

Shallow-water regular echinoids (Echinodermata: Echinoidea) from Kenya

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The shallow-water regular echinoid fauna of Kenya is documented, based on the results of several field trips, and additional information from the literature. The specimens observed and/or collected from Kenyan coral reefs and sea-grass beds belong to six families, 16 genera and 20 species. Two additional species are reported from the literature only. An identification key to generic level and synoptic descriptions are provided. *Prionocidaris pistillaris* (Lamarck, 1816), *Salmacis bicolor* L. Agassiz in Agassiz & Désor, 1841, and *Pseudoboletia maculata maculata* Troschel, 1869, are new records for Kenya, the last species also being a new record for the western Indian Ocean. Twenty-two species of regular echinoids are now known from Kenya.

Key words: sea urchins, Regularia, Kenya, taxonomy.

INTRODUCTION

The East African coast was intensively surveyed for echinoderms (mainly holothuroids) between 1997 and 2001. These surveys not only resulted in the addition of several new records for Kenya and the Indian Ocean (Samyn 2000; Samyn & Vanden Berghe 2000; Bolton *et al.* 2001; Samyn & Thandar 2003a), but also in the description of new species (Massin *et al.* 1999; Samyn *et al.* 2001; Samyn & Thandar 2003b) and revisions of certain holothuroid taxa (Massin *et al.*, in press; Samyn & Massin, in press).

The purpose of the present paper is to provide an up-to-date systematic account of Kenyan shallow-water regular echinoids, with reference to local and global distributions. Such an annotated checklist is urgently needed by Kenyan reef ecologists who use the presence and abundance of certain regular sea urchin species as indicators of reef health and fishing pressure (Muthiga & McClanahan 1987; McClanahan 1988; McClanahan & Shafir 1990; McClanahan & Mutere 1994; McClanahan *et al.* 1994). At present, these ecologists rely mostly on Clark & Rowe's (1971) monograph of shallow-water echinoderms of the Indo-West Pacific Ocean to identify species. As the monograph was published more than 30 years ago, the taxonomic keys require updating to accommodate new taxa that have been described from the Indo-West Pacific region as well as other taxonomic changes. All species included in the present report are represented in Clark & Rowe's keys. A recent field guide (Rowe & Richmond

1997) briefly details the echinoderms of eastern Africa, but without specific reference to the Kenyan coast. On the other hand, Tortonese (1949, 1951, 1980) provided important descriptions of the echinoderm fauna of Somalia, but as some of these works are in Italian, researchers rarely use them at present. The keys and annotated checklist presented below should, in combination with Clark & Rowe (1971), enable reliable identification of regular echinoids from the Kenyan coastline.

The present study expands an earlier effort (Samyn & Vanden Berghe 2000) to document the shallow-water echinoid biodiversity of Kenya. The results from the Kiunga Marine Reserve (Samyn & Vanden Berghe 2000) are reconsidered here and are supplemented with records from other sites along the Kenyan coast. For species discussed in Samyn & Vanden Berghe (2000), only abridged descriptions are provided below.

STUDY SITES

Collections were made on the inner and outer coral reefs and in sea-grass beds at several sites along the Kenyan coast. For practical reasons, the extensive mangrove forests that fringe the coastline were not visited. Specimens were taken at the following sites: Kiunga Marine National Reserve (see also Samyn & Vanden Berghe 2000), Malindi Marine National Park and Reserve, Watamu Marine National Park and Reserve, Shariani, Kanamai, Mombasa Marine National Park and Reserve, Diani Marine National Reserve, Gazi Bay and the Shimoni Marine Park and Reserve (Fig. 1).

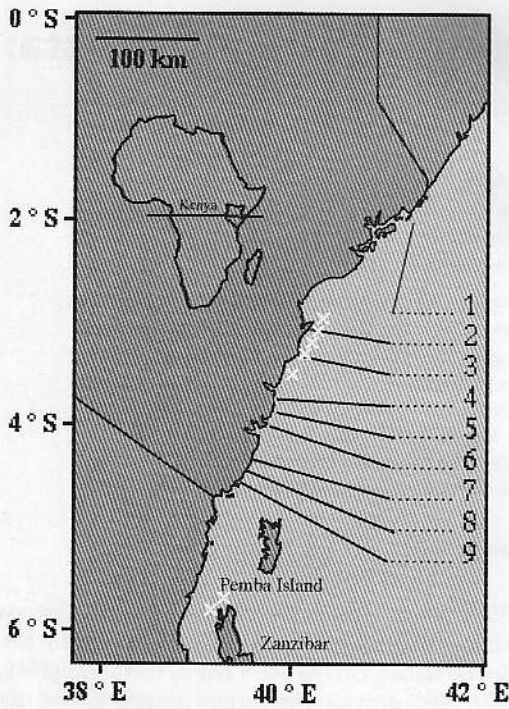


Fig. 1. Collection and observation sites along the Kenyan coast. 1, Kiunga Marine National Reserve (see also Samyn & Vanden Berghe 2000); 2, Malindi Marine National Park and Reserve; 3, Watamu Marine National Park and Reserve; 4, Shariani; 5, Kanamai; 6, Mombasa Marine National Park and Reserve; 7, Diani Marine National Reserve; 8, Gazi Bay; 9, Shimoni Marine National Park and Reserve. The white crosses are the sampling localities of Humphreys (1981).

MATERIALS & METHODS

Collecting was done by hand at low tide, by snorkelling and scuba-diving (to depths of 28 m), in July 1997, August 1998 and April 1999. These expeditions were joint efforts of the Free University Brussels, WWF Kenya and the Kenya Wildlife Services. The first individual of each species encountered was collected as a voucher specimen, except when the animal could be unmistakably identified in the field (see also Figs 2–4). Confirmation of our identifications was possible during research visits to The Natural History Museum, London (NHM), and to the Muséum Royal de l’Afrique Centrale, Tervuren, Belgium (MRAC). Although Humphreys (1981) stated that part of his voucher material from Kenya had been deposited in the National Museum of Kenya, Nairobi (NMK), no voucher specimens were found in that collection (E. Vanden Berghe, pers. comm.).

Specimens from the Kiunga Marine Reserve are

in the Institut Royal des Sciences Naturelles, Brussels, Belgium (under the number IG 28 268); material from the other Kenyan localities is in the Muséum Royal de l’Afrique Centrale, Tervuren, Belgium (under the numbers MRAC 1671–1691).

RESULTS

In total, 45 specimens representing six families, 14 genera and 18 species were collected (Table 1). In addition, two species [*Astropyga radiata* (Leske, 1778) and *Colobocentrotus atratus* (Linnaeus, 1758)] were readily identifiable in the field. Two species [*Heterocentrotus trigonarius* (Lamarck, 1816) and *Parasalenia gratiosa* A. Agassiz, 1863] were neither collected nor observed, but are reported with certainty in the literature. An overview of recent literature of shallow-water regular echinoids from the western Indian Ocean, and Kenya in particular, is provided in Table 2. Several important historical papers are not included in Table 2, but are, when relevant, cited in the systematic account.

SYSTEMATIC ACCOUNT

Family CIDARIDAE Gray, 1825

Diagnosis. Members of this family are characterized by high interambulacral plates, with massive, blunt primary spines, widely separated from each other, usually surrounded by much smaller, often spatulate, secondary spines. The large, naked primary spines are often encrusted with epizoic organisms. Pore pairs on the ambulacral plates form single, almost vertical series. Imbricate ambulacral and interambulacral plates cover the peristome up to the mouth. Primary tubercles perforate, crenulate, sometimes smooth.

Key to the Kenyan genera
(after Clark & Rowe 1971)

1. Adult test size usually less than 30 mm horizontal diameter (h.d.); ambulacral pores non-conjugate; apical system fringed by a ring of spatulate enlarged secondary spines and their tubercles; plates of apical system with minute glassy bumps
..... *Eucidaris* Pomel, 1883
- 1'. Adult test size usually exceeding 30 mm h.d.; ambulacral pores conjugate, sunk in a common furrow; apical system densely covered by spinelets or tubercles of similar small size..... 2
2. Ocular plates make contact with the periproct (insert); large globiferous pedicellariae with

Table 1. List of specimens collected from the Kenyan coast. One specimen below low-water mark, not representative of the taxon.

Taxon

REGULARIA

Cidaridae

Eucidaris metularia (Lamarck, 1816)

Phyllocentrotus trigonarius (Lamarck, 1816)

Parasalenia gratiosa (Agassiz, 1863)

Astropyga radiata (Leske, 1778)

Colobocentrotus atratus (Linnaeus, 1758)

Table 1. List of shallow-water regular echinoids collected and/or observed at the different sites along the Kenyan coast. One specimen (*Phyllacanthus imperialis*) originated from Pemba Island (Tanzania). Depths are in metres below low-water mark; they represent the depth range at which the species was observed and/or collected and are not representative of the depth range of the species. i.t. = intertidal; s.s.z. = supra-intertidal splash zone.

Taxon	Site	Min-max depth (m)	Collection number
REGULARIA			
Cidaridae			
<i>Eucidaris metularia</i> (Lamarck, 1816)	Malindi Marine Reserve	18	MRAC1671/KMalE9801 (1 specimen)
<i>Phyllacanthus imperialis</i> (Lamarck, 1816)	Kiunga Marine Reserve	5-7	IRSNB IG 28 268/KKiun9901 (1 specimen)
	Fundu South	14	MRAC1672/TFunE9802 (1 specimen)
<i>Prionocidaris baculosa</i> (Lamarck, 1816)	Mombasa Marine Reserve	3	MRAC1673/KMomE9803 (1 specimen)
<i>Prionocidaris pistillaris</i> (Lamarck, 1816)	Mombasa Marine Reserve	3-5	MRAC1674/KMomE9804 (1 specimen)
<i>Prionocidaris verticillata</i> (Lamarck, 1816)	Shimoni Marine Park	20	MRAC1675/KShimE9805 (1 specimen; primary spine only)
Diadematidae			
<i>Astropyga radiata</i> (Leske, 1778)	Kiunga Marine Reserve	2	None
	Mombasa Marine Reserve	5-9	None
	Mombasa Marine Park	4-6	None
	Gazi Bay	2-3	None
<i>Diadema savignyi</i> Michelin, 1845	Kiunga Marine Reserve	1-9	IRSNB IG 28 268/KKiun9903 (2 specimens)
	Malindi Marine Park	1-21	None
	Malindi Marine Reserve	1-22	None
	Watamu Marine Reserve	1-20	None
	Kanamai	1-5	None
	Mombasa Marine Reserve	i.t.-12	None
	Mombasa Marine Park	i.t.-20	None
	Diani Marine Reserve	i.t.-5	None
	Gazi Bay	1-4	MRAC1676/KGazE9806 (2 specimens)
Shimoni Marine Park	1-18	None	
<i>Diadema setosum</i> (Leske, 1778)	Kiunga Marine Reserve	2-8	IRSNB IG 28 268/KKiun9902 (1 specimen)
	Malindi Marine Park	1-14	None
	Malindi Marine Reserve	1-16	None
	Watamu Marine Reserve	1-20	None
	Kanamai	1-5	None
	Mombasa Marine Reserve	i.t.-12	None
	Mombasa Marine Park	i.t.-20	None
	Diani Marine Reserve	i.t.-3	None
	Gazi Bay	1-4	None
Shimoni Marine Park	1-16	None	
<i>Echinothrix calamaris</i> (Pallas, 1774)	Kiunga Marine Reserve	2	IRSNB IG 28 268/KKiun9905 (1 specimen)
	Malindi Marine Park	8-12	None
	Kanamai	2-4	None
	Mombasa Marine Park	2-14	None
	Diani Marine Reserve	i.t.-2	None
<i>Echinothrix diadema</i> (Linnaeus, 1758)	Kiunga Marine Reserve	1-12	IRSNB IG 28 268/KKiun9904 (1 specimen)
	Shariani	4-6	None
	Kanamai	2-4	None
	Mombasa Marine Park	2-14	None
Diani Marine Reserve	i.t.-2	None	
Echinometridae			
<i>Colobocentrotus atratus</i> (Linnaeus, 1758)	Mombasa Marine Park	s.z.	None
	Malindi Marine Park	s.z.	None
<i>Echinometra mathaei</i> (de Blainville, 1825)	Kiunga Marine Reserve	i.t.-10	IRSNB IG 28 268/KKiun9913 (6 specimens)
	Malindi Marine Park	8	MRAC1677/KMalE9808 (1 specimen)
	Malindi Marine Reserve	6-10	None
	Watamu Marine Park	4	None
	Watamu Marine Reserve	i.t.-?	None
Kanamai	1-3	MRAC1678/KKanE9702 (1 specimen)	

Continued on p. 196

Table 1 (continued)

Taxon	Site	Min-max depth (m)	Collection number
	Mombasa Marine Reserve	4-8	None
	Mombasa Marine Park	2-22	MRAC1679/KMome9809 (1 specimen)
	Diani Marine Reserve	i.t.	None
	Gazi Bay	i.t.-4	MRAC1680/KGazE9701 (1 specimen)
	Mombasa Marine Park	2-22	MRAC1679/KMome9809 (1 specimen)
	Diani Marine Reserve	i.t.	None
	Gazi Bay	i.t.-4	MRAC1680/KGazE9701 (1 specimen)
	Shimoni Marine Park	8	MRAC1681/KShime9807 (2 specimens)
	Shimoni Marine Reserve	Unknown	None
<i>Echinostrephus molaris</i> (de Blainville, 1825)	Kiunga Marine Reserve	i.t.-10	IRSNB IG 28 268/KKiun9913 (1 specimens)
	Malindi Marine Park	10-18	None
	Malindi Marine Reserve	5-15	None
	Watamu Marine Park	8-18	None
	Watamu Marine Reserve	Unknown	None
	Kanamai	2-3	None
	Mombasa Marine Reserve	1-5	None
	Mombasa Marine Park	1-28	None
	Diani Marine Reserve	1-3	None
	Shimoni Marine Park	8-15	None
	Shimoni Marine Reserve	Unknown	None
<i>Heterocentrotus mammillatus</i> (Linnaeus, 1758)	Kiunga Marine Reserve	2-5	None
	Mombasa Marine Park	4	MRAC1682/KMome9703 (1 specimen; primary spine only)
Stomopneustidae			
<i>Stomopneustes variolaris</i> (Lamarck, 1816)	King Marine Reserve	1-8	IRSNB IG 28 268/KKiun9910 (3 specimens)
	Malindi Marine Park	6	MRAC1683/KMalE9810 (1 specimen)
	Mombasa Marine Park	4	None
	Mombasa Marine Reserve	2-3	MRAC1684/KMome9704 (1 specimen)
	Gazi Bay	4	MRAC1685/KGazE9811 (1 specimen)
Temnopleuridae			
<i>Microcyphus rousseaui</i> L. Agassiz, 1846	Kiunga Marine reserve	7-17	IRSNB IG 28 268/KKiun9906 (1 specimen) IRSNB IG 28 268/KKiun9907 (1 specimen)
<i>Salmacis bicolor</i> L. Agassiz in Agassiz & Désor, 1841	Kanamai	1-2	MRAC1686/KKanE9812 (1 specimen)
	Gazi Bay	2	MRAC1687/KGazE9708 (1 specimen)
Toxopneustidae			
<i>Pseudoboletia maculata maculata</i> Troschel, 1869	Kanamai	2	MRAC1688/KKanE9813 (1 specimen)
<i>Toxopneustes pileolus</i> (Lamarck, 1816)	Kiunga Marine Reserve	1-5	IRSNB IG 28 268/KKiun9911 (1 specimen)
	Malindi Marine Park	7	None
	Malindi Marine Reserve	3-5	MRAC1689/KMalE9706 (1 specimen)
	Mombasa Marine Park	3-6	None
	Mombasa Marine Reserve	2-4	None
	Gazi Bay	2	MRAC1690/KGazE9705 (1 specimen)
<i>Tripneustes gratilla</i> (Linnaeus, 1758)	Kiunga Marine Reserve	1-15	IRSNB IG 28 268/KKiun9908 (1 specimen) IRSNB IG 28 268/KKiun9909 (1 specimen) IRSNB IG 28 268/KKiun9912 (1 specimen)
	Malindi Marine Park	3	None
	Malindi Marine Reserve	3-4	None
	Shariani	2-4	None
	Kanamai	i.t.-2	None
	Mombasa Marine Park	2-5	None
	Mombasa Marine Reserve	i.t.-5	None
	Gazi Bay	i.t.-3	MRAC1691/KGazE9707 (1 specimen)
	Shimoni Marine Park	4	None
	Shimoni Marine Reserve	4	None

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with serrated edges
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2 Ocular plates make no contact
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Genus EUCIDARIS P

Eucidaris metula
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Kenya
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numerous fringes on stalk; primary spines with serrated edges

- *Prionocidaris* A. Agassiz, 1836
 2' Ocular plates make no contact with periproct (exsert); globiferous pedicellariae without frill of rods on stalk close to the head; primary spines smooth or with fine continuous longitudinal ridges
 *Phyllacanthus* Brandt, 1835

Genus *EUCIDARIS* Pomel, 1883

***Eucidaris metularia* (Lamarck, 1816), Fig. 2A**

Material examined. Kenya (Malindi Marine Reserve), coll. Y. Samyn, MRAC1671/KMaIE9801; Kenya (Mombasa Marine Reserve, as 'Nyali Reef'), coll. P. Cambridge, NHM 1967.4.4.42; Kenya (Kisite), coll. J.D. Taylor, NHM 1973.10.4.52; Kenya (Kilifi), coll. Banga Watamu exp., NHM 1974.4.2.6.9; Kenya, coll. M. Good, NHM 1981.3.10.11; Tanzania (Pemba Channel), coll. W.F. Humphreys, NHM 1979.1.25.40-44; Kenya (Mida Creek), coll. W.F. Humphreys, MRAC 1603.

Diagnosis. Small-bodied sea urchin; test moderately high, flattened above; horizontal diameter up to 30 mm; primary spines massive, cigar-shaped, relatively short and thick, naked, striped orange-brown, crown-like tip, shaft with longitudinal series of low spinules; primary spines ringed by small, spatulate, pinkish secondary spines; interambulacral plates high; ambulacral plates simple, non-conjugated pore pairs in single vertical series; primary tubercles not crenulate; apical system about half of horizontal diameter, more or less bare, but for some minute spinelets, a marginal fringe of larger petaloid spines and a small cluster of spinelets on periproct; plates of apical system covered with minute glassy bumps, visible when denuded; oculars exsert.

Taxonomic description. Mortensen (1928: 386-392, figs 113a,b, 114, f115(1), 116; pl. 41, figs 1-8; pl. 73, fig. 6; pl. 86, figs 11-14).

Ecology. *E. metularia* is known as a relatively sedentary species in unexposed coral-rich areas, in and under coral heads in lagoon sea-grass beds (Sloan *et al.* 1979); often in relatively shallow water (A.M. Clark 1984; Clark & Courtman-Stock 1976). Grazes on encrusting organisms, especially animals (Birkeland 1989). Forages actively at night (Birkeland 1989; pers. obs.). Generally considered a littoral species, but reported by Mortensen (1931) to a depth of 570 m.

Kenyan distribution. Rare in Kenya. Only observed

once, in the Malindi Marine Reserve, but reported several times by others: several specimens from Kenya, Tanzania, Zanzibar and Aldabra are in NHM and MRAC.

Distribution. Well-known species from the tropical Indo-West-central Pacific Ocean (including the Red Sea) (Mortensen 1928; Clark & Rowe 1971; Rowe & Gates 1995; Rowe & Richmond 1997).

Genus *PHYLLACANTHUS* Brandt, 1835

***Phyllacanthus imperialis* (Lamarck, 1816), Fig. 2B, B'**

Material examined. Tanzania (Pemba Island, Fundu South), coll. Y. Samyn, MRAC1672/TFunE9802; Kenya (Kiunga Marine Reserve), coll. Y. Samyn, IRSNB IG 28 268 KKiun9901; Zanzibar (Chukwi, Tele), coll. P.J. Herring, NHM 1965.1.12.10; Seychelles (Mahé), coll. Mission MRAC-ULB VII/IX/1966, MRAC 1150, 1232.

Field description. See Samyn & Vanden Berghe (2000: 8, pl. 1B).

Taxonomic description and diagnosis. Mortensen (1928: 504-509, fig. 163; pl. 54, fig. 4; pl. 57, fig. 3; pl. 74, fig. 6; pl. 88, figs 4-10).

Ecology. *P. imperialis* is a relatively sedentary species, during daylight hours hiding in unexposed coral-rich areas, beneath rocks, slabs of dead or live coral. During the night *P. imperialis* leaves its shelter and forages close to the crevice in which it hides, feeding on encrusting animals and plants. Sloan *et al.* (1979) stated that *P. imperialis* was abundant on some sponge-covered rocks in Aldabra.

Kenyan distribution. Only reported from the Kiunga Marine Reserve (Samyn & Vanden Berghe 2000). As the species was also found on the coral reefs of Pemba Island (Tanzania), the presence of this species at other Kenyan localities is likely.

Distribution. See Samyn & Vanden Berghe (2000).

Genus *PRIONOCIDARIS* A. Agassiz, 1836

***Prionocidaris baculosa* (Lamarck, 1816), Fig. 2C, C', C''**

Material examined. Kenya (Mombasa Marine Reserve), coll. Y. Samyn, MRAC1673/KMomeE9803; Mauritius (Barkly Island), coll. E. Vaughan, NHM 1952.3.24.1; Aldabra, coll. J.D. Taylor, NHM 1969.5.1.9-13; Seychelles (Mahé), coll. Mission MRAC-ULB VII/IX/1966, MRAC 1390, 1111, 1150.

Diagnosis. Large-bodied sea urchin; horizontal diameter up to 80 mm; primary spines massive,

Table 2. Shallow-water regular echinoids from East Africa with emphasis on Kenya (recent records only). 1: Clark & Rowe (1971), with the echinoids from East Africa and Madagascar lumped in one group; 2: Tortonese (1949, 1951, 1980) described the echinoderms from Somalia in three papers, here the records are collated; 3: Herring (1972) discussed the ecology of the most ubiquitous echinoids from Zanzibar; 4: Humphreys (1981) provided a checklist of the echinoderms of Kenya and Zanzibar; 5: Rowe & Richmond (1997) briefly described the echinoderms of the western Indian Ocean, i.e. 'from about central Somalia to the center Kwazulu-Natal coast of South-Africa, embracing the islands of Madagascar, the Comores, Zanzibar, la Réunion, Mauritius and the Seychelles'; 6: Samyn & Vanden Berghe (2000) provided an annotated checklist of the echinoids and holothurians of the Kiunga Marine Reserve, Kenya; 7: this study; 8: total regular echinoid fauna for Kenya.

Family/species	1	2	3	4	5	6	7	8
Cidaridae								
<i>Eucidaris metularia</i> (Lamarck, 1816)	x	x		x	x		x	x
<i>Phyllacanthus imperialis</i> (Lamarck, 1816)	x				x	x	x	x
<i>Prionocidaris baculosa</i> (Lamarck, 1816)	x			x	x		x	x
<i>Prionocidaris pistillaris</i> (Lamarck, 1816)	x				x		x	x*
<i>Prionocidaris verticillata</i> (Lamarck, 1816)	x	x		x	x		x	x
Diademmatidae								
<i>Astropyga radiata</i> (Leske, 1778)	x		x	x	x	x	x	x
<i>Diadema savignyi</i> Michelin, 1845	x			x	x	x	x	x
<i>Diadema setosum</i> (Leske, 1778)	x		x	x	x	x	x	x
<i>Echinothrix calamaris</i> (Pallas, 1774)	x	x	x	x	x	x	x	x
<i>Echinothrix diadema</i> (Linnaeus, 1758)	x	x		x	x	x	x	x
Echinometridae								
<i>Colobocentrotus atratus</i> (Linnaeus, 1758)	x	x		x	x		x	x
<i>Echinometra mathaei</i> (de Blainville, 1825)	x	x	x	x	x	x	x	x
<i>Echinostrephus molaris</i> (de Blainville, 1825)	x			x	x	x	x	x
<i>Heterocentrotus mammillatus</i> (Linnaeus, 1758)	x			x	x	x	x	x
<i>Heterocentrotus trigonarius</i> (Lamarck, 1816)	x	x		x	x			x
Echinothuridae								
<i>Asthenosoma varium</i>					x			
Parasaleniiidae								
<i>Parasalenia gratiosa</i> A. Agassiz, 1863	x			x	x			x
Stomopneustidae								
<i>Stomopneustes variolaris</i> (Lamarck, 1816)	x	x	x	x	x	x	x	x
Temnopleuridae								
<i>Microcyphus rousseaui</i> L. Agassiz, 1846	x	x	x		x	x	x	x
<i>Salmaciella dussumieri</i> (L. Agassiz, 1846)	x				x			
<i>Salmacis bicolor</i> in Agassiz & Désor, 1846	x	x			x		x	x*
<i>Temnopleurus reevesi</i> (Gray, 1855)	x							
<i>Temnopleurus toreumaticus</i> (Leske, 1778)	x				x			
<i>Temnotrema siamense</i> (Mortensen, 1904)	#				x			
Toxopneustidae								
<i>Cyrtechinus verruculatus</i> (Lütken, 1864)					x			
<i>Gymnechinus robillardi</i> (de Loriol, 1883)					x			
<i>Pseudoboletia indiana</i> (Michelin, 1862)	x				x			
<i>Pseudoboletia maculata maculata</i> Troschel, 1869							x	x**
<i>Toxopneustes pileolus</i> (Lamarck, 1816)	x	x		x	x	x	x	x
<i>Tripneustes gratilla</i> (Linnaeus, 1758)	x	x	x	x	x	x	x	x

= NHM record, not examined.

*New record for Kenya.

**New record for the western Indian Ocean.

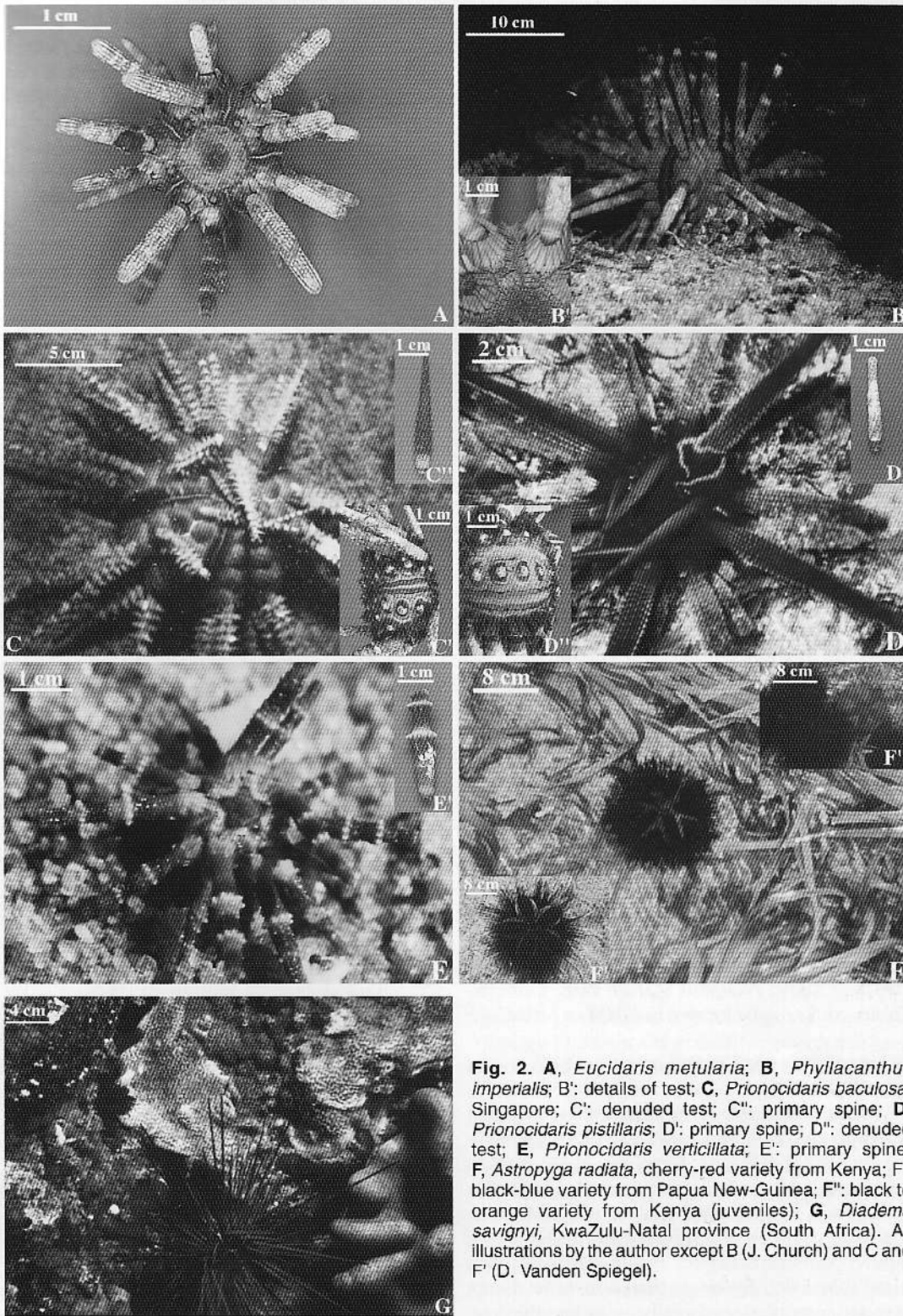


Fig. 2. A, *Eucidaris metularia*; B, *Phyllacanthus imperialis*; B': details of test; C, *Prionocidaris baculosa*, Singapore; C': denuded test; C'': primary spine; D, *Prionocidaris pistillaris*; D': primary spine; D'': denuded test; E, *Prionocidaris verticillata*; E': primary spine; F, *Astropyga radiata*, cherry-red variety from Kenya; F': black-blue variety from Papua New-Guinea; F'': black to orange variety from Kenya (juveniles); G, *Diadema savignyi*, KwaZulu-Natal province (South Africa). All illustrations by the author except B (J. Church) and C and F' (D. Vanden Spiegel).

brown, naked (often encrusted with epizoic organisms), tapering or (especially on the smaller primary spines) ending in a thorny whorl, orally with longitudinal series of thorns, flattened adorally (thorns greatly reduced), collar smooth, spotted with red or purple; ambulacral plates simple with conjugate pore pairs in single almost vertical series; apical system with numerous minute spinelets and insert ocular plates; large globiferous pedicellariae with frill of rods on the stalk close to head.

Taxonomic description. Mortensen (1928 [*forma typica* (including var. *erythraea* Döderlein) only]: 437–442, fig. 136(1); pls 45, 46, 47, figs 2–3; pl. 48, fig. 2; pl. 51, fig. 2; pl. 53, figs 4–11; pl. 55, fig. 2; pl. 57, figs 6–7; pl. 73, figs 13–17; pl. 87, figs 1–5, 10–11).

Ecology. In Kenya, *P. baculosa* can be found hiding in sea-grass beds dominated by *Thalassodendron ciliatum* (Forskål, 1757) or in lagoon areas with rocky outcrops and some isolated coral heads. *P. baculosa* can cover itself with sea-grass and algal debris. Sloan *et al* (1979) reported that *P. baculosa* was also found in old *Stomopneustes variolaris* (Lamarck, 1816) burrows.

Kenyan distribution. *P. baculosa* is quite rare in Kenya, only having been seen in the Mombasa Marine Reserve and in Kanamai, always in small numbers. Humphreys (1981) was the only one to report it previously from Kenya (Watamu Marine Park, Kibirijini Point).

Distribution. *P. baculosa* is relatively well known from the western Indian Ocean, as reflected by the specimens from Zanzibar, Aldabra, Mauritius and the Seychelles in NHM and MRAC. Clark & Rowe (1971) listed it as an Indo-West-central Pacific species, occurring from East Africa (including the Red Sea) to Japan (see also H.L. Clark 1925; Mortensen 1928; Rowe & Richmond 1997).

Remarks. Specimens collected by Humphreys (1981) in Kenya (Watamu Marine Park, Kibirijini Point), could not be located in NHM or MRAC.

***Prionocidaris pistillaris* (Lamarck, 1816), Fig. 2D, D', D''**

Material examined. Kenya (Mombasa Marine Reserve), coll. Y. Samyn, MRAC1674/KMomeE9804; Seychelles (Mahé), coll. Gardiner, NHM 1907.7.1.93 (type of *Prionocidaris baculosa lineata* Gardiner)

Diagnosis. Large-bodied sea urchin; horizontal diameter up to 60 mm; test flattened above and below; primary tubercles never crenulate; primary spines slightly longer than horizontal diameter, tapering, flattened orally, with longitudinal

series of thorns; oral primaries distinctly flattened; collar of primary spines conspicuously striped with purple; apical system with all oculars broadly insert, covered with uniform small tubercles. Denuded test greenish, pore zones reddish brown and primary tubercles whitish to purple.

Taxonomic description. Mortensen (1928: 452–456, figs 139, 140 (1), pls 49, 50; pl. 51, fig. 1; pl. 73, fig. 18; pl. 86, figs 20, 21).

Ecology. Often found on loose substrates: sand, broken shells, coral rubble; in sea-grass beds or under coral slabs.

Kenyan distribution. *P. pistillaris* is rare in Kenya, only six individuals having been observed in sea-grass beds in the Mombasa Marine Reserve.

Distribution. *P. pistillaris* is a relatively well-known species from southern Africa (records before 1976: Clark & Courtman-Stock 1976), East Africa, Mauritius and the Seychelles (records before 1969: Clark & Rowe 1971; Rowe & Richmond 1997).

Remarks. The present voucher specimen is a new record for Kenya.

***Prionocidaris verticillata* (Lamarck, 1816), Fig. 2E, E'**

Material examined. Kenya (Shimoni Marine Park), coll. Y. Samyn, MRAC1675/KShimeE9805 (primary spine only); Seychelles (Mahé), coll. M. Blackman, NHM 1967.4.4.67; Aldabra, coll. J.D. Taylor, NHM 1969.5.1.14.

Diagnosis. Large-bodied sea urchin; horizontal diameter known to exceed 30 mm; primary spines massive, naked, distinctively verticillate, with three or four spaced complete thorny whorls along their lengths; collar of primary spines unspotted; conjugate pore pairs; apical system with a more or less dense covering of spinelets and insert ocular plates; large globiferous pedicellariae with frill of rods on the stalk close to head.

Taxonomic description. Mortensen [1928 (as *Plocoidaris verticillata*): 428–433, figs 131, 132, 133; pl. 51, figs 3–7; pl. 74, fig. 5; pl. 83, figs 19–21].

Ecology. Under coral slabs, in less exposed areas of sea grass and in passages in the reef (Sloan *et al.* 1979; A.M. Clark 1984). Littoral species down to a depth of 50 m (Mortensen 1931).

Kenyan distribution. Very rare in Kenya, the only records prior to the present one being those of Humphreys (1981) from Watamu Marine Park and Mida creek.

Distribution. *P. verticillata* is well known from East Africa as is illustrated by the distribution table in Mortensen (1928) and in Clark & Rowe (1971)

and by the colle
bat, Seychelles, an
in NHM. Rowe & G
West-central Pacific O
Remarks. As this speci
only a primary spine was
individual seen. The cyp
so its abundance is pro
specimens collected
(Watamu Marine
be located.

and by the collection of East African (e.g., Zanzibar, Seychelles, and Aldabra) voucher specimens in NHM. Rowe & Gates (1995) indicated an Indo-West-central Pacific Ocean distribution.

Remarks. As this species is very rare in Kenya, only a primary spine was collected from the single individual seen. The cyptic behaviour of this species makes it easy to overlook during surveys, so its abundance is possibly underestimated. The specimens collected by Humphreys in Kenya (Watamu Marine Park and Mida Creek), could not be located in NHM or MRAC.

Family DIADEMATIDAE Peters, 1855

Diagnosis. Members of this family are characterized by a low test; vertical diameter rarely more than 55% of horizontal diameter, often much less. Interambulacral plates with numerous brittle primary spines per plate and scattered secondary spines. Spines usually hollow, long, cylindrical, thin and breakable, with a finely thorny or ridged surface. Ambulacral plates fused, pore pairs in arcs. Peristome without plates, but with soft skin. Test often somewhat flattened, rather flexible, sometimes rigid. Primary tubercles well developed over entire test surface, perforate and crenulate.

Key to the Kenyan genera

(after Clark & Rowe 1971)

1. Genital plates conspicuously elongated into the interambulacrum, periproct flat or slightly conical; test rather flexible
..... *Astropyga* Gray, 1825
- 1'. Genital plates not longer than wide, periproct distinctively extruded, spines markedly barbed terminally 2
2. Ambulacral spines of aboral side very fine and needle-like, near the tip barbs directed backward, contrasting with other spines; horizontal test diameter up to 130 mm
..... *Echinothrix* Peters, 1853
- 2'. Ambulacral spines of aboral side without backward-directed barbs, not contrasting with other spines; horizontal test diameter up to 100 mm *Diadema* Gray, 1825

Genus *ASTROPYGA* Gray, 1825

Astropyga radiata (Leske, 1778), Fig. 2F, F', F''

Material examined. Several unnumbered specimens in MRAC. It is unclear whether these represent Humphreys' (1981) specimens.

Field description. See Samyn & Vanden Berghe (2000: 9, pl. 1C).

Taxonomic description and diagnosis. Mortensen (1940: 187–196, figs 111–115; pl. 8, fig. 6; pl. 9, figs 6–9; pls 10–12, figs 1–2; pl. 12, fig. 1; pl. 14, figs 1–3; pl. 15, fig. 2; pl. 16, fig. 1; pl. 17, fig. 1; pl. 18, fig. 1; pl. 20, fig. 4; pl. 70, figs 1–3, 7, 13–17; pl. 71, figs 2, 4, 6).

Ecology. *A. radiata* has been observed in shallow sea-grass beds, sandy shelves (Sloan *et al.* 1979; de Beer 1990; pers. obs.) in the coral region just below the low-tide level and on shallow reefs (Herring 1972; pers. obs.). It often occurs in small aggregations, forming larger clusters before, and during, spawning (pers. obs.). *A. radiata* feeds on sandy sediment and fine coral debris, foraging actively only during the night.

Kenyan distribution. *A. radiata* is quite common in Kenya. It has been observed in the Kiunga Marine Reserve, Watamu Marine Park, Mombasa Marine Park and Reserve, Gazi Bay, and the Malindi Marine Park.

Distribution. Well-known tropical Indo-West-central Pacific (including the Red Sea) species (Rowe & Gates 1995; Samyn & Vanden Berghe 2000).

Genus *DIADEMA* Gray, 1825

Diadema savignyi Michelin, 1845, Fig. 2G

Material examined. Kenya (Gazi Bay), coll. Y. Samyn, MRAC1676/KGazE9806; Kenya (Kiunga Marine Reserve), coll. Y. Samyn, IRSNB IG 28 268 KKiun/9903; Kenya (Malindi), coll. J. Dumont, NHM 1981.2.19.48.

Field description. See Samyn & Vanden Berghe (2000: 9).

Taxonomic description and diagnosis. Mortensen (1940: 265–269, figs 136, 141b, 143; pl. 48, fig. 1; pl. 49, fig. 4; pl. 52, figs 1–2; pl. 53, figs 2–5; pl. 59, figs 1–12; pl. 60, figs 4–6; pl. 74, figs 10–14, 16, 19).

Ecology. *D. savignyi* is generally restricted to reef lagoons and shallow sea-grass beds with quiet and protected waters. *D. savignyi* can either be solitary, hiding under coral heads and in crevices, or occur in open areas, in association with conspecifics and its sister species *D. setosum*. It is a generalist herbivore, found grazing on sand and coral rubble. Active foraging occurs mainly at night (see also de Beer 1990), in order to avoid diurnal predators like the fishes *Balistapus undulatus* (Park, 1797) and *Rhinecanthus aculeatus* (Linnaeus, 1758). It is a littoral species, but has been recorded from depths

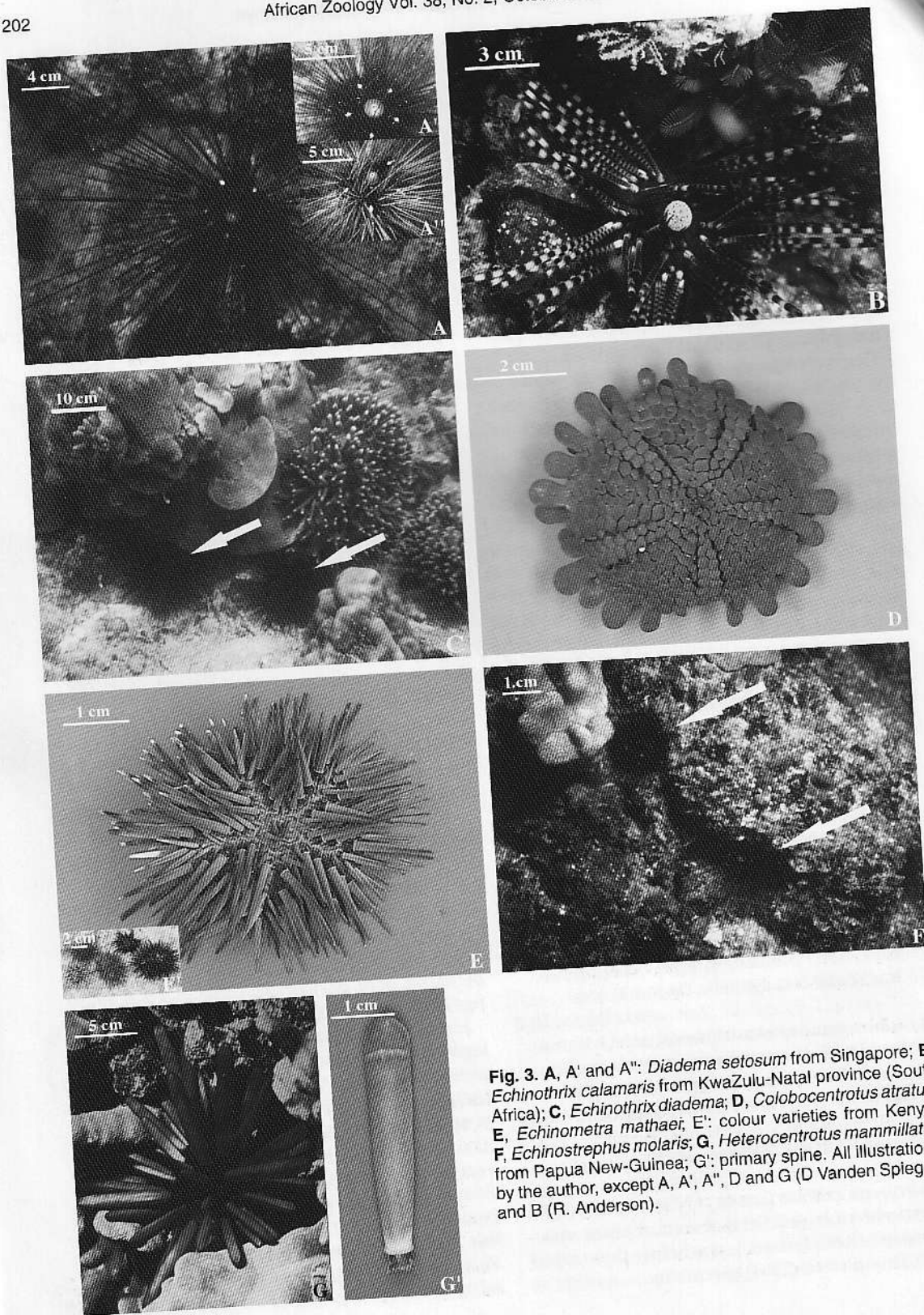


Fig. 3. A, A' and A'': *Diadema setosum* from Singapore; B, *Echinothrix calamaris* from KwaZulu-Natal province (South Africa); C, *Echinothrix diadema*; D, *Colobocentrotus atratus*; E, *Echinometra mathaei*, E': colour varieties from Kenya; F, *Echinostrephus molaris*; G, *Heterocentrotus mammillatus* from Papua New-Guinea; G': primary spine. All illustrations by the author, except A, A', A'', D and G (D Vanden Spiegel) and B (R. Anderson).

down to 70 m (Mortensen 1931).

Kenyan distribution. Well-known species along the entire Kenyan coast.

Distribution. Well-known tropical Indo-Pacific (excluding the Red Sea) species (Rowe & Gates 1995; Samyn & Vanden Berghe 2000).

Diadema setosum (Leske, 1778), Fig. 3A, A'

Material examined. Kenya (Kiunga Marine Reserve), iv 1999, coll. Y. Samyn, IRSNB IG 28 268 KKiu9902; Kenya (Watamu), coll. W.F. Humphreys, NHM 1979.2.5.160; Kenya (Watamu Marine Park), coll. W.F. Humphreys, MRAC 1628.

Field description. See Samyn & Vanden Berghe (2000: 10).

Taxonomic description and diagnosis. Mortensen (1940: 256–264, figs 140, 141a; pl. 49, figs 1–2; pls 50, 51, 52, fig. 3; pl. 53, fig. 1; pl. 54, figs 2–3; pl. 55, figs 1–6; pl. 56, figs 1–13; pl. 60, figs 1–2; pl. 61, fig. 1; pl. 73, figs 1, 10–12; pl. 74, figs 15, 17, 18, 20).

Ecology. In Kenya, *D. setosum* is found in the shallow and protected coral reef lagoons and in sea-grass beds.

Kenyan distribution. *D. setosum* is one of the most common species on Kenya's coral reefs (contrary to the situation in Aldabra; Sloan *et al.* 1979): it was recorded at all study sites, apart from Malindi and the Watamu Marine Park and Reserve.

Distribution. Well-known tropical Indo-West-central Pacific species (including the Red Sea) (Rowe & Gates 1995; Samyn & Vanden Berghe 2000).

Remarks. *D. setosum* and *D. savignyi* occur sympatrically throughout the tropical Indo-Pacific region and have been suspected of hybridizing (Mortensen 1940; Mayr 1954). This was unequivocally demonstrated by Lessios & Pearse (1996). Such hybridization renders identification ambiguous, but if colour dichotomies – as outlined by Pearse & Arch (1969) and Lessios & Pearse (1996) – are taken into account the two species can be readily distinguished in the field.

Genus **ECHINOTHRIX** Peters, 1853

Echinothrix calamaris (Pallas, 1774), Fig. 3B

Material examined. Kenya (Kiunga Marine Reserve), vii 1998, coll. Y. Samyn, IRSNB IG 28 268 KKiu9905; Kenya (Kilifi), coll. W.F. Humphreys, NHM 1979.2.5.162; Kenya (Malindi), coll. W.F. Humphreys, NHM 1981.2.19.35; Kenya (Watamu), coll. W.F. Humphreys, NHM 1979.2.5.163; Kenya (Watamu Marine Park, Turtle Bay), coll. W.F. Humphreys, MRAC 1622.

Field description. See Samyn and Vanden Berghe (2000: 10).

Taxonomic description and diagnosis. Mortensen (1940: 285–290, figs 147–149; pl. 39, fig. 1; pl. 40, pl. 41, figs 1–2; pl. 42, figs 1–5; pl. 43, fig. 3; pl. 44, figs 2–10; pl. 46, fig. 1; pl. 47, figs 1–3, 5; pl. 48, fig. 3; pl. 71, figs 5–8).

Ecology. *E. calamaris* from Kenya occurs in shallow protected waters of back reefs, where it hides in crevices during the day. Juveniles are often found on sea-grass beds. At night they forage on coral rubble close to the crevices.

Kenyan distribution. *E. calamaris* was seen in the Mombasa Marine Park and Reserve, in the Diani Marine Reserve and at Gazi Bay. Humphreys (1981) recorded it in the Watamu Marine Park and at Mida Creek and Kilifi. The largest numbers were found in the Mombasa Marine Park.

Distribution. Well-known tropical Indo-West-central Pacific species (including the Red Sea) (Rowe & Gates 1995; Samyn & Vanden Berghe 2000).

Echinothrix diadema (Linnaeus, 1758), Fig. 3C

Material examined. Kenya (Kiunga Marine Reserve), coll. Y. Samyn, IRSNB IG 28 268 KKiu9905; Mauritius, coll. Cultres, NHM 75.4.21.4.

Field description. See Samyn & Vanden Berghe (2000: 11).

Taxonomic description and diagnosis. Mortensen (1940: 290–295, figs 150–152; pl. 43, figs 1–2; pl. 44, fig. 1; pl. 45, figs 1–8; pl. 46, figs 2–4; pl. 47, figs 4, 6–7; pl. 48, fig. 4; pl. 71, figs 1, 3).

Ecology. *E. diadema* lives in shallow water on the inner reefs, in sheltered sea-grass beds and under coral boulders. When population numbers are high, *E. diadema* can form social groups; when population numbers are low, individuals tend to hide (e.g. under coral boulders). It feeds preferentially on sea grass and fleshy algae (pers. obs.) and on hard coral when the preferred food is scarce.

Kenyan distribution. *E. diadema* is very abundant in the Mombasa Marine Park and Reserve. It has also been observed at all other sites except the Watamu Marine Park and Reserve.

Distribution. Well-known tropical Indo-West-central Pacific species (including the Red Sea) (Rowe & Gates 1995; Samyn & Vanden Berghe 2000).

Family **ECHINOMETRIDAE** Gray, 1855

Diagnosis. Members of this family have a rigid, circular or oval test. Primary spines short and solid; few secondary spines. Ambulacral plates

compound. Pore pairs in arcs. Peristome covered with skin. Periproct with multiple plates. Primary tubercles imperforate. Gill slits shallow. Globiferous pedicellariae with unpaired lateral tooth.

Key to the Kenyan genera
(after Clark & Rowe 1971)

1. Slender, round, relatively short (up to 40 mm) primary spines 2
- 1'. Very robust or flattened primary spines 3
2. Longest spines on ambital plates; secondary spines very short (up to 10 mm) and scattered *Echinometra* Gray, 1825
- 2'. Longest spines in tuft on aboral side *Echinostrephus* A. Agassiz, 1863
3. Single row of short spatulate spines projecting from the ambitus to form a discontinuous ventrolateral fringe; extremely short truncated aboral spines, forming a compact, smooth, continuous mosaic *Colobocentrotus* Brandt, 1835
- 3'. Primary spines projecting horizontally but not restricted to a single row; aboral primary spines fewer and shorter but similar in shape to the ambital ones and not forming a mosaic *Heterocentrotus* Brandt, 1835

Genus COLOBOCENTROTUS Brandt, 1835

Colobocentrotus atratus (Linnaeus, 1758),
Fig. 3D

Material examined. Somalia (Mogadishu), coll. H. Gayne, NHM 1960.10.4.20; Zanzibar, Kirk, NHM 68.3.6-7; Mauritius (Barkly Island), coll. R.E. Vaughan, NHM 1952.3.24.4-5; Djibouti (as French Somalia), coll. P. Mars, MRAC 1088.

Diagnosis. Dark-purple to black, limpet-like sea urchin; rigid oval test with longest axis through ambulacra II and interambulacra 4; imperforate tubercles; 8-16 pore pairs in each arc aborally; single row of short spatulate spines projecting from the ambitus to form a discontinuous ventrolateral fringe; extremely short, truncated aboral spines, forming a compact smooth continuous mosaic; marginal spines with rounded, often swollen tips; tube-feet especially concentrated on lower side.

Taxonomic description. Mortensen [1943b (as *Colobocentrotus (Podophora) atratus* (Linnaeus, 1758): 434-439; pl. 50, figs 1-2; pl. 52, figs 1-2; pl. 65, fig. 7].

Ecology. Sedentary, found on reefs exposed to strong wave action and water turbulence, especially in the supra-intertidal splash zone or the

upper intertidal region, rarely submerged, but always wet (Birkeland 1989). This species appears to feed on crustose coralline algae (Birkeland 1989). However, no empirical data are available as yet. Humphreys (1981) noted that it can be found in dense aggregations among rocks along with *Echinometra mathaei* (de Blainville, 1825), *Stomopneustes variolaris* (Lamarck, 1816), *Heterocentrotus mammillatus* (Linnaeus, 1758) and *Heterocentrotus trigonarius* (Lamarck, 1816).

Kenyan distribution. Rare on Kenyan coral reefs, having been observed only in the supra-intertidal splash zone of the outer reefs in the Mombasa and Malindi Marine national parks. However, it is considered as abundant in Kenya (Ras Ngomeni) by Humphreys (1981).

Distribution. Locally, *C. atratus* is reported from Zanzibar by A. Agassiz (1872, in Ludwig 1899); from Madagascar by Hoffmann (1874, in Ludwig 1899); from the Seychelles by L. Agassiz (1846, in Ludwig 1899), A. Agassiz (1872, in Ludwig 1899) and A.M. Clark (1984); from Mauritius by Lorient (1883, in Clark & Rowe 1971) and Möbius (1880, in Clark & Rowe 1971); from Somalia (Mogadishu) by Tortonesi (1949) as *Colobocentrotus (Podophora) atratus*; from Aldabra by Sloan *et al.* (1979). Overall, *C. atratus* is a relatively well-known tropical Indo-West Pacific species (excluding the Red Sea) (A.H. Clark 1954; Clark & Rowe 1971; Rowe & Richmond 1997).

Genus ECHINOMETRA Gray, 1825

Echinometra mathaei (de Blainville, 1825),
Fig. 3E, E'

Material examined. Kenya (Kiunga Marine Reserve), coll. Y. Samyn, IRSNB IG 28 268 KKiun9913; Kenya (Malindi Marine Park), coll. Y. Samyn, MRAC1677/KMalE9808; Kenya (Kanamai), coll. Y. Samyn, MRAC1678/KKanE9702; Kenya (Mombasa Marine Park), coll. Y. Samyn, MRAC1679/KMomE9809; Kenya (Gazi Bay), coll. Y. Samyn, MRAC1680/KGazE9701; Kenya (Shimoni Marine Reserve), coll. Y. Samyn, MRAC1681/KShimE9807; Kenya (Watamu Marine Park), coll. W.F. Humphreys, NHM 1979.2.5.169, 1979.2.5.170-174; Kenya (Watamu, Kibirijini), coll. W.F. Humphreys, NHM 1979.2.5.180; Kenya (Watamu, Turtle Bay), coll. W.F. Humphreys, NHM 1979.2.5.175-179; Kenya (Malindi & vicinity), coll. J. Dumont, NHM 1981.2.19.49-50; Kenya (Mombasa Marine Reserve), coll. L.F. Brown, NHM 1956.7.21.43; Kenya (Mombasa), coll. B.M.E

Exped., NHM 1931.6.16
 R. Bass, NHM 1987.3.11.2; K
 Park), coll. W.F. Humphreys, M
 (Dar Es Salaam), coll. H. Sassoon,
 chelles (Mahé), coll. Mission MR
 1966, MRAC 1171-1175.
 Field description. See Samyn
 (2000: 11).
 Taxonomic description
 (1943b: 381-393, figs
 pl. 47, figs 1-4; pl. 6
 Ecology. Relativ
 self-excavated
 or among b
 corals (B
 outside
 of d

Exped., NHM 1931.6.16.7; Kenya (Shimoni), coll. R. Bass, NHM 1987.3.11.2; Kenya (Watamu marine Park), coll. W.F. Humphreys, MRAC 1585; Tanzania (Dar Es Salaam), coll. H. Sassoon, MRAC 1069; Seychelles (Mahé), coll. Mission MRAC-ULB VII/IX 1966, MRAC 1171–1175.

Field description. See Samyn & Vanden Berghe (2000: 11).

Taxonomic description and diagnosis. Mortensen (1943b: 381–393, figs 185–194; pl. 42, figs 1–10; pl. 47, figs 1–4; pl. 65, figs 16–26).

Ecology. Relatively sedentary, often found in self-excavated dwellings and grooves in the reef, or among branches within colonies of branching corals (Birkeland 1989). Large populations live outside their burrows, feeding on the surface of dead corals. A.M. Clark (1984) reported on *E. mathaei* living on sand patches of the reef flats, a habitat type not found in Kenya. Smaller populations feed mainly on boring and encrusting algae, coral, and sometimes drift algae (Birkeland 1989). Sloan *et al.* (1979) reported on coexistence with the gnathophyllid shrimp *Gnathophyllum americanum* Guérin, 1856, and the porcellanid crab *Petrolisthes virgatus* Paulson, 1876.

Kenyan distribution. Very abundant species all along the Kenyan coast (see also McClanahan & Shafir 1990).

Distribution. Well-known tropical Indo-Pacific species (including the Red Sea) (Samyn & Vanden Berghe 2000).

Remarks. *E. mathaei* is renowned for its colour variations (e.g. H.L. Clark 1925, 1946; Fig. 3E'). It has been suggested that these different colour forms are gametically incompatible, and that *E. mathaei* may therefore be a species complex rather than a single species (Uehara & Shingaki 1985; Uehara *et al.* 1986). Palumbi & Metz (1991) investigated the evolutionary distance between the four known morphological types of *E. mathaei* (specimens from Hawaii, Tahiti, Guam and Okinawa) and concluded that the observed divergence was only 1–3%. Arakaki *et al.* (1998) investigated whether the colour variations, as found in Mauritius (type locality of *E. mathaei*) and Okinawa, represent more than one species. Through field surveys in Mauritius, Arakaki *et al.* (1998) were able to carry out cross-fertilization experiments between the three Mauritian and the four Okinawan colour forms. They discovered that only the brown- and the violet-spined Mauritian colour forms successfully cross-fertilize with one of the colour forms of Okinawa. Arakaki *et al.*

(1998) concluded that the violet- and brown-spined specimens from Mauritius represent *E. mathaei sensu stricto* and that the black-spined species from Mauritius possibly represents another species. Unfortunately, they did not take into account the possibility of natural hybridization between echinoid species [see, for instance, Mayr (1954) and Strathmann (1979, 1981) for morphological evidence of echinoid hybrids, and Lessios & Pearse (1996) for genetic proof of gene introgression in echinoids], nor did they assess the genetic heterogeneity of the different colour forms [see Watts *et al.* (1990) for electrophoretic studies on Australian *E. mathaei* subpopulations, and Lessios *et al.* (1996, 1998) for electrophoretic and nucleotide sequence analysis of diademata specimens from either side of the East Pacific Barrier]. As such, no unambiguous proof regarding the existence of several *Echinometra* spp. along the East African coast exists at present.

I was unaware of this intriguing problem when I collected specimens along the Kenyan coast. The specimens in the present collection (with spine colouration varying from black to brown to green to violet, sometimes with white tips) are too few in number to allow a detailed assessment of variation, and consequently the colour forms are here tentatively treated a single species.

Genus *ECHINOSTREPHUS* A. Agassiz, 1863

Echinostrephus molaris (de Blainville, 1825), Fig. 3F

Material examined. Kenya (Kiunga Marine Reserve), coll. Y. Samyn, IRSNB IG 28 268 KKiun9914; Kenya (Watamu, Mida Channel), coll. W.F. Humphreys, NHM 1979.2.5.165; Tanzania (Pemba Channel), coll. W.F. Humphreys, NHM 1979.1.25-46-48; Kenya (Watamu, Turtle Bay), coll. W.F. Humphreys, NHM 1979.2.5.166; Tanzania (Pemba Channel), coll. W.F. Humphreys, MRAC 1591.

Field description. See Samyn & Vanden Berghe (2000: 12).

Taxonomic description and diagnosis. Mortensen (1943b: 311–316, figs 149a,b, 150a,b; pl. 35, figs 1–10; pl. 58, figs 1, 2, 4, 9).

Ecology. This species is always found in deep, self-made crevices in hard substrates. It feeds primarily on drift algae, which it captures with the spines and pedicellariae. It was recorded from a depth of 5 m, mostly in deeper waters with strong currents.

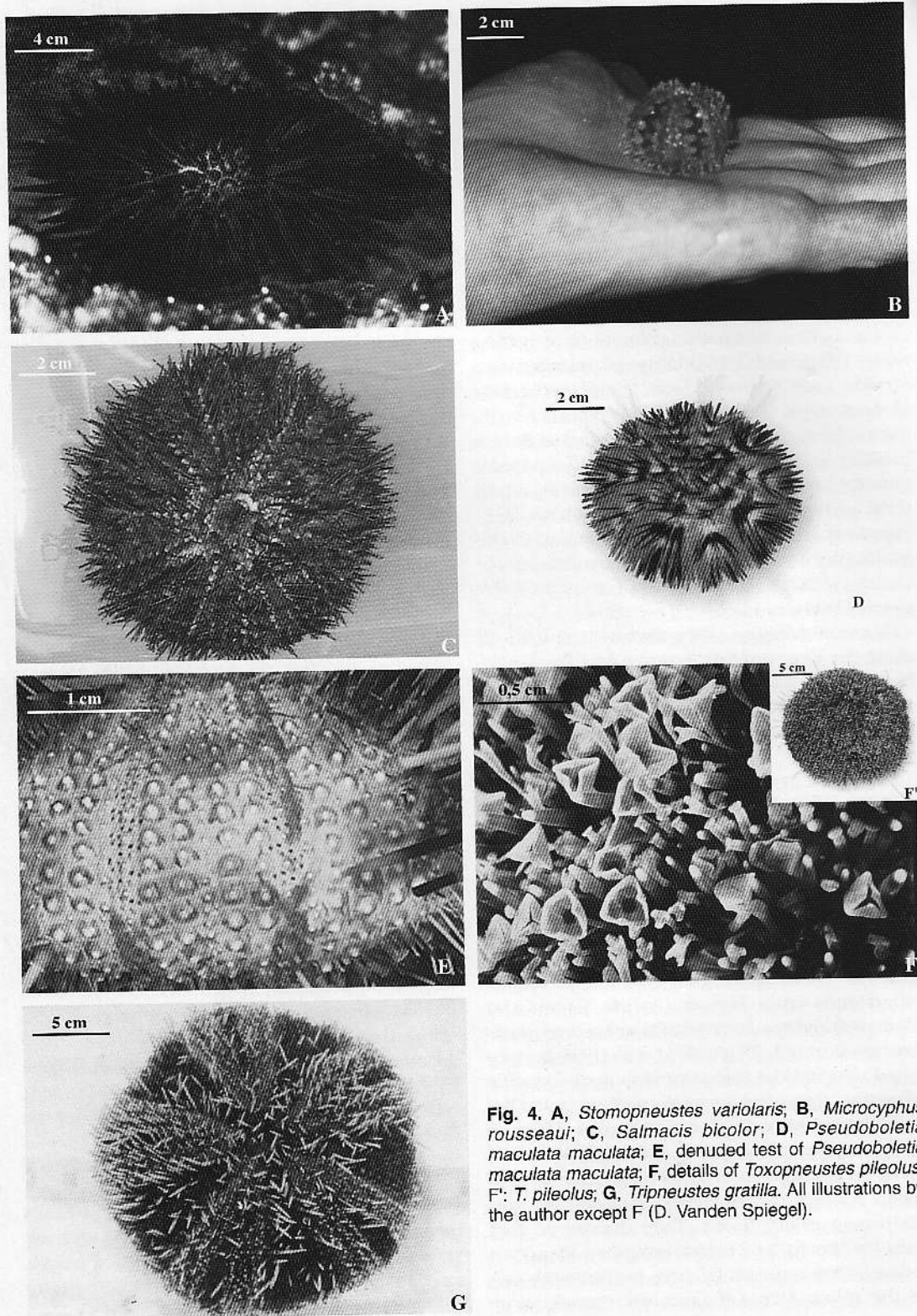


Fig. 4. A, *Stomopneustes variolaris*; B, *Microcyphus rousseaui*; C, *Salmacis bicolor*; D, *Pseudoboletia maculata maculata*; E, denuded test of *Pseudoboletia maculata maculata*; F, details of *Toxopneustes pileolus*; F': *T. pileolus*; G, *Tripneustes gratilla*. All illustrations by the author except F (D. Vanden Spiegel).

Kenyan distribution
Gazi Bay (Samryn C
Distribution: Well-
Pacific species (includin
Vanden Berghe 2000).
Genus **HETEROCENTROTUS**
Heterocentrotus mam
1759), Fig. 3G, G'
Material exam
(primarily
NHM
V

Kenyan distribution. Present at all sites except Gaz Bay (Samyn & Vanden Berghe 2000).

Distribution. Well-known tropical, Indo-West Pacific species (including the Red Sea) (Samyn & Vanden Berghe 2000).

Genus **HETEROCENTROTUS** Brandt, 1835

Heterocentrotus mammillatus (Linnaeus, 1758), Fig. 3G, G'

Material examined. Kenya (Mombasa Marine Park), coll. Y. Samyn, MRAC1682/KMomE9703 (primary spine only); Mauritius, coll. F. Cole, NHM 42.12.26.41-42; Mauritius, coll. unknown, NHM 55.4.4.10/11/14; Mauritius, coll. unknown, NHM 60.11.7.39; Djibouti (as French Somalia), coll. P. Mars, MRAC 1087, 1089, 1091, 1092.

Field description. See Samyn & Vanden Berghe (2000: 14, pl. 1D).

Taxonomic description and diagnosis. Mortensen (1943b: 409-420, figs 204, 205a, 206, 207a,b, 208a, 209, 210; pl. 51, figs 1-6; pl. 52, figs 6-8; pl. 66, figs 7, 9-20).

Ecology. Generally herbivorous, feeding on filamentous algae, found in shallow subtidal regions of reefs subjected to a strong wave surge (Birkeland 1989). In the Mombasa Marine Park and in the Kiunga Marine Reserve, *H. mammillatus* was also found in sheltered lagoons, under live coral heads.

Kenyan distribution. Rare in Kenya, having been observed only once in the Kiunga Marine Park, and once in the Mombasa Marine Park.

Distribution. Well-known tropical Indo-Pacific species (including the Red Sea) (A.H. Clark 1954; Samyn & Vanden Berghe 2000).

Heterocentrotus trigonarius (Lamarck, 1816)

Material examined. We did not observe this species along the Kenyan coastline. In the NHM catalogue (specimens not examined), A.M. Clark noted several records from the western Indian Ocean (Kenya, Aldabra, Mauritius) and from the Red Sea.

Diagnosis (after Clark & Rowe 1971). Primary spines projecting horizontally but not restricted to a single row; primary spines smooth, massive, blunt, and slightly tapering toward the tip; aboral primary spines slightly shorter, not truncated and not forming a mosaic; secondary spines brownish and scattered over total test surface; rigid oval test with longest axis through ambulacrum II and interambulacrum 4; peristome skin-covered; primary tubercles imperforate and uncrenulate,

gradually decreasing in size aborally; shallow gill slits; periproct with multiple plates; tridentate pedicellariae leaf-shaped valves, contiguous over entire length; usually 15-16 pore pairs in each arc in the ambital region.

Taxonomic description. Mortensen (1943b: 420-425; pl. 50, figs 3-6; pl. 52, figs 4-5; pl. 53, pl. 56 figs 1-6, 8).

Ecology. Generally herbivorous, feeding on filamentous algae, found in shallow subtidal regions of reefs exposed to a strong wave surge (Birkeland 1989).

Kenyan distribution. Not encountered during present study. Previously reported by Humphreys (1981) as abundant at mid-eulittoral cliffs of a medium-energy shore at Ras Ngomeni.

Distribution. Locally *H. trigonarius* has been reported from Zanzibar by Pfeffer (1896, in Ludwig 1899); from Madagascar by A. Agassiz (1872, in Ludwig 1899); from Mauritius by Lorient (1883, in Clark & Rowe 1971) and Michelin (1845, in Clark & Rowe 1971); from Madagascar (Diégo Bay) by Lambert (1921/22); from Somalia (Mogadishu) by Tortonese (1949); from Aldabra (Point Hodul) by Sloan *et al.* (1979) and from the Seychelles by A.M. Clark (1984). Overall, *H. trigonarius* is a well-known tropical Indo-West Pacific species (including the Red Sea) (A.H. Clark 1954; Clark & Rowe 1971; Price 1982; Rowe & Gates 1995).

Remarks. A.H. Clark (1954) noted that the habits of *H. mammillatus* and *H. trigonarius* are apparently the same, and that the absence of *H. mammillatus* in the central Polynesian region is problematic. In the distribution table of Clark & Rowe (1971) the same discontinuous distribution was noted.

Family **PARASALENIIDAE** A. Agassiz, 1863

Diagnosis. This family comprises rather small (horizontal diameter less than 30 mm), markedly elongated species. Interambulacral plates compound, covered by several solid, primary spines and scattered secondary spines. Primary tubercles imperforate and uncrenulate, smaller on the ambital ambulacral plates. Gill slits shallow. Periproct with only four (3-5) plates. Globiferous pedicellariae with no lateral teeth.

Genus **PARASALENIA** A. Agassiz, 1863

Parasalenia gratiosa A. Agassiz, 1863

Material examined. This species was not observed along the Kenyan coastline. In the NHM catalogue (specimens not examined) A.M. Clark noted

several records from the western Indian Ocean (Kenya, Zanzibar, Aldabra Maldives and Chagos Archipelago).

Diagnosis (after Clark & Rowe 1971). Small (horizontal diameter less than 30 mm), but markedly elongated sea urchin; uniformly dark-coloured primary spines with lengths about equal to the maximum horizontal diameter of test. Primary spines of juveniles with tendency towards banding. Globiferous pedicellariae with no lateral teeth. Naked test: periproct with only four plates, uncrenulate and imperforate tubercles.

Taxonomic description. Mortensen (1943b: 269–270; pl. 29, figs 5–11; pl. 30, fig. 1; pl. 31, figs 3–5, 7–13; pl. 57, figs 4–10, 17).

Ecology. Sloan *et al.* (1979) reported *P. gratiosa* on coral rubble, at depths of about 10 m.

Kenyan distribution. Reported by Humphreys (1981) from the Watamu Marine Park.

Distribution. Locally, *P. gratiosa* is reported from Zanzibar by A. Agassiz (1863, in Ludwig 1899); from Madagascar by Meissner (1892, in Ludwig 1899) and from Aldabra (Passe Dubois) by Sloan *et al.* (1979). Overall, *P. gratiosa* is a relatively poorly known species from the tropical Indo-West Pacific (excluding the Red Sea) (Clark & Rowe 1971; Rowe & Gates 1995; Rowe & Richmond 1997).

Family STOMOPNEUSTIDAE Pomel, 1883

Description. Members of this family have large, round and rigid tests (horizontal diameter up to 100 mm). Peristome skin-covered. Primary spines massive. Tubercles imperforate and uncrenulate. Ambulacral tubercles usually as large as interambulacral tubercles. Ambulacra compound, trigeminate or polyporous. Epiphyses not forming a complete bridge at the upper end of each of the five pyramids of the Aristotle's lantern.

Genus STOMOPNEUSTES L. Agassiz, 1841

Stomopneustes variolaris (Lamarck, 1816), Fig. 4A

Material examined. Kenya (Kiunga Marine Reserve), coll. Y. Samyn, IRSNB IG 28 268 KKiu9910; Kenya (Malindi Marine Park), coll. Y. Samyn, MRAC1683/KMalE9810; Kenya (Mombasa Marine Reserve), coll. Y. Samyn, MRAC1684/KMomE9704; Kenya (Gazi Bay), coll. Y. Samyn, MRAC1685/KGazE9811; Kenya (Watamu Marine Park), coll. W.F. Humphreys, NHM 1979.2.5.230; Kenya, coll. unknown, NHM 1981.3.10.16; Tanzania (Zanzibar, Coopers), coll. P.J. Herring, NHM 1965.1.12.14;

Tanzania (Dar Es Salaam), coll., L. Burgeon, MRAC 3.

Field description. See Samyn & Vanden Berghe (2000: 16).

Taxonomic description and diagnosis. Mortensen 1935: 507–512, fig. 301, 302; pl. 71, figs 3–5; pl. 72, figs 1, 2; pl. 89, figs 16–26).

Ecology. Common in hollows along the shallow eulittoral and sublittoral fringe on exposed coral platforms (A.M. Clark 1984; pers. obs.). In Kenya, *S. variolaris* is sometimes found on coral rubble and in sea-grass beds. Sloan *et al.* (1979) reported the presence of two species of crustaceans in the burrows: the gnathophyllid shrimp *Gnathophyllum americanum* Guérin, 1856, and the porcellanid crab *Petrolisthes virigatus* Paulson, 1876.

Kenyan distribution. This species is quite abundant all along the Kenyan coast: it was observed in the Kiunga Marine Reserve, Malindi Marine Park, Mombasa Marine Park and Reserve and in Gazi Bay. Humphreys (1981) reported it as 'extremely numerous and widespread' from Kilifi, Watamu Marine Park, Mida Creek and Kibirijini.

Distribution. Well-known tropical, Indo-West Pacific species (Samyn & Vanden Berghe 2000).

Family TEMNOPLEURIDAE A. Agassiz, 1872

Diagnosis. Members of this family are characterized by interambulacral plates with numerous short and solid primary spines per plate and scattered secondary spines. Peristome always skin-covered. Primary tubercles imperforate, slightly crenulate. Distinct pits, troughs or pores at the angles of the sutures of the plates.

Key to the Kenyan genera (after Clark & Rowe 1971)

1. Conspicuous naked interambulacral areas; tubercles indistinctly crenulate, sutural pores inconspicuous
..... *Microcyphus* L. Agassiz, 1841
- 1'. No naked interambulacral areas; tubercles slightly but distinctly crenulate; sutural pores, small but distinct
..... *Salmacis* L. Agassiz, 1841

Genus MICROCYPHUS L. Agassiz, 1841

Microcyphus rousseaui L. Agassiz, 1846, Fig. 4B

Material examined. Kenya (Kiunga Marine Reserve), coll. Y. Samyn, IRSNB IG 28 268 KKiu9906–07; Tanzania (Zanzibar, Coopers), coll. P.J.

Herring, NHM 1965.1.12.14;
coll. Robertson, NHM 1952.11.18.
Field description. See Samyn & Vanden Berghe (2000: 14).
Taxonomic description and diagnosis (1943a: 155–159, fig. 84; pl. 12, figs 18–20, 23–24).
Ecology. A littoral species restricted to coral humps on which it feeds (pers. obs.). Contrary to Herring (1979) *M. rousseaui* is 'robust' and lives out of water provided with a network of crevices and overhangs. It was observed *M. rousseaui* at depths of 7 m. It appears to be a common species in protected areas. Specimens from KwaZulu-Natal are deposited in the University of Cape Town.

Herring, NHM 1965.1.12.17; Tanzania (Zanzibar), coll. Robertson, NHM 1952.11.18.52.

Field description. See Samyn & Vanden Berghe (2000: 14).

Taxonomic description and diagnosis. Mortensen (1943a: 155–159, fig. 84; pl. 12, figs 18–25; pl. 47, figs 18–20, 23–24).

Ecology. A littoral species, restricted to protective coral lumps on which it feeds (Herring 1972; pers. obs.). Contrary to Herring's (1972) statement that *M. rousseaui* is 'robust enough to tolerate periods out of water providing it can utilize the shelter of crevices and other surface irregularities'; we observed *M. rousseaui* only at depths exceeding 7 m. It appears that *M. rousseaui* tends to leave its protected shelter at night, since the Kiunga specimens were seen only during the night. In KwaZulu-Natal (South Africa), the same behaviour was observed (pers. obs.).

Kenyan distribution. Very rare in Kenya, only reported in the Kiunga Marine Reserve (see Samyn & Vanden Berghe 2000).

Distribution. Locally reported from Madagascar as *Microcyphus decaryi* Lambert, 1923, by Lambert (1923), from Zanzibar by Herring (1972), from Somalia by Tortonesi (1980). Overall, *M. rousseaui* is a species not too often found. Its distribution comprises the tropical Indo-West Pacific Ocean (including the Red Sea) (Clark & Rowe 1971; Price 1982; Rowe & Richmond 1995; Samyn & Vanden Berghe 2000).

Genus *SALMACIS* L. Agassiz, 1841

Salmacis bicolor L. Agassiz in Agassiz & Désor, 1841, Fig. 4C

Material examined. Kenya (Gazi Bay), coll. Y. Samyn, MRAC1687/KGazE9707; Kenya (Kanamai), coll. Y. Samyn, MRAC1686/KKanE9812; Kenya (Mombasa), coll. BMEA Exped., NHM 1931.6.16.10/11; Tanzania (Zanzibar, Wasin), coll. Crossland, NHM 1903.4.2.3; Tanzania (Zanzibar), coll. Crossland, NHM 1903.4.2.6.

Diagnosis. Primary tubercles slightly but distinctively crenulate; conspicuous pits at the angles of the sutures; each ambulacral and ambital plate with a primary tubercle; pores distinct; globiferous narrow bladed pedicellariae with one lateral tooth on each side; circular test, with a dense covering of short spines; spines around peristome markedly flattened; spines red or purple around base with attractive yellow banding towards distal ends.

Taxonomic description. Mortensen (1943a: 112–

116; pl. 4, figs 1–8; pl. 5, figs 1–3, 10–12; pl. 6, figs 1–8; pl. 46, figs 1, 13, 16, 19, 20).

Ecology. *S. bicolor* was found in a sheltered lagoon, amongst sea grass. It was also seen between shallow coral patches in Kanamai.

Kenyan distribution. *S. bicolor* is a uncommon echinoid in Kenya. Only two individuals were spotted: one in Kanamai and one in Gazi Bay.

Distribution. Locally *S. bicolor* is reported from Zanzibar by Martens (1869, in Ludwig 1899) and A. Agassiz (1872, in Ludwig 1899); from Madagascar (Nosy-Faly) by Hoffmann (1874, in Ludwig 1899, in Lambert 1923), from Mauritius by Lorient (1876, in Clark & Rowe 1971); from Mozambique (Kerimba Archipelago) by Brown (1910, in Clark & Rowe 1971); from Somalia by Tortonesi (1951); from the Seychelles by A.M. Clark (1984). Overall, *S. bicolor* is a relatively well-known tropical Indo-West Pacific species (including the Red Sea) (Clark & Rowe 1971; Price 1982; Rowe & Richmond 1997).

Remarks. Although the NHM holds a voucher specimen collected at Mombasa, we could not retrieve any record of *S. bicolor* from Kenya in the literature. *S. bicolor* is thus here reported for the first time from Kenya.

Family TOXOPNEUSTIDAE Troschel, 1872

Diagnosis. Members of this family are characterized by round tests with relatively short primary spines forming a dense coat. Ambulacral plates trigeminate or polyporous. Ambulacral and interambulacral tubercles uncrenulate and imperforate, forming regular vertical series. Gill slits sharp and deep. Globiferous pedicellariae either very numerous or extremely large, without lateral teeth.

Key to the Kenyan genera (after Clark & Rowe 1971)

1. Ambulacral plates with four pore pairs; test with large blotches of reddish brown, however not forming bands
..... *Pseudoboletia* Troschel, 1869
- 1'. Ambulacral plates with three pore pairs each 2
2. Test high, almost globular; only one in three or four ambulacral plates with a primary tubercle; pore pairs in horizontal arcs; globiferous pedicellariae not enlarged but extremely numerous
..... *Tripneustes* L. Agassiz, 1841
- 2'. Test low; every second ambulacral plate with a primary tubercle; globiferous pedi-

cellariae very large and conspicuous
 *Toxopneustes* L. Agassiz, 1841

Genus PSEUDOBOLETIA Troschel, 1869

Pseudoboletia maculata maculata Troschel, 1869, Fig. 4D, E

Material examined. Kenya (Kanamai), coll. Y. Samyn, MRAC1688/KKanE9813.

Diagnosis. Large-bodied circular sea urchin (horizontal diameter up to 80 mm) with solid but short primary spines; primary tubercle imperforate and uncrenulate, present over entire test length; ambulacral plates polyporous (four pore pairs per arc); test yellowish brown with large patches of reddish brown, largest at the ambitus.

Taxonomic description. Mortensen (1943a: 532–534; pl. 42, figs 4–5; pl. 55, figs 2, 5, 6, 16, 17, 21).

Ecology. *P. maculata maculata* was found in a shallow, 1-m deep, sea-grass bed, covered by sea-grass debris. Rowe (in Rowe & Gates 1995) recorded a depth range of 10–70 m.

Kenyan distribution. This species uncommon in Kenya, the only record being from Kanamai. First record for the Kenyan coast.

Distribution. From Kenya (present record) to Sri Lanka and Japan (Clark & Rowe 1971). More recently, Sastry (1991) noted its distribution from Lakshadweep to the Phillipines and North Australia; Rowe (in Rowe & Gates 1995) similarly noted a tropical, east Indo-West Pacific distribution. With this first record of *P. maculata* west of Lakshadweep, this species thus has a tropical Indo-West Pacific distribution (excluding the Red Sea).

Remarks. Mortensen (1943a) noted that *Pseudoboletia indiana* (Michelin, 1862) (species characterized by the absence of dark spots on its test) is known from Mauritius and Hawaii, whereas *P. maculata* is expected to occur in the Malay region. The present record supports Mortensen's (1943a) claim that *P. maculata* and *P. indiana* should be retained as separate species (see also Rowe & Gates 1995). The present voucher specimen represents the first record for the western Indian Ocean. As Pawson (1978) reduced *P. atlantica* Clark, 1912, to a subspecies of *P. maculata*, the Indo-Pacific form must be referred to as *P. maculata maculata*.

Genus TOXOPNEUSTES L. Agassiz, 1841

Toxopneustes pileolus (Lamarck, 1816), Fig. 4F, F'

Material examined. Kenya (Kiunga Marine Re-

serve), coll. Y. Samyn, IRSNB IG 28 268 KKiun9911; Kenya (Malindi Marine Reserve), coll. Y. Samyn, MRAC1689/KMaIE9706; Kenya (Gazi Bay), coll. Y. Samyn, MRAC1690/KGazE9705; Kenya (Watamu), coll. W.F. Humphreys, NHM 19-79.2.5.164; Tanzania (Zanzibar), coll. M.D. Richmond, NHM 1995.492; Kenya (Watamu Marine National Park, Turtle Bay), coll. W.F. Humphreys, MRAC 1621; Seychelles (Mahé), coll. Mission MRAC-ULB VII/IX 1966, MRAC 1107, 1108.

Field description. See Samyn & Vanden Berghe (2000: 15).

Taxonomic description and diagnosis. Mortensen, (1943a: 472–480, figs 240b, 293a, 294, 295a, 296, 297a,b, 298; pl. 26, fig. 3; pl. 27, figs 1–4; pl. 28, figs 1, 2; pl. 29, figs 1–5; pl. 30, figs 1–4; pl. 31, fig. 9; pl. 33, figs 5, 6; pl. 54, figs 1, 3–6, 8–10, 13–16; pl. 55, fig. 13).

Ecology. The Kenyan specimens were always found in shallow waters, on coarse rubble.

Kenyan distribution. *T. pileolus* is a common species in Kenya. Humphreys (1981) recorded this species as 'widely occurring over the reef flats of Watamu Marine Park' and in 'dense aggregations on top of the patch reef in Malindi Marine Park'. I failed to observe this species in the Watamu Marine Park.

Distribution. *T. pileolus* is a well-known Indo-West Pacific species (excluding the Red Sea, but including the Arabian Sea) (Price 1982; Samyn & Vanden Berghe 2000).

Genus TRIPNEUSTES L. Agassiz, 1841

Tripneustes gratilla (Linnaeus, 1758), Fig. 4G

Material examined. Kenya (Kiunga Marine Reserve), coll. Y. Samyn, IRSNB IG KKiun9908-09-12; Kenya (Kanamai), coll. Y. Samyn, MRAC1691/KGazE9707; Kenya (Watamu), coll. W.F. Humphreys, NHM unnumbered; Kenya (Mombasa Marine Reserve, as Nyali), coll. P. Cambridge, NHM 1967.4.4.44–46; Kenya (Wasin Channel), coll. J.D. Taylor, NHM 1973.10.4.53–55; Kenya (Malindi and vicinity), coll. J. Dumont, NHM 1981.2.19.46; Kenya (Watamu Marine Reserve, Turtle Bay), coll. W.F. Humphreys, MRAC 1623; Seychelles (Mahé), Mission MRAC-ULB VII/IX 1966, MRAC 1109, 1110.

Field description. See Samyn & Vanden Berghe (2000: 15).

Taxonomic description and diagnosis. Mortensen (1943a: 500–508, figs 306, 307; pl. 33, figs 1–3; pl. 34, figs 2–6; pl. 35, figs 3–4; pl. 37, figs 1–2, 4–10; pl. 38, figs 1–4; pl. 56, fig. 11).

Ecology. *T. pileolus* is a common species in Kenya. Humphreys (1981) recorded this species as 'widely occurring over the reef flats of Watamu Marine Park' and in 'dense aggregations on top of the patch reef in Malindi Marine Park'. I failed to observe this species in the Watamu Marine Park.
Distribution. *T. pileolus* is a well-known Indo-West Pacific species (excluding the Red Sea, but including the Arabian Sea) (Price 1982; Samyn & Vanden Berghe 2000).

Ecology. *T. gratilla* is restricted by its food preferences to shallow sea-grass beds, particularly *Thalassodendron ciliatum* (Herring 1972; pers. obs.). As a response to the high light intensities associated with the shallow (up to 4 m max.) clear waters, *T. gratilla* covers its aboral side with fragments of sea grass, and also with shells.

Kenyan distribution. *T. gratilla* is, after *E. mathaei*, perhaps the most common sea urchin in Kenya. However, *T. gratilla* is restricted to shallow sea-grass beds while *E. mathaei* is invariably associated with hard substrates.

Distribution. Well-known tropical, Indo-West Pacific species (including the Red Sea) (Samyn & Vanden Berghe 2000).

DISCUSSION

Identification of echinoderm specimens from the Indo-West Pacific has to date relied heavily on the 1971 monographic work of Clark & Rowe. It is, however, in need of revision in the light of more recent discoveries. This is especially evident when dealing with the fauna from a limited area such as the Kenyan coast.

Based on collecting and observations in the field, the present study of regular echinoids from Kenya resulted in the recognition of 20 species belonging to six families and 16 genera. Although the collection is small, it is relatively complete since only two species known to occur in Kenya, *Heterocentrotus trigonarius* and *Parasalenia gratiosa*, were not collected during the surveys. The list of echinoids provided by Humphreys (1981) is enlarged by five species, *Phyllacanthus imperialis*, *Prionocidaris pistillaris*, *Microcyphus rousseaui*, *Salmacis bicolor* and *Pseudoboletia maculata maculata*. Two of these, *P. imperialis* and *M. rousseaui*, were recently reported as new records for Kenya (Samyn & Vanden Berghe 2000). *P. pistillaris* and *S. bicolor* are here added to the Kenyan fauna, while *P. maculata maculata* are additions to the fauna of the western Indian Ocean. None of the species recorded here is limited to Kenya and/or the western Indian Ocean; instead, all the species have a wide tropical, Indo-Pacific distribution (Clark & Rowe 1971).

Although six further species, *Salmaciella dussimieri* (L. Agassiz, 1846), *Temnopleurus toreumaticus* (Leske, 1778), *Temnotrema siamense* (Mortensen, 1904), *Cyrtechinus verruculatus* (Lütken, 1864), *Gymnechinus robillardii* (de Loriol, 1883) and *Pseudoboletia indiana* (Michelin, 1862) have been reported from the western Indian Ocean (Rowe, in Rowe & Richmond, 1997), it remains unknown

whether these also occur along the Kenyan coast.

In conclusion, the shallow-water regular echinoid fauna of Kenya currently comprises 22 species, but the extensive mangrove forests could well hold some surprises.

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