Amsterdam and St. Paul Islands; 8, Eyre Peninsula; 9, Tasmania; 10, E. Australia (south of 28° S); 11, Lord Howe Island; 12, Valparaíso, Juan Fernandez Islands, Chile.

For zoogeographical reasons, Dartnall (1971) suggested that Gray's specimens of *Asterina minuta* were a related form, such as *Asterina folium*. The same reasoning can be applied to *Asteriscus minutus* Müller & Troschel, 1842 (= *Asterina minuta* Gray) from Brazil. Verrill (1913) created the generic name *Patiriella* and synonymized *Asteriscus pentagonus* Müller & Troschel, 1842, and *Asterina kraussii* Gray, 1840, with *Patiriella exigua*. In his revision of the Australian starfishes of the genus *Patiriella*, Dartnall (1971) distinguished between the temperate *Patiriella exigua* and a new species created by him, viz. *Patiriella pseudoexigua* Dartnall, 1971.

Patiriella exigua with ventrally directed gonopores is, at least in Australia, found south of 28° S. To the north it is replaced by *P. pseudoexigua* with dorsally orientated gonopores. An investigation of the tropical and South African specimens in the Nationaal Natuurhistorisch Museum (RMNH), Leiden, identified as *P. exigua*, confirms Dartnall's distinction. Perrier (1876) investigated seven type specimens identified by Lamarck, but without locality, and found them to be identical with a further nine specimens from the Cape of Good Hope, also in Paris and labelled *Asterias exigua* although not by Lamarck. The type locality ("American seas, etc.") remains doubtful and the type specimens could not be located. Dartnall (1971) therefore designated a neotype from False Bay, South Africa. Müller & Troschel (1842) described an *Asteriscus kraussii* (= *Asterina kraussii* Gray) from the Indian Ocean and *Asteriscus pentagonus* from the Red Sea and the Indian Ocean. Those names and *Patiriella exigua* when applied to tropical specimens are most probably synonymous with *Patiriella pseudoexigua* Dartnall, 1971. Dartnall did not mention the occurrence of *Patiriella exigua* on St. Helena, as has been reported by Mortensen (1933b). The Nationaal Natuurhistorisch Museum (RMNH), Leiden, contains a collection of *Patiriella* specimens, made by Mr J.C. den Hartog on the shores of St. Helena, where the species dominates the tidal zone (Coll. Nrs. 5720, 5721, 5722). These specimens, with ventrally directed gonopores, fit the description of *P. exigua* and, as Mortensen

noted, "conform perfectly" with the specimens from southern Africa.

Mortensen (1933a) included *Patiriella dyscrita* (H.L. Clark, 1923) in the synonymy of *Asterina (Patiriella) exigua*. A.M. Clark (1974), however, found that *P. dyscrita* differs from *Patiriella exigua* s.s. in the dorsally directed gonopores of the former. This means that all records of both *P. exigua* and *P. dyscrita* in temperate regions will have to be checked as to the direction of the gonopores. The possibility of *P. pseudoexigua* being synonymous with *P. dyscrita* should also be investigated. Mortensen (1933a) and A.M. Clark & Courtman-Stock (1976) considered the South African specimens, described by Koehler (1908) and H.L. Clark (1923) as *Asterina calcarata* (Gay, 1854), to be *P. exigua*. Koehler had compared his specimens with others from the coast of Chile and found them completely identical. In view of the known distribution of *Patiriella exigua*, its presence on the shores of southern South America is not at all inconceivable, and if Gay's specimens can be located, it would be worthwhile to investigate their possible identity with *P. exigua*.

Madsen (1956) considered *Asteriscus calcaratus* Gay, 1854, to be synonymous with *Patiria chilensis* (Lütken, 1859) and suggested to disregard the older synonym. *Patiriella calcarata* (= *Asteriscus calcaratus*; Perrier, 1869) should, according to Madsen, be maintained for Perrier's specimens from the Juan Fernandez Islands [and Valparíso], which belong to "another species than Lütken's *chilensis*". If *Asteriscus calcaratus* Gay, 1854, and *Patiria chilensis* are indeed synonyms, the older name should be maintained. If the specimens of Perrier (1869) and subsequent authors (e.g., Meissner, 1896; Fisher, 1931) belong to a different species they should be renamed, however, Madsen does not prove this.

Sumário

A presente colecção de estrelas-do-mar de águas pouco profundas contém 16 das 17 espécies assinaladas com certeza na Ilha da Inhaca e Baía de Maputo. *Archaster angulatus* foi registada por Jangoux (1973). Cinco espécies não eram conhecidas anteriormente no sul de Moçambique: *Astropecten monacanthus*, *Monachaster sanderi*, *Fromia milleporella*, *Ophidiaster hemprichii* e *Stellaster equestris*. A presença de algumas espécies, julgadas residentes das águas da Inhaca, como *Astropecten granulatus*, *A. acanthifer*, *A. antares*, *Leiaster leachii*, *Asterina coronata*, *Linckia guildingii* e *Patiriella dyscrita*, é duvidosa. *Patiriella exigua*, que tem uma ampla distribuição nas águas subtropicais-temperadas do hemisfério sul, incluindo possivelmente América do Sul, é a única espécie que se encontra nos rochedos expostos do Cabo da Inhaca (figs. 2 e 33); é ausente nas águas mais quentes e mais protegidas da Ilha e da Baía de Maputo, onde se encontram as outras 16 espécies.

Estas espécies são todas tropicais e amplamente distribuídas no Oceano Índico e no Oceano Pacífico ocidental. Para dez delas, a Ilha da Inhaca e a Baía de Maputo formam o limite austral da distribuição. Um exemplar jovem de *Linckia laevigata*, que normalmente se encontra nos corais, foi encontrado nos rochedos expostos da Ponta de Ouro. Quatro espécies foram localizadas até ao Natal (29° S). *Stellaster equestris* tem, no Índico ocidental, a sua localização mais austral na Baía de Maputo. Nas águas da Austrália, encontra-se até ao norte de Nova Gales do Sul (fig. 16). Os resultados estão então de acordo com aqueles de A.M. Clark & Courtman-Stock (1976). Devido à presença de Madagáscar, Moçambique é mais protegida contra a acção das ondas que o Natal (Hartnoll, 1976). Esse facto e a protecção dada pela própria Ilha da Inhaca podem explicar a extensão, pelo menos no que diz respeito às estrelas-do-mar, da Província Tropical da África oriental até à Baía de Maputo.

A taxonomia de certos asteroídeos, principalmente o "Grupo *Scoparius*" do género *Astropecten* e as Asterinidae, precisa de mais clarificação. O estudo da fauna dos corais nas águas de Natal pode fornecer ainda mais dados interessantes.

Acknowledgements

The curators of the echinoderm collections in the Nationaal Natuurhistorisch Museum (Rijksmuseum van Natuurlijke Historie), Leiden, the British Museum (Natural History), London and the Musée Royal de l'Afrique Centrale, Tervuren, Belgium, Dr M.R.R.B. Best, Mr G. Patterson and Dr F. Puylaert, respectively, were very hospitable and helpful when they made their samples available for consultation. Dr L.B. Holthuis of the Nationaal Natuurhistorisch Museum (RMNH) in Leiden was so kind as to read the manuscript critically. Mr Eugène van Esch of the Nationaal Natuurhistorisch Museum, Leiden, took the photographs. Finally, I should like to thank Ms Dita Dirks, Mr Luciano Cuna, Mr Rungo Alberto and all Mozambican students and staff-members who participated in the collection of the present material.

References

- Achituv, Y., 1969a. Observations on the biology of *Asterina burtoni* Gray.— Israel J. Zool., 18: 119.
- Achituv, Y., 1969b. Studies on the reproduction and distribution of *Asterina burtoni* Gray and *A. wega* Perrier (Asteroidea) in the Red Sea and the eastern Mediterranean.— Israel J. Zool., 18: 329-342.
- Achituv, Y., 1973a. On the distribution and variability of the Indo-Pacific sea star *Asterina wega* (Echinodermata: Asteroidea) in the Mediterranean.— Sea. Mar. Biol. Berlin, 18 (4): 333-336.
- Achituv, Y., 1973b. The genital cycle of *Asterina burtoni* Gray (Asteroidea) from the Gulf of Elat, Red Sea.— Cah. Biol. mar., 14 (4): 547-553.
- Agassiz, L., 1835. Prodrome d'une monographie des radiaires ou échinodermes.— Mémoires de la Société des Sciences Naturelles de Neuchatel, Tome 1, 1835: 168-199.
- Agassiz, L., 1838. Prodromus of a monograph of the Radiata and Echinodermata.— Ann. Mag. nat. Hist., 1838, 1 (49): 440-449.
- Audouin, V., 1826. Explication des planches d'échinodermes de l'Egypte et de Syrie, publiées par J.C. de Savigny.— Description de l'Egypte, Histoire Naturelle, Paris, 1(4): 203-212.
- Aziz, A., 1979. Checklist of the echinoderm collections of the Rumphius expedition II.— Proc. internat. Symp. mar. biogeogr. evol. southern Hemisphere, Auckland, New Zealand, 17-20 July 1978, N.Z. DSIR Inf. Ser., 137 (2): 717-726.
- Aziz, A., 1981. Fauna Echinodermata dari terumbu karang pulau pari, pulau-pulau Seribu.— Oseanol. Indonesia, 14: 41-50.
- Aziz, A., 1986. La faune d'astérides (Echinodermata) de la région indo-malaise: Taxonomie, zoogéographie et bathymétrie: i-xv, 1-663.— Thesis, Université Libre de Bruxelles.
- Aziz, A. & M. Jangoux, 1984. Les astéries (échinodermes) du plateau de la Sonde (Indonesia).— Indo-Malayan Zool., 1 (1): 127-140.
- Balinsky, B.I., 1958. The echinoderms. In: W. Macnae & M. Kalk (eds.). A natural history of Inhaca Island, Moçambique: 96-107.— Witwatersrand Univ. Press, Johannesburg.
- Balinsky, B.I., 1969. The echinoderms. In: W. Macnae & M. Kalk (eds.). A natural history of Inhaca Island, Moçambique (2nd ed.): 96-107.— Witwatersrand Univ. Press, Johannesburg.
- Bedford, F.P., 1900. On the echinoderms from Singapore and Malacca.— Proc. zool. Soc. Lond., 1900: 271-299.
- Bell, F.J., 1882a. Note on the species of the Linnean genus *Asterias* which are ascribed to Retzius.— Ann. Mag. nat. Hist. (5) 9: 166-168.
- Bell, F.J., 1882b. Note on the echinoderm-fauna of the Island of Ceylon, together with some observations on heteractinism.— Ann. Mag. nat. Hist., (5) 10: 218-225.
- Bell, F.J., 1884a. Contributions to the systematic arrangement of the Asteroidea. II. The species of *Oreaster*.— Proc. zool. Soc. Lond., 1884: 57-87.
- Bell, F.J., 1884b. Echinodermata.— Report on the zoological collections made in the Indo-Pacific Ocean during the voyage of H.M.S. "Alert" 1881-2. London, 1884, part I: 117-177.
- Bell, F.J., 1884c. Echinodermata.— Report on the zoological collections made in the Indo-Pacific Ocean during the voyage of H.M.S. "Alert" 1881-2. London, 1884, part II: 509-512.

- Bell, F.J, 1887a. Report on a collection of Echinodermata from the Andaman Islands.— Proc. zool. Soc. Lond., 1887: 139-145.
- Bell, F.J, 1887b. The echinoderm fauna of the Island of Ceylon.— Scient. Trans. R. Dubl. Soc., (2) 3 (14): 643-658.
- Bell, F.J, 1888. Report on a collection of Echinoderms made at Tuticorin, Madras, by Mr. Edgar Thurston, C.M.Z.S., Superintendent, Government Central Museum, Madras.— Proc. zool. Soc. Lond., 1888: 383-389.
- Bell, F.J, 1889a. Additions to the Echinoderm fauna of the Bay of Bengal.— Proc. zool. Soc. Lond., 1889: 6-7.
- Bell, F.J, 1889b. Note on a remarkably large specimen of *Luidia* from the Island of Mauritius.— Ann. Mag. nat. Hist., (6) 3: 422-423.
- Bell, F.J, 1894. On the echinoderms collected during the voyage of H.M.S. "Penguin" and by H.M.S. "Egeria", when surveying Macclesfield Bank.— Proc. zool. Soc. Lond., 1894: 392-413.
- Bell, F.J, 1899. Report on the echinoderms (other than holothurians) collected by Dr. Willey. In: A. Willey. Zoological results based on material from New Britain, New Guinea, Loyalty Islands and elsewhere, collected during the years 1895, 1896 and 1897 by Arthur Willey II: 133-140.— Cambridge Univ. Press.
- Bell, F.J, 1902. The Actinogonidiate Echinoderms of the Maldive and Laccadive islands. In: J.S. Gardiner (ed.). The fauna and geography of the Maldive and Laccadive Archipelagoes (1) 3 (1): 223-233.— London.
- Bell, F.J, 1903. Report on a collection of echinoderms from the neighbourhood of Zanzibar, Part I.— Ann. Mag. nat. Hist., (7) 12: 244-248.
- Bell, F.J, 1909. Report on the echinoderma (other than holothurians) collected by Mr. J. Stanley Gardiner in the western parts of the Indian Ocean.— Trans. Linn. Soc. Lond. (zool.), (2) 13: 17-22.
- Berry, P.F., 1980. The inter- and subtidal invertebrate fauna of Maputaland. In: M.N. Bruton & K.H. Cooper (eds.). Studies on the ecology of Maputaland: 102-110.— Rhodes University, Grahamstown and the Natal Branch of the Wildlife Society of southern Africa, Durban.
- Blainville, H.M.D. de, 1830. Zoophytes. Dictionnaire des sciences naturelles, 60: 1-631.— Levrault, Paris.
- Blainville, H.M.D. de, 1834. Manuel d'Actinologie ou de Zoophytologie: 1-644, pls. 1-100.— Levrault, Paris.
- Boone, L., 1935. Scientific results of the world cruise of the yacht "Alva", 1931, William K. Vanderbilt, commanding. Echinodermata: Asteroidea and Echinoidea.— Bull. Vanderbilt mar. Mus., 6: 235-264.
- Boshoff, P.H., 1969. Development and constitution of the coral reefs. In: W. Macnae & M. Kalk (eds.). A natural history of Inhaca Island, Moçambique (2nd ed.): 49-56.— Witwatersrand Univ. Press, Johannesburg.
- Boshoff, P.H., 1980. The corals of Maputaland. In: M.N. Bruton & K.H. Cooper (eds.). Studies on the ecology of Maputaland: 111-113.— Rhodes University, Grahamstown and the Natal Branch of the Wildlife Society of southern Africa, Durban.
- Branch, G.M. & M.L. Branch, 1980. Competition between *Cellane tramoserica* (Sowerby) (Gastropoda) and *Patiriella exigua* (Lamarck) (Asteroidea), and their influence on algal standing stocks.— J. exp. mar. Biol. Ecol., 48 (1): 35-49.
- Branch, G.M. & M.L. Branch, 1981. The living shores of southern Africa: 1-272.— Struik, Cape Town.
- Bright, K.M.F., 1938. The South African intertidal zone and its relation to ocean currents. 3. An area of the northern part of the West coast.— Trans. Roy. Soc. S. Afr., 26: 67-88.
- Brown, A.C. & N. Jarman, 1978. Coastal marine habitats. In: M.J.A. Werger (ed.). Biogeography and ecology of southern Africa.: 1241-1277.— Junk, The Hague.
- Brown, R.N., 1910. Echinoidea and Asteroidea from the Mergui archipelago and Moskos islands, lower Burma. Proc. R. phys. Soc. Edinb., 18 (1): 21-35.
- Campbell, A.C. & M. Morrison, 1988. The echinoderm fauna of Dhofar (southern Oman) excluding holothuroids. In: R.D. Burke, P.V. Mladenov, P. Lambert & R.L. Parsley (eds.). Echinoderm biology: 369-378.— Balkema, Rotterdam.
- Celis, A.K. de, 1980. The asteroids of Marinduques Island.— Acta manil., (A) 19: 20-74.
- Clark, A.H., 1949. On a collection of sea-stars from the Philippine Islands.— Proc. biol. Soc. Wash., 62: 73-77.

- Clark, A.H., 1952. Echinoderms from the Marshall Islands.— Proc. U. S. natn. Mus., 102 (3302): 265-303.
- Clark, A.H., 1954. Records of Indo-Pacific echinoderms.— Pacif. Sci., 8 (3): 243-263.
- Clark, A.H. & F.M. Bayer, 1948. Some echinoderms from Biak, Schouten Islands.— J. Wash. Acad. Sci., 38: 143-144.
- Clark, A.M., 1952. The "Manihine" Expedition to the Gulf of Aqaba 1948-1949. VII. Echinodermata.— Bull. Br. Mus. nat. Hist. (Zool.), 1 (8): 203-214.
- Clark, A.M., 1953. Notes on Asteroidea in the British Museum (Natural History). III. *Luidia*. IV. *Tosia* and *Pentagonaster*.— Bull. Br. Mus. nat. Hist. (Zool.), 1: 379-412.
- Clark, A.M., 1967. Echinoderms from the Red Sea. Part 2. (Crinoids, Ophiuroids, Echinoids and more Asteroidea).— Bull. Sea Fish. Res. Stn. Haifa, Israel, 41: 26-58.
- Clark, A.M., 1974. Notes on some echinoderms of southern Africa.— Bull. Br. Mus. nat. Hist. (Zool.), 26 (6): 421-487.
- Clark, A.M., 1976. Asterozoa from Amsterdam and St. Paul Islands, southern Indian Ocean.— Bull. Br. Mus. nat. Hist. (Zool.), 30 (6): 247-261.
- Clark, A.M., 1982. Echinoderms of Hong Kong. In: Morton, B. & C.K. Tseng (eds.). The marine flora and fauna of Hong Kong and southern China. Vol. 1. Introduction and taxonomy: 485-501.— Hong Kong Univ. Press, Hong Kong.
- Clark, A.M., 1983. Notes on Atlantic and other Asteroidea. 3. The families Ganeriidae and Asterinidae, with description of a new asterinid genus.— Bull. Brit. Mus. nat. Hist. (Zool.), 45 (7): 359-380.
- Clark, A.M., 1984. 5. Echinodermata of the Seychelles. In: D.R. Stoddart (ed.). Biogeography and ecology of the Seychelles Islands: 83-102.— Junk, The Hague.
- Clark, A.M. & J. Courtman-Stock, 1976. The echinoderms of southern Africa.— Publ. Trustees British Museum (Natural History), London, 776: 1-277.
- Clark, A.M. & F.W.E. Rowe, 1971. Monograph of shallow-water Indo-West Pacific echinoderms.— Publ. Trustees British Museum (Natural History), London, 690: 1-238.
- Clark, A.M. & P. Spencer Davies, 1966. Echinoderms of the Maldives Islands.— Ann. Mag. nat. Hist., (13) 8: 597-612.
- Clark, H.L., 1908. Some Japanese and East Indian echinoderms.— Bull. Mus. comp. Zool. Harv., 51 (11): 277-311.
- Clark, H.L., 1909. Echinodermata. Scientific results of the trawling expedition of H.M.C.S. "Thetis" off the coast of New South Wales in February and March, 1898.— Mem. Aust. Mus., 4: 519-564.
- Clark, H.L., 1915. The echinoderms of Ceylon other than Holothurians.— Spolia zeylan., Colombo, 10 (37): 83-102.
- Clark, H.L., 1921. The echinoderm fauna of Torres Strait.— Pap. Dep. mar. Biol. Carnegie Instn. Wash., 10: i-vi, 1-223.
- Clark, H.L., 1923. The echinoderm fauna of South Africa.— Ann. S. Afr. Mus., 13 (7): 221-435, pls. 8-23.
- Clark, H.L., 1926. Notes on a collection of echinoderms from the Australian Museum.— Rec. Aust. Mus., 15 (2): 183-192.
- Clark, H.L., 1938. Echinoderms from Australia.— Mem. Mus. comp. Zool. Harv., 55: i-viii, 1-596.
- Clark, H.L., 1946. The echinoderm fauna of Australia. Its composition and its origin.— Publs. Carnegie Instn., 566: 1-567.
- Crossland, C., 1907. Reports on the marine biology of the Sudanese Red Sea. II. Narrative of the Expedition.— J. Linn. Soc., Zool., 31: 3-10.
- Dartnall, A.J., 1970. The asterinid sea-stars of Tasmania.— Pap. Proc. R. Soc. Tasm., 104: 73-77.
- Dartnall, A.J., 1971. Australian seastars of the genus *Patriella* (Asteroidea, Asterinidae).— Proc. Linn. Soc. N.S.W., 96 (1): 39-49.
- Davis, L.V., 1967. The suppression of autotomy in *Linckia multifora* (Lamarck) by a parasitic gastropod, *Stylifer linckiae* Sarasin.— Veliger, 9: 343-346.
- Day, J.H., 1959. The biology of Langebaan lagoon: A study of the effect of shelter from wave action.— Trans. R. Soc. S. Afr., 35 (5): 475-547.
- Day, J.H., 1967. A monograph of the Polychaeta of southern Africa, Part 1: Errantia: i-viii, 1-458; Part 2: Sedentaria: i-xvii, 459-878.— British Museum (Natural History), London.
- Day, J.H., 1969. A guide to marine life on South African shores: 1-300.— Univ. Cape Town, Balkema.

- Day, J.H., 1974. The ecology of Morrumbene Estuary, Moçambique.— Trans. R. Soc. S. Afr., 41 (1): 43-97.
- Day, J.H., J.G. Field & M.J. Penrith, 1970. The benthic fauna and fishes of False Bay, South Africa.— Trans. R. Soc. S. Afr., 39 (1): 1-108.
- Day, J.H., N.A.H. Millard & A.D. Harrison, 1952. The ecology of South African estuaries. 3. Knysna: a clear open estuary.— Trans. Roy. Soc. S. Afr., 33 (3): 367-413.
- Day, J.H. & J.F.C. Morgans, 1956. The ecology of South African estuaries. 7. The biology of Durban Bay.— Ann. Natal Mus., 13 (3): 259-312.
- Decary, R., 1924. Liste d'échinodermes recueillis au Madagascar.— Bull. Acad. malgache, 6: 37-41.
- Desjardins, J., 1830. Note sur l'astérie discoïde (*Asterias discoïdea*) et l'astérie miliare (*Asterias laevigata*) de Lamarck.— Annls Sci. nat., 20: 177-179.
- Döderlein, L., 1888. Echinodermen von Ceylon. Bericht über die von den Herrn Dres. Sarasin gesammelten Asteroidea, Ophiuroidea und Echinoidea.— Zool. Jb., 3: 822-846.
- Döderlein, L., 1896. Bericht über die von Herrn Professor Semon bei Amboina und Thursday Island gesammelten Asteroidea.— Denkschr. med.-naturw. Ges. Jena, 8. OR Semon's zool. Forsch. austr. malaysche Archipel, 5: 301-322.
- Döderlein, L., 1902. Japanische Seesterne.— Zool. Anz., 25: 326-335.
- Döderlein, L., 1910. Asteroidea, Ophiuroidea, Echinoidea. In: Schultze, L., 1910. Forschungsreise im westlichen und zentralen Südafrika, 4 (1).— Denkschr. med.-naturw. Ges. Jena, 16: 245-258.
- Döderlein, L., 1916. Über die Gattung *Oreaster* und Verwandte.— Zool. Jb., 40: 409-440.
- Döderlein, L., 1917. Die Asteriden der Siboga-Expedition. I. Die Gattung *Astropecten* und ihre Stammesgeschichte.— Siboga Exped. 81 (46a) Leiden: 1-191.
- Döderlein, L., 1920. Die Asteriden der Siboga Expedition. II. Die Gattung *Luidia* und ihre Stammesgeschichte.— Siboga Exped. 80 (46b) Leiden: 193-293.
- Döderlein, L., 1926. Über Asteriden aus dem Museum von Stockholm.— K. svenska VetenskAkad. Handl., (3) 2 (6): 1-22.
- Döderlein, L., 1927. Die Seesterne der deutschen Südpolar Expedition, 1901-1903.— Dt. Sdpol. Exped., 19, Zool. II: 291-301.
- Döderlein, L., 1935. Die Asteriden der Siboga-Expedition. III. *Oreasteridae*.— Siboga Exped. 125 (46c) Leiden : 67-110.
- Döderlein, L., 1936. Die Asteriden der Siboga-Expedition. III. Die Unterfamilie *Oreasterinae*.— Siboga Exped. 126 (46c) Leiden : 295-369.
- Domantay, J.S., 1936. The ecological distribution of the echinoderm fauna of the Puerto Galera Marine Biological Station.— Bull. nat. appl. Sci., Univ. Philippines, (4) 5: 385-418.
- Domantay, J.S., 1972. Monographic studies and check list of Philippines littoral echinoderms.— Acta manil., (A) 9 (15): 36-161.
- Domantay, J.S. & T.E. Acosta, 1970. The littoral echinoderm fauna of Ilocos Sur between Candon and Vigan.— Acta manil., (A) 5 (10): 49-103.
- Domantay, J.S. & P. Conclu, 1968. The echinoderm fauna of Manila Bay.— Philipp. J. Sci., 97 (2): 159-176.
- Domantay, J.S. & H.A. Roxas, 1938. The littoral Asteroidea of Port Galera Bay and adjacent waters.— Philipp. J. Sci., 65: 203-237.
- Dujardin, M.F. & M.H. Hupé, 1862. Histoire naturelle des zoophytes échinodermes comprenant la description des crinoïdes, des ophiurides, des astérides, des échinides et des holothuroïdes: 1-628. — Librairie Encyclopédique de Roret, Paris.
- Ebert, T.A., 1979. Natural History notes on two Indian Ocean starfishes in Seychelles: *Protoreaster lincki* (de Blainville) and *Pentaceraster horridus* (Gray).— J. mar. biol. Ass. India, 18 (1): 71-77.
- Edmondson, C.H., 1935. Autotomy and regeneration in Hawaiian starfishes.— Occ. Pap. Bernice P. Bishop Mus., 11 (8): 1-20.
- Ekman, S., 1967. Zoogeography of the sea: i-xiv, 1-417.— Sidgwick & Jackson, London.
- Ely, C.A., 1942. Shallow-water Asteroidea and Ophiuroidea of Hawaii.— Bull. Bernice P. Bishop Mus., 176: 1-163, figs. 1-18.
- Endean, R., 1953. Queensland Faunistic Records, III. Echinodermata (excluding Crinoidea).— Pap. Dep. Zool. Univ. Qd., 1 (3): 53-60.
- Endean, R., 1956. Queensland faunistic records. IV. Further records of Echinodermata (excluding Crinoidea).— Pap. Dep. Zool. Univ. Qd., 1 (5): 123-140.

- Endean, R., 1957. The biogeography of Queensland's shallow-water echinoderm fauna (excluding Crinoidea), with a rearrangement of the faunistic provinces of Tropical Australia.— *Aust. J. mar. Freshwat. Res.*, 8 (3): 233-273.
- Endean, R., 1961. Queensland faunistic records. VII. Additional records of Echinodermata (excluding Crinoidea).— *Pap. Dep. Zool. Univ. Qd*, 1 (13): 289-298.
- Engel, H., 1938a. Astéries du voyage aux Indes Orientales Néerlandaises (1932) de LL. AA. RR. Le Prince et La Princesse Léopold de Belgique.— *Mém. Mus. r. Hist. nat. Belg.*, 14 (18): 1-4.
- Engel, H., 1938b. Astéries et Ophiures. In: Résultats scientifiques du voyage aux Indes Orientales Néerlandaises.— *Mém. Mus. r. Hist. nat. Belg. (hors série)*, 3 (18): 1-29.
- Engel, H., 1942. *Linckia rosenbergi* von Martens, a synonym of *L. laevigata* (L.).— *Zool. Meded. Leiden*, 23: 273-274.
- Eyre, J., 1939. The South African intertidal zone and its relation to ocean currents. 7. An area in False Bay.— *Ann. Natal Mus.*, 9 (2): 283-306.
- Eyre, J., G.J. Broekhuysen & M.I. Crichton, 1938. The South African intertidal zone and its relation to ocean currents. 6. The East London district.— *Ann. Natal Mus.*, 9 (1): 83-111.
- Eyre, J. & T.A. Stephenson, 1938. The South African intertidal zone and its relation to ocean currents. 5. A sub-tropical Indian Ocean shore.— *Ann. Natal Mus.*, 9 (1): 21-46.
- Fabricius, O., 1780. *Fauna Groenlandica*: 1-452.— Gottlob Rothe, Hafniae et Lipsiae.
- Fisher, W.K., 1906. The starfishes of the Hawaiian Islands.— *Bull. U.S. Fish Commisn for 1903*, 23 (3): 987-1130.
- Fisher, W.K., 1919. Contributions to the biology of the Philippine Archipelago and adjacent regions. Starfishes of the Philippine seas and adjacent waters.— *Bull. U.S. natn. Mus.*, 100 (3): 1-546.
- Fisher, W.K., 1925. Sea stars of tropical central Pacific.— *Bull. Bernice P. Bishop Mus.*, 27 (1): 63-88.
- Fisher, W.K., 1931. Report on the South American sea stars collected by Waldo L. Schmitt.— *Proc. U.S. natn. Mus.*, 78 (16): 1-10.
- Fisher, W.K., 1940. Asteroidea.— *Disc. Repts.*, 20: 69-306.
- Fouda, M.M. & A.M. Hellal, 1987. The echinoderms of the northwestern Red Sea. Asteroidea.— *Fauna and Flora of Egypt, Nat. Hist. Mus. Egypt*, 2: i-iv, 1-64.
- Gay, C., 1854. *Historia física y política de Chile segun documentos adquiridos en este república durante doce años de residencia en ella y publicado bajo los auspicios del supremo gobierno.*— *Zoologia* 8: 1-499. Maulde & Renou, Paris.
- Gibbs, P.E., A.M. Clark & C.M. Clark, 1976. Echinoderms from the northern region of the Great Barrier Reef, Australia.— *Bull. Br. Mus. nat. Hist. (Zool.)*, 30 (4): 101-144.
- Gibson-Hill, C.A., 1947. The Echinodermata [of Christmas Island, Indian Ocean].— *Bull. Raffles Mus.*, 18: 22-26.
- Gmelin, J.F., 1791. Echinodermata. In: C. Linnaeus.— *Systema Naturae* (ed. 13), 1 (6): 3160-3201.
- Goto, S., 1914. A descriptive monograph of Japanese Asteroidea. I. Archasteridae, Benthoplectinidae, Porcellanasteridae, Astropectinidae, Luidiidae, Pentagonasteridae, Oreasteridae, Gymnasteridae, Asterinidae.— *J. Coll. Sci. imp. Univ. Tokyo*, 29 (1): 808.
- Gravely, F.H., 1927. Littoral fauna of Krusadai island in the Gulf of Manaar. Echinodermata.— *Bull. Madras Govt. Mus., new Series, nat. Hist. Sect.*, 1: 163-173.
- Gray, J.E., 1840. A synopsis of the genera and species of the class Hypostoma (*Asterias* Linnaeus).— *Ann. Mag. nat. Hist.*, (1) 6 (22): 175-184; (1) 6 (32): 275-290.
- Gray, J.E., 1847. Descriptions of some new genera and species of Asteridae.— *Ann. Mag. nat. Hist.*, 20: 193-204, OR: *Proc. zool. Soc., London*, 15 (1847): 72-83.
- Gray, J.E., 1866. Synopsis of the species of starfish in the British Museum: i-iv, 1-18.— John van Voorst, London.
- Gray, J.E., 1872. List of echinoderms collected by Robert M'Andrew, Esq., F.R.S., in the Gulf of Suez in the Red Sea.— *Ann. Mag. nat. Hist.*, (4) 10: 115-124.
- Grube, A.E., 1864. Uebersicht der Resultate eines Aufenthalter auf der Insel Lussin.— *Jber. schles. Ges. vaterl. Kult.*, 1864: 47-51.
- Guille, A. & M. Jangoux, 1978. Astérides et ophiurides littorales de la région d'Amboine (Indonésie).— *Ann. Inst. ocanogr. Paris, nouvelle Série*, 54 (1): 47-74.
- Guille, A. & S. Ribes, 1981. Echinoderms associés aux scléactiniaires d'un récif frangeant de l'île de

- la Réunion (océan Indien).— Bull. Mus. natn. Hist. nat. Paris, (4) 4 (A, 1): 73-92.
- Habe, T., 1952. Parasitic gastropods found in echinoderms from Japan.— *Publs Seto mar. biol. Lab.*, (2) 2 (6): 73-85.
- Hartlaub, C., 1892. Ueber die Arten und den Skelettbau von *Culcita*.— *Notes Leyden Mus.*, 14: 65-118.
- Hartnoll, R.G., 1976. The ecology of some rocky shores in tropical East Africa.— *Estuar. cst. mar. Sci.*, 4 (1): 1-21.
- Hayasaka, I., 1949. On some starfishes from Taiwan.— *Bull. oceanogr. Inst. Taiwan*, 5: 11-19.
- Hayashi, R., 1938a. Sea-stars of the Ogasawara Islands.— *Annotnes zool. jap.*, 17 (1): 59-68.
- Hayashi, R., 1938b. Sea-stars of the Caroline Islands.— *Palao trop. biol. Stn. Stud.*, 3: 417-446.
- Hayashi, R., 1938c. Sea-stars of the Ryu-Kyu Islands.— *Bull. biogeogr. Soc. Japan*, 8: 197-222.
- Hayashi, R., 1938c. Sea-stars in the vicinity of the Seto marine biological laboratory.— *Bull. biogeogr. Soc. Japan*, 8: 271-292.
- Hayashi, R., 1952. Sea-stars of Seto and adjacent waters.— *Publs Seto mar. biol. Lab.*, (2) 2 (9): 143-159.
- Hayashi, R. & Hirohito (Emperor), 1973. The sea-stars of Sagami Bay: collected by his Majesty the Emperor of Japan.— *Biol. Lab. Imperial Household Japan*, v-xi, 1-114.
- Herdman, W.A., 1906. I. General summary and recommendation. II. Discussion of faunistic results.— *Rpt. Ceylon Pearl Oyster Fish.*, 5: 109-136, 433-452.
- Herdman, W.A. & J.B. Herdman, 1904. On the Echinoderma.— *Report to the Government of Ceylon on the Pearl Oyster Fisheries of the Gulf of Manaar. London (Royal Society) Suppl. Rep.*, 10: 137-147. (With notes and additions by F.J. Bell).
- Hoffmann, C.K., 1874. Crustacés et échinodermes de Madagascar et ses dépendences.— *Leyden*, 1874, 5 (2): 1-58.
- Holly, M., 1932. Echinodermata from Pearl and Hermes Reef.— *Occ. Pap. Bernice P. Bishop Mus.*, 10 (1): 1-9.
- Jackson, L.F., 1976. Aspects of the intertidal ecology of the east coast of South Africa.— *Investl. Rep. Oceanogr. Res. Inst. Durban*, 46: 1-72.
- James, D.B., 1969. Catalogue of echinoderms in the reference collections of the Central Marine Fisheries Research Institute.— *Bull. cent. mar. Fish. Res. Inst.*, 7: 51-62.
- James, D.B., 1972. Note on the development of the asteroid *Asterina burtoni* Gray.— *J. mar. biol. Ass. India*, 14 (2): 883-884.
- James, D.B. & J.S. Pearse, 1969. Echinoderms from the Gulf of Suez and the northern Red Sea.— *J. mar. biol. Ass. India*, 11 (1-2): 78-125.
- Jangoux, M., 1973. Les astéries de l'île d'Inhaca (Mozambique) (Echinodermata, Asteroidea). I. Les espèces récoltes et leur répartition géographique.— *Annls Mus. r. Afr. cent. (Zool.)*, 208: 1-50.
- Jangoux, M., 1978. Biological results of the Snellius Expedition. 29. Echinodermata, Asteroidea.— *Zool. Meded. Leiden*, 52 (5): 287-300.
- Jangoux, M., 1984. Les astérides littoraux de Nouvelle-Calédonie.— *Bull. Mus. natn. Hist. nat. Paris*, (4) 6 (A, 2): 279-293.
- Jangoux, M., 1986. Les astérides. In: A. Guille, P. Laboute & J. L. Menou (eds.). *Guide des étoiles de mer, oursins et autres échinodermes du lagon de Nouvelle-Calédonie.*— *Faune Tropicale* 25. Orstom, Paris: 109-153.
- Jangoux, M. & A. Aziz, 1984. Les astérides (échinodermes) du centre-ouest de l'océan Indien (Seychelles, Maldives et les Mineures).— *Bull. Mus. natn. Hist. nat. Paris*, (4) 6 (A, 4): 857-884.
- John, D.D., 1948. Notes on asteroids in the British Museum (Natural History). I. The species of *Astropecten*.— *Novit. zool.*, 42 (3): 485-508.
- Julka J.M. & S. Das, 1978. Studies on the shallow-water starfishes of the Andaman and Nicobar Islands.— *Mitt. zool. Mus. Berl.*, 54 (2): 345-351.
- Kalk, M., 1954. Marine biological research at Inhaca Island, Moçambique: An interim Report.— *S. Afr. J. Sci.*, 51: 107-115.
- Kalk, M., 1958. Ecological studies on the shores of Moçambique. I. The fauna of intertidal rocks at Inhaca Island, Delagoa Bay.— *Ann. Natal Mus.*, 14: 189-242.
- Kalk, M., 1959. A general ecological survey of some shores in northern Moçambique.— *Revta Biol.*, 2 (1): 1-24.
- Koehler, R., 1895. Catalogue raisonné des échinodermes recueillis par M. Korotnev aux îles de la

- Sonde.— Mm. Soc. zool. Fr., 8: 374-423.
- Koehler, R., 1905a. Echinides, astéries et ophiures recueillis par M. Gravier dans le Mer Rouge (Golfe de Tadjourah).— Bull. Mus. Hist. nat. Paris, 11: 184-186.
- Koehler, R., 1905b. Echinides, stellérides et ophiures recueillis par MM. Bonnier et Pérez dans le Mer Rouge (Côtes d'Arabie) en 1903.— Bull. Mus. Hist. nat. Paris, 11: 458-486.
- Koehler, R., 1908. Astéries, ophiures et échinides de l'expédition antarctique nationale Ecosaise.— Trans. Roy. Soc. Edinb., 46 (3) 22: 529-649.
- Koehler, R., 1910a. Astéries du Musée de Calcutta. II. Les astéries littorales. In: Echinoderma of the Indian Museum 6: 1-192.— Publ. Trustees Indian Museum, Calcutta.
- Koehler, R., 1910b. Echinodermes des îles Aru et Kei.— Abh. senckenb. naturforsch. Ges. 33: 265-295.
- Koehler, R., 1914. Asteroidea, Ophiuroidea et Echinoidea. In: Michaelsen, W.— Wiss. Beitr. Kennt. Meeresfauna Westaf., 1 (2): 129-303.
- Lamarck, J.B.P.A. de, [1815]1816. Histoire naturelle des animaux sans vertèbres (1re ed.), 2: 1-568.— Verdière, Paris.
- Lawson-Kerr, C. & D.T. Anderson, 1978. Reproduction, spawning and development of the starfish *Patiriella exigua* (Lamarck) (Asteroidea: Asterinidae) and some comparisons with *P. calcar* (Lamarck).— Aust. J. mar. Freshwat. Res., 29 (1): 45-53.
- Leipoldt, F., 1895. Die von F. Orsini im Rothen Meere gesammelten Asteroiden (Anhang).— Z. wiss. Zool., 59: 644-654.
- Linck, J.H., 1733. De stellis marinis liber singularis: i-xxii, 1-107.— J. Schuster, Lipsiae.
- Linnaeus, C., 1758. Systemae Naturae (ed. 10): 1-824.
- Linnaeus, C., 1767. Systema naturae (ed. 12, reform.) 1 (2): 533-1327.— Holmiae.
- Livingstone, A.A., 1932. Asteroidea.— Scient. Rep. Gr. Barrier Reef Exped., 4 (8): 241-265, pls. 1-12.
- Lopes, H.P., 1939. Equinodermes da Ilha da Inhaca.— Documentos trimestrais de Moçambique, 20: 71-88.
- Loriol, P. de, 1885. Catalogue raisonné des échinodermes recueillis par M.V. de Robillard l'île Maurice. 2. Stellérides.— Mém. Soc. Phys. Hist. nat. Genève, 29 (4): 1-84.
- Loriol, P. de, 1893. Echinodermes de la Baie d'Amboine.— Revue suisse Zool., 1: 359-426.
- Ludwig, H., 1899. Echinodermen des Sansibargebietes.— Abh. senckenb. naturforsch. Ges., 1 (4): 537-563.
- Ludwig, H., 1905. Asteroidea.— Mem. Mus. comp. Zool. Harv., 32: 1-292.
- Lütken, C., 1859. Bidrag til kundskab om de ved kysterne af Mellemog Syd-Amerika levende Arter af Søstjerner.— Vidensk. Meddr. dansk naturh. Foren., 1859: 25-97.
- Lütken, C., 1864. Kritiske Bemaerkninger om forskjellige Søstjerner (Asterider), med Beskrivelse af nogle nye Arter.— Vidensk. Meddr. dansk naturh. Foren., 1864, 8-12: 123-169.
- Lütken, C., 1871. Fortsatte kritiske og beskrivende bidrag til kundskab om søstjerne (Asteriderne).— Vidensk. Meddr. dansk naturh. Foren.: 227-304.
- Macan, T.T., 1938. Asteroidea.— Scient. Rep. John Murray Exped., 4 (9): 323-435.
- Macnae, W., 1957. The ecology of the plants and animals in the intertidal regions of the Zwartkops estuary, near Port Elizabeth, South Africa, 2.— J. Ecol., 45: 361-387.
- Macnae, W., 1969. The geographic and oceanographic setting of Inhaca. In: W. Macnae & M. Kalk (eds.). A natural history of Inhaca Island, Moçambique (2nd. ed.): 1-4.— Witwatersrand Univ. Press, Johannesburg.
- Macnae, W. & M. Kalk (eds.), 1958. A natural history of Inhaca Island, Moçambique: i-v, 1-163.— Witwatersrand Univ. Press, Johannesburg.
- Macnae, W. & M. Kalk, 1962. The fauna and flora of sand flats at Inhaca Island, Moçambique.— J. anim. Ecol., 31: 93-128.
- Macnae, W. & M. Kalk, 1969. A natural history of Inhaca Island, Moçambique (2nd. ed.): 1-163.— Witwatersrand Univ. Press, Johannesburg.
- Madsen, F.J., 1956. Reports of the Lund University Chile Expedition 1948-1949. 24. Asteroidea, with a survey of the Asteroidea of the Chilean Shelf.— Acta Univ. lund., 52 (2): 1-53.
- Marsh, L.M., 1974. Shallow-water asterozoans of southern Polynesia. 1. Asteroidea.— Micronesia, 10 (1): 65-104.
- Marsh, L.M., 1976. Western Australian Asteroidea since H.L. Clark.— Thalassia jugosl., 12 (1): 213-225.
- Marsh, L.M., 1977. Coral reef asteroids of Palau, Caroline Islands.— Micronesia, 13 (2): 251-281.
- Martens, E. von, 1865. Ueber ostasiatische Echinodermen. I. Asterien. 1. Japanische Seesterne. 2.

- Chinesische Seesterne.— Arch. Naturgesch., 31: 345-360.
- Martens, E. von, 1866. Ueber ostasiatische Echinodermen. 3. Seesterne des indischen Archipels.— Arch. Naturgesch., 32: 57-88.
- Martens, E. von, 1869. Seesterne und Seeigel. In: C.C. von der Decken, 1869. Reisen in Ost Afrika.— Leipzig & Heidelberg, 3 (1): 125-134.
- Martens, E. von, 1889. Echinodermen aus Neu-Guinea.— Sber. Ges. naturf. Freunde Berl. (1889): 183-185.
- McKnight, D.G., 1968. Some echinoderms from Tongatabu Island and the South Minerva Reef. N. Z.— J. mar. freshw. Res., 2 (4): 712-715.
- McKnight, D.G., 1972. Echinoderms collected by the Cook Islands Eclipse Expedition 1965.— NZOI Records, 1 (3): 37-43.
- McNeill, F.A. & A.A. Livingstone, 1926. A supplementary list of the echinoderms collected by Surgeon Lieutenant-Commander W.E.J. Partridge, R.A.N., in Queensland and North Australia.— Rec. Aust. Mus., 15 (2): 193-199.
- Meissner, M., 1892. Asteriden gesammelt von Herrn Stabarzt Dr. Sander auf der Reise S.M.S. "Prinz Adalbert".— Arch. Naturgesch., 58: 183-190.
- Meissner, M., 1896. Die von Herrn Dr. L. Plate aus Chile und Feuerland heimgebrachten See-Sterne.— Arch. Naturgesch., 1896 (1): 91-108.
- Michelin, H., 1845. Essai d'une faune de l'Île Maurice, publiée avec les matériaux et les notes laissés par Julien Desjardins, sous la direction et par les soins de M. F.E. Guérin Méneville. Zoophytes, échinodermes et stellérides.— Magasin de Zoologie, d'Anatomie comparée et de Palaeontologie, 2: 1-27.
- Möbius, K., 1880. Eine Reise nach der Insel Mauritius im Jahre 1874-75. In: Beiträge zur Meeresfauna der Insel Mauritius und der Seychellen: 1-61.— Verlag der Gutmann'schen Buchhandlung, Berlin.
- Morgans, J.F.C., 1959. The benthic ecology of False Bay. 1. The biology of infratidal rocks observed by diving, related to intertidal rocks.— Trans. R. Soc. S. Afr., 35 (5): 387-442.
- Morgans, J.F.C., 1962. The benthic ecology of False Bay. 2. Soft and rocky bottoms observed by diving and sampled by dredging, and the recognition of grounds.— Trans. R. Soc. S. Afr., 36: 288-334.
- Mortensen, T., 1921. Studies of the development and larval forms of echinoderms: 1-261.— G.E.C. GAD., Copenhagen.
- Mortensen, T., 1926. VI. Report on the echinoderms.— Trans. zool. Soc. Lond., 22: 117-131.
- Mortensen, T., 1933a. Echinoderms of South Africa (Asteroidea and Ophiuroidea). Papers from Dr. Th. Mortensen's Pacific Expedition 1914-16.— Vidensk. Meddr. dansk naturh. Foren., 93 : 215-490.
- Mortensen, T., 1933b. The echinoderms of St. Helena (other than crinoids).— Vidensk. Meddr. dansk naturh. Foren., 93: 401-473.
- Mortensen, T., 1934. Echinoderms of Hong Kong.— Hong Kong Nat., Suppl. 3: 3-14.
- Mortensen, T., 1940. Echinoderms from the Iranian Gulf. Asteroidea, Ophiuroidea, and Echinoidea.— Dan. Scient. Invest. Iran, 2: 55-110.
- Müller, J. & F.H. Troschel, 1840. Über die Gattungen der Asterien.— Arch. Naturgesch., 6 (1): 318-326.
- Müller, J. & F.H. Troschel, 1842. System der Asteriden: i-xx, 1-134.— Braunschweig.
- Müller, J. & F.H. Troschel, 1843. Neue Beiträge zur Kenntniss der Asteriden.— Arch. Naturgesch., 9 (1): 113-136.
- Nardo, J.D., 1834. De spongiis. De asteriis.— Oken's Isis, 1-12: 714-718.
- Oguro, C., 1983. Supplementary notes on the sea-stars from the Palau and Yap Islands 1.— Annotnes zool. jap., 56 (3): 221-226.
- Penrith, M.L. & B.F. Kensley, 1970. The constitution of the intertidal fauna of rocky shores of South West Africa. 1. Lüderitzbucht.— Cimbebasia (A) 1 (9): 189-239.
- Perrier, E., 1869. Recherches sur les pédicellaires et les ambulacres des astéries et des oursins.— Anns. Sci. nat., 12: 197-304.
- Perrier, E., 1875. Révision de la collection de stellérides du Museum d'Histoire Naturelle de Paris.— Archs Zool. exp. gn., 4: 265-450.
- Perrier, E., 1876. Révision de la collection de stellérides du Museum d'Histoire Naturelle de Paris.— Archs Zool. exp. gn., 5: 1-104, 209-309.
- Perrier, E., 1878. Etude sur la répartition géographique des Astérides.— Nouv. Arch. Mus. Hist. nat. Paris, (2) 1: 1-108.

- Peters, W., 1852. Übersicht der Seesterne (Asteridae) von Mossambique.— Ber. Akad. Wiss. Berlin, 1853: 177-178.
- Pfeffer, G., 1896. Ostafrikanische Echiniden, Asteriden und Ophiuriden, gesammelt von Herrn Dr. F. Stuhlmann im Jahre 1888 und 1889.— Mitt. naturh. Mus. Hamb., Beiheft Jb. hamb. wiss. Anst., 1895, 13: 43-48.
- Pfeffer, G., 1900. Echinodermen von Ternate. Echiniden, Asteriden, Ophiuriden und Comatuliden.— Abh. senckenb. naturforsch. Ges., 25: 81-86.
- Price, A.R.G., 1981. Studies of the echinoderm fauna of the western Arabian Gulf.— J. nat. Hist., 5 (1): 1-15.
- Price, A.R.G., 1982. Western Arabian Gulf echinoderms in high salinity waters and the occurrence of dwarfism.— J. nat. Hist., 16 (4): 519-527.
- Price, A.R.G., 1983. Echinoderms of Saudi Arabia, echinoderms of the Arabian Gulf coast of Saudi Arabia.— Fauna Saudi Arabia, 5: 28-107.
- Retzius, A.J., 1805. Dissertatio sistens species cognitae Asteriarum: 1-37.— Lundae.
- Rideout, R.S., 1978. Asexual reproduction as a means of population maintenance in the coral reef asteroid *Linckia multifora* on Guam.— Mar. Biol. Berlin, 47 (3): 287-295.
- Rowe, F.W.E., 1977. A new family of Asteroidea (Echinodermata) with the description of five new species and one new subspecies of *Asterodiscides*.— Rec. Aust. Mus., 31 (5): 187-233.
- Rowe, F.W.E., 1985. Six new species of *Asterodiscides* A.M. Clark (Echinodermata, Asteroidea) with a discussion of the origin and distribution of the Asterodiscidae and other "amphi-Pacific" echinoderms.— Bull. Mus. nat. Hist. nat. Paris (Zool. Biol. Ecol. anim.), (4) 7 (A, 3): 531-577.
- Rowe, F.W.E. & D.L. Pawson, 1977. A catalogue of echinoderm type specimens in the Australian Museum, Sydney.— Rec. Aust. Mus., 30 (14): 337-364.
- Russo, A., 1894. Echinodermi raccolti nel Mar Rosso dagli ufficiale della R. marina italiana.— Boll. Soc. Nat. Napoli, (1) 7: 159-163.
- Russo, A., 1929. Echinodermi raccolti dal Prof. L. Sanzo nella Campagna della R.N. Ammiraglio Magnaghi in Mar Rosso e zone viciniori, 1923-1924. Memoria biologica IX della Campagna. Nota I. Crinoidea, Asteroidea.— Memorie R. Com. talassogr. ital., 166: 1-9.
- Sarasin, P. & F. Sarasin, 1887. Knospfenbildung bei Seesternen.— Zool. Anz., 10: 674-675.
- Satyamurti, S.T., 1967. Guide to the invertebrate galleries.— Madras Govt. Mus., 1-164.
- Schumann, E.H., & M.J. Orren, 1980. The physico-chemical characteristics of the south-west Indian Ocean in relation to Maputaland. In: M.N. Bruton & K.H. Cooper (eds.). Studies on the ecology of Maputaland: 8-11.— Rhodes University, Grahamstown and the Natal Branch of the Wildlife Society of southern Africa, Durban.
- Seba, A., 1761. Locupletissimi rerum naturalium thesauri accurata descriptio et iconibus artificiosissimis expressio, per universam physices historiam opus, cui, in hoc rerum genere, nullum par exstitit. Ex toto terrarum orbe collegit, digessit, descripsit, et depingendum curavit. 3: 1-212.— Arksteum & Merkm, Amsterdam.
- Shepherd, S.A., 1968. The shallow water echinoderm fauna of South Australia. Part 1. The asteroids.— Rec. S. Austr. Mus., 15 (4): 729-756.
- Simpson, J.J. & R.N.R. Brown, 1910. Asteroidea of Portuguese East Africa, collected by Jas. J. Simpson.— Proc. R. phys. Soc. Edinb., 18 (4): 45-60.
- Sladen, W.P., 1883. The Asteroidea of H.M.S. "Challenger" Expedition. (Preliminary notices). 2. Astropectinidae.— J. Linn. Soc. (Zool.), 17: 214-269.
- Sladen, W.P., 1888. On the Asteroidea of the Mergui Archipelago, collected for the trustees of the Indian Museum, Calcutta, by Dr. John Anderson, F.R.S., Superintendent of the Museum.— J. Linn. Soc. (Zool.), 21: 319-331.
- Sladen, W.P., 1889. Asteroidea.— Rep. scient. Results Voy. Challenger, Zool., 30: i-xlii, 1-893, pls. 1-117.
- Sloan, N.A., A.M. Clark & J.D. Taylor, 1979. The echinoderms of Aldabra and their habitats.— Bull. Br. Mus. nat. Hist. (Zool.), 37 (2): 81-128.
- Sluiter, C.P., 1889. Die Evertrebraten aus der Sammlung des königlichen naturwissenschaftlichen Vereins in Niederländisch Indien in Batavia. Die Echinodermen. 2. Echinoidea, 3. Asteroidea.— Natuurk. Tijdschr. Ned. Indië 48: 285-313.
- Sluiter, C.P., 1895. Die Asteriden Sammlung des Museums zu Amsterdam.— Bijdr. Dierk., 17: 49-64.
- Smith, E.A., 1879. Echinodermata of the island of Rodriguez.— Phil. Trans. R. Soc., 168: 564-568.

- Smith, G.A., 1927. On *Asterina burtonii* Gray.— Ann Mag. nat. Hist., (9) 19: 641-645.
- Stephenson, T.A. 1944. The constitution of the intertidal fauna and flora of South Africa.— Ann. Natal Mus., 10 (3): 261-358.
- Stephenson, T.A., A. Stephenson & K.M.F. Bright, 1938. The South African intertidal zone and its relation to ocean currents. 4. The Port Elizabeth district.— Ann. Natal Mus., 9 (1): 1-19.
- Stephenson, T.A., A. Stephenson & J.H. Day, 1939. The South African intertidal zone and its relation to ocean currents. 8. Lambert's Bay and the West coast.— Ann. Natal Mus., 9 (3): 345-380.
- Stephenson, T.A., A. Stephenson & C.A. Du Toit, 1937. The South African intertidal zone and its relation to ocean currents. 1. A temperate Indian Ocean shore.— Trans. R. Soc. S. Afr., 24: 341-382.
- Stephenson, T.A., A. Stephenson, G. Tandy & M. Spender, 1931. The structure and ecology of Low Isles and other reefs.— Scient. Rep. Gr. Barrier Reef Exped., 3 (2): 17-112.
- Studer, T., 1884. Verzeichniss der während der Reise S.M.S. "Gazelle" um die Erde 1874-1876, gesammelten Asteriden und Euryaliden.— Phys. Math. Abh. k. Akad. Wiss. Berlin, 2: 1-64.
- Sukarno, M. & M. Jangoux, 1977. Révision du genre *Archaster* Müller & Troschel (Echinodermata, Asteroidea: Archasteridae).— Revue Zool. afr., 91 (4): 817-844.
- Thurston, E., 1895. II. Littoral fauna of the Gulf of Manaar.— Bull. Madras Govt. Mus., 3: 102-138.
- Tortonese, E., 1935. Gli Echinodermi del museo di Torino. Part III. Asteroidei.— Boll. Musei Zool. Anat. comp. R. Univ. Torino 45 (3): 27-132.
- Tortonese, E., 1936. Echinodermi del Mar Rosso.— Annali Mus. civ. Stor. nat. Giacomo Doria, 59 (15): 202-245.
- Tortonese, E., 1949. Echinodermi della Somalia Italiana.— Annali Mus. civ. Stor. nat. Giacomo Doria, 64: 30-42.
- Tortonese, E., 1953. Spedizione subaquea Italiana nel mar Rosso. Ricerche zoologiche. 2. Echinodermi.— Riv. Biol. colon., 13: 25-48.
- Tortonese, E., 1960. Echinoderms from the Red Sea. I. Asteroidea.— Bull. Sea Fish. Res. Stn. Israel, 29: 17-23.
- Tortonese, E., 1966. Echinoderms from the coast of Lebanon.— Misc. Pap. nat. Sci. Am. Univ. Beirut, 5: 1-5.
- Tortonese, E., 1976. Researches on the coast of Somalia. Seastars of the genus *Monachaster* (Echinodermata, Asteroidea).— Monitore zoologico italiano, 7, Suppl. 6: 271-276.
- Tortonese, E., 1977. Report on echinoderms from the Gulf of Aqaba (Red Sea).— Monitore zool. ital., 12, Suppl. 9: 273-290.
- Tortonese, E., 1979. Echinoderms collected along the eastern shore of the Red Sea (Saudi Arabia).— Atti Soc. ital. Sci. nat., 120 (4): 314-319.
- Tortonese, E., 1980a. Researches on the coast of Somalia. Littoral Echinodermata.— Monitore zool. ital., 5, Suppl. 13: 99-139.
- Tortonese, E., 1980b. Review of present status of knowledge of the Mediterranean echinoderms. In: M. Jangoux (ed.). Echinoderms: present and past. Proc. Colloquium echinoderms, Brussels, 3-8 September 1979: 141-149.— Balkema, Rotterdam.
- Verrill, A.E., 1913. Revision of the genera of starfishes of the subfamily Asterininae.— Am. J. Sci., 35 (40): 477-485.
- Viguié, C., 1878. Anatomie comparée du squelette des Stellérides.— Archs Zool. exp. gn., 7: 33-250.
- Walter, A., 1885. Ceylonische Echinodermen.— Z. Naturw., 18: 368-384.
- Yamaguchi, M., 1975. Coral reef asteroids of Guam.— Biotropica, 7 (1): 12-23.
- Yamaguchi, M., 1977. Population structure, spawning and growth of the coral reef asteroid *Linckia laevigata* (Linnaeus).— Pacif. Sci., 31 (1): 13-30.
- Zeidler, W. & S.A. Shepherd, 1982. Sea-stars (Class Asteroidea). In: Shepherd S.A. & I.M. Thomas (eds.). Marine invertebrates of southern Australia. I: 400-418.— Woolman, South Australia.

Received: 15.v.1989

Accepted: 6.iii.1990

Edited: M.R.R.B. Best & J.C. den Hartog