

ROYAUME BELGE — ROYAL MUSEUM FOR MIDDLE AFRICA — TERVUREN, BELGIË
DOCUMENTATION ZOOLOGIQUE — N° 19 — 1981

39

THE ECHINODERMS
OF KENYA'S
MARINE PARKS
AND ADJACENT REGIONS

by

W.F. HUMPHREYS

MUSEE ROYAL DE L'AFRIQUE CENTRALE — TERVUREN, BELGIQUE
DOCUMENTATION ZOOLOGIQUE — N° 19 — 1981

VLIZ (vzw)
VLAAMS INSTITUUT VOOR DE ZEE
FLANDERS MARINE INSTITUTE
Oostende - Belgium

66712

THE ECHINODERMS
OF KENYA'S
MARINE PARKS
AND ADJACENT REGIONS

THE ECHINODERMS OF KENYA'S MARINE PARKS
AND ADJACENT REGIONS

W.F. HUMPHREYS

Western Australian Museum, Francis Street,
Perth, Western Australia

VLIZ (vzw)
VLAAMS INSTITUUT VOOR DE ZEE
FLANDERS MARINE INSTITUTE
Oostende - Belgium

66712

THE ECHINODERMS
OF KENYA'S
MARINE PARKS
AND ADJACENT REGIONS

by

W.F. HUMPHREYS

Western Australian Museum, Francis Street,
Perth, Western Australia

CONTENTS

	Pages
SUMMARY	IX
INTRODUCTION	1
COLLECTION AREAS	3
DISTRIBUTION OF SPECIES BY HABITAT	7
SYSTEMATIC ACCOUNT	15
CLASS CRINOIDEA	16
Subclass Asteroidea	16
Subclass Ophiuroidea	20
CLASS ECHINOIDEA	27
CLASS HOLOTHURIOIDEA	32
ACKNOWLEDGEMENTS	37
REFERENCES	39

SUMMARY

The echinoderm collection made during the Bangor-Watamu Expedition is documented. For many of the 107 species recorded, notes are given on habitat, appearance in life and biotic relations. Most of the collection was made in the Watamu Marine Park, Kenya and smaller collections made at several locations between Lamu and Zanzibar. The species distribution is tabulated according to habitat and abundance. Full systematic and biological references are omitted as they have been fully referenced in several recent works.

... than recently established
Watamu Marine Park, Kenya (4°S, 40°E) and the associated Bangor
Iringid Nida Creek. Further observations were made at the Malindi Marine
Park, Lamu, Was Ngomai, Kilifi, Kitambala and Shimoni in Kenya and
Erko Zanzibar and the Zanzibar Channel in Tanzania (Fig. 1).



Fig. 1. Location of collecting sites in the eastern Indian Ocean.

INTRODUCTION

This report documents the echinoderm collection made during the University College of North Wales "Bangor-Watamu Expedition" in 1969. It correlates biological information with an annotated species list. Such information is sparse for the East African region save for those from Zanzibar (HERRING, 1972) and for Inhaca Island in Moçambique (BALINSKY, 1958).

Most observations come from the then recently established Watamu Marine Park, Kenya ($40^{\circ}\text{E } 3^{\circ}24'\text{S}$) and the associated mangrove fringed Mida Creek. Further observations were made at the Malindi Marine Park, Lamu, Ras Ngomeni, Kilifi, Kikambala and Shimoni in Kenya and from Zanzibar and the Zanzibar Channel in Tanzania (fig. 1).

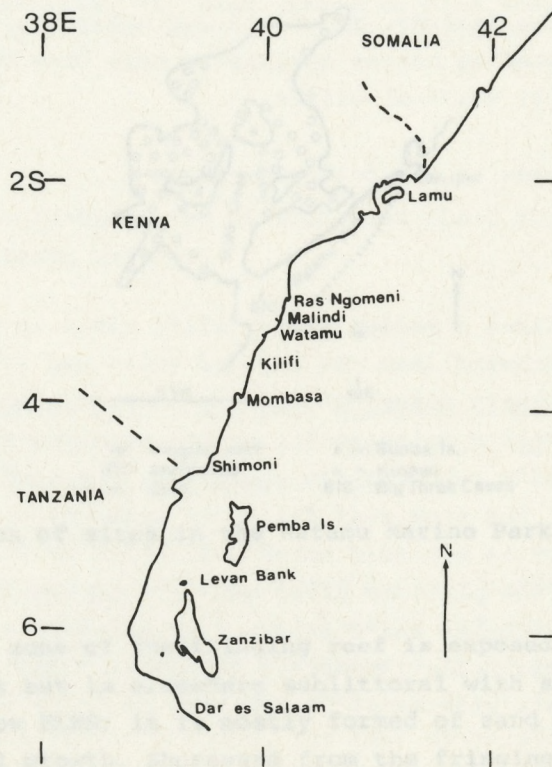


Fig. 1. - Location of collecting sites in the western Indian Ocean.

The collections are deposited with the British Museum (Natural History), the Musée Royal de l'Afrique Centrale, Tervuren, Belgium and the National Museum of Kenya.

A general description of the area is given in BRANDER, McLEOD and HUMPHREYS (1971) and further details of the flora and fauna the Watamu Marine Park and some of the other areas mentioned may be found in JONES (1971).



Fig. 1. Location of collecting sites in the western Indian Ocean.

COLLECTION AREAS

The Watamu Marine Park (fig. 2) encloses the area between the shore and fringing reef between Kibirijini and Whale Island (5.5 km). To the north of the park in Turtle Bay the shore, the champignon islets and Kibirijini are surrounded by extensive rock platforms about 0.9 m above datum (cf. MLWN 1.2 m, MLWS 0.3m). This seaward platform is also extensive to the south where it diverges from the coast and a remaining fragment forms the roof of Big Three Caves which rises 2 - 3 m above the channel floor at the entrance to Mida Channel. The only typical high energy cliff is to the seaward side of Whale Island where the cliffs slope back 40 - 45° typical of high energy cliffs (STODDART, 1967). Turtle Rock and Kibirijini are vertical medium energy cliffs while in the bay and to the lee of the islets the cliffs are typically low energy with varying degrees of overhang.

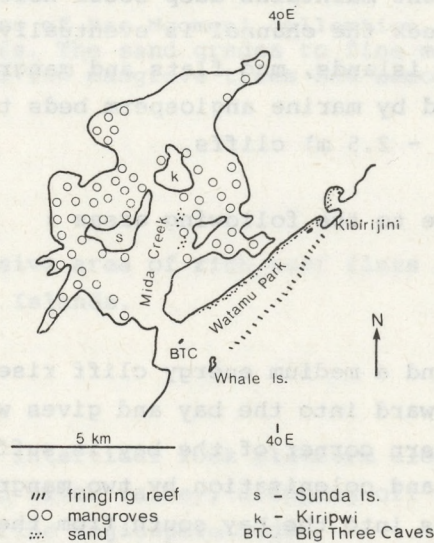


Fig. 2. - Location of sites in the Watamu Marine Park and Mida Creek.

The surf zone of the fringing reef is exposed at LWS in the north of the park but is elsewhere sublittoral with surge channels to about 2 m below ELWS; it is mostly formed of sand and coral debris cemented by algal growth. Shoreward from the fringing reef are extensive marine angiosperm beds over sand and coral debris and heavily eroded in places particularly to the southern end of the park. These beds extend from just above LWS to a depth of about 2.5 m. The back-

reef angiosperm beds are dissected by 3 - 4.6 m deep sand channel which runs parallel to the fringing reef midway to the shore; within this channel are the massive coral growths of the parks "coral gardens". The angiosperm beds are terminated in the south by the entrance to Mida Channel.

South of Kibirijini the shore consists of sand beaches interrupted at intervals by the rock platforms, and extending to the mangrove areas of Mida Creek. The beach is exposed to heavy wave action at high tide during the south east monsoon but is sheltered to the north by Kibirijini and this is reflected by the beach profiles and particle size distribution (JONES, 1971).

Mida Channel broadens and shallows seaward of Big Three Caves towards Whale Island. Landward of the caves the channel is more confined as it passes into Mida Creek reaching a depth of 8 m. The channel contains large limestone boulders and is covered by encrusting corals, algae and sponges with angiosperm beds in more sheltered backwaters. The maximum tidal current recorded on a spring tide (29.8.69) was 4.7 knots (2.4 m s^{-1}) and 1.2 knots (0.6 m s^{-1}) during a neap tide (6.9.69). This strong current maintains deep scour holes within the channel.

Within the creek the channel is eventually lost by detritic branching amongst the islands, mud flats and mangroves. Where the mud flats are consolidated by marine angiosperm beds they drop off into the channel in low (1 - 2.5 m) cliffs.

Brief visits were made to the following areas :

Ras Ngomeni (fig. 3)

On the headland a medium energy cliff rises 10 m vertically and curves away southward into the bay and gives way to massive fixed sand-dunes. The northern corner of the bay is sufficiently sheltered for mud accumulation and colonisation by two mangrove trees. A raised limestone reef extends into the bay south from the headland and is exposed at low water. The rock reef falls off seawards to reef slopes and is surmounted by an echinoid notch maintained by *Stomopneustes variolaris*. Shorewards the platform gives way to a boulder zone of limestone boulders and cobbles and then to a lagoon about 1.5 m deep at ELW with the drainage being impeded by luxurious coral growth. This small area thus has a wide range of habitats which is reflected by the rich biota.

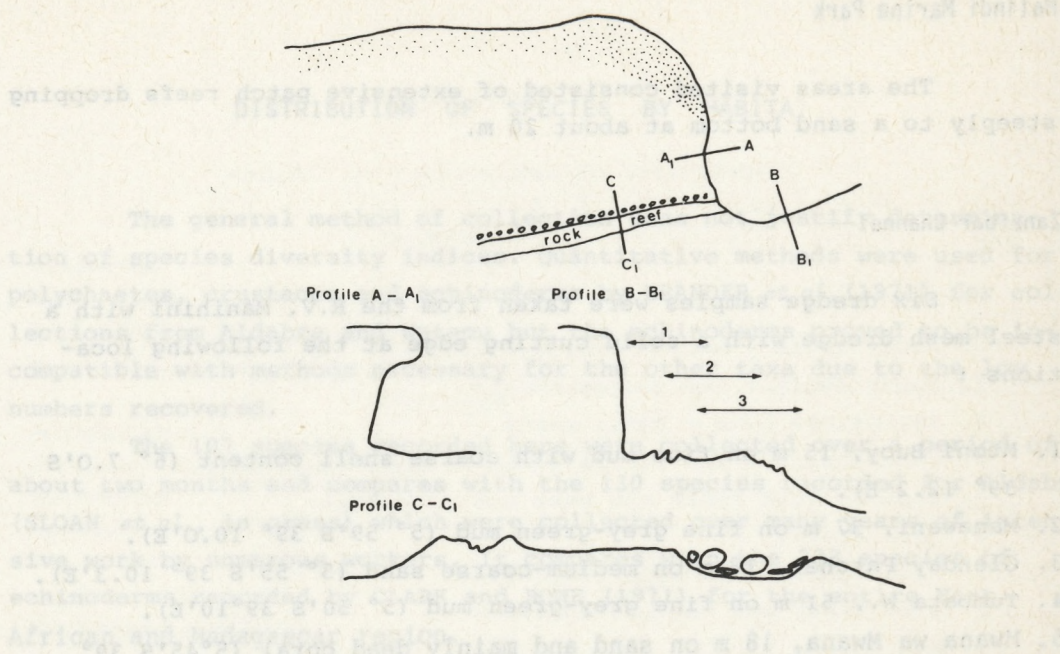


Fig. 3. - Diagrams of Ras Ngomeni collection area to show range of habitats. The sand grades to fine mud in the corner of the bay and two mangrove trees had become established.

Shimoni

An extensive area of rich reef flats and channels around Kisiti and Wasin Islands.

Kilifi

A smooth intertidal rock platform along the sides and mouth of a deep drowned river valley, dropping off to a mud bottom or, in the north, to marine angiosperm beds.

Pange and Fungu Chawamba, Zanzibar

Pange is a sandbank rising 3 m above the sea floor, partly fringed by a rock platform intertidally and completely surrounded by coral. The east of the bank was covered by up to 0.6 m of water at LWS and surmounted by numerous small (0.3 - 0.6 m dia.) coral heads with a rich echinoderm fauna. The reef drops off to a mud bottom at about 20 m. Fungu Chawamba, 2 km to the west of Pange, is similar but without the extensive level sand platform. The coral fauna is rich with massive growth forms much rarer than at Watamu.

Malindi Marine Park

The areas visited consisted of extensive patch reefs dropping steeply to a sand bottom at about 20 m.

Zanzibar Channel

Six dredge samples were taken from the R.V. Manihini with a steel mesh dredge with a solid cutting edge at the following locations :

1. Mtoni Buoy, 15 m on fine mud with coarse shell content ($6^{\circ} 7.0'S$ $39^{\circ} 12.2'E$).
2. Manawani, 37 m on fine grey-green mud ($5^{\circ} 59'S$ $39^{\circ} 10.0'E$).
3. Glenday Patches, 18 m on medium-coarse sand ($5^{\circ} 55'S$ $39^{\circ} 10.3'E$).
4. Tumbata W., 51 m on fine grey-green mud ($5^{\circ} 50'S$ $39^{\circ} 10'E$).
5. Mwana wa Mwana, 18 m on sand and mainly dead coral ($5^{\circ} 45'S$ $39^{\circ} 15'E$).
6. Levin Bank, 15 m on live and dead coral, and encrusted boulders ($5^{\circ} 38'S$ $39^{\circ} 18'E$).

Echinoderms were taken only from stations 4 - 6.

DISTRIBUTION OF SPECIES BY HABITAT

The general method of collection does not justify determination of species diversity indices. Quantitative methods were used for polychaetes, crustacea and echinoderms by BRANDER *et al.* (1971) for collections from Aldabra and Watamu but the echinoderms proved to be incompatible with methods necessary for the other taxa due to the low numbers recovered.

The 107 species recorded here were collected over a period of about two months and compares with the 130 species recorded for Aldabra (SLOAN *et al.*, in press) which were collected over many years of intensive work by numerous workers. It compares with the 233 species of echinoderms recorded by CLARK and ROWE (1971) for the entire East African and Madagascar region.

The habitat distribution of the species recorded is given in table 1, together with an indication of their abundance. The distribution of taxa between habitats and their proportion distribution are shown in tables 2a and 2b respectively.

The largest proportion of the species available are found on inshore rock reefs and wave cut platforms (36%), while the reef flats contain about 27% of the species present whether they are covered by marine angiosperm beds or by backreef channels with their associated rubble, sand or coral substrates. Coral areas are slightly richer with 30% of the species available, and are as rich as the floor of Mida Channel with its covering of encrusting biota. Intertidal cliffs, while sometimes having dense aggregations such as at Ras Ngomeni, have low diversity. The low diversity of the reef front is artefactual as little diving was conducted there due to the prevailing south-east monsoon.

Asteroids reach highest diversity on angiosperm beds, inshore rockreefs and wave-cut platforms and in Mida Channel, and are particularly low on cliffs and mud substrates. Ophiuroids are especially diverse on rockreefs and wave-cut platforms but are diverse in all sublittoral backreef areas. Echinoids are most diverse on marine angiosperm beds but are associated with all hard substrates. Holothurians reach particularly high diversity in Mida Channel and moderately so in backreef channels and rock platforms.

Table 1

Distribution of echinoderms by habitat

KEY

Habitat

1. Rocky shore : medium energy cliffs.
2. Rocky shore : low energy cliffs.
3. Angiosperm beds - sublittoral.
4. Sand channels and rubble areas of reef flats.
5. Inshore rock reefs and wave cut platforms.
6. Reef front.
7. Mida Channel; in main tidal flow.
8. Mida Creek and channel backwaters.
9. Mud bottom.
10. Bases of coral or patch reefs.
11. Fringing reef; surf zone.
12. Coral on reef flats.

Abundance

- X. Present.
- R. Rare.
- C. Common.
- A. Abundant.

Subscript

1. Epifaunal.
2. Beneath cobbles, microatolls or encrusting corals or algae.
3. In sand or mud.
4. In fauna of coral or coral rock.
- m. Mida Creek only.
- d. Dredged.
- s. On sand.
- c. On coral.
- sp. Associated with sponge.
- ? Indicates finding location of dead specimens.

	1	2	3	4	5	6	7	8	9	10	11	12	Habitats per species	
CRINOIDEA														
Comasteridae														
<i>Comissia hartmeyeri</i>						A					A ₂		2	
Tropiometridae														
<i>Tropiometra carinata</i>										R			1	
ASTEROIDEA														
Astropectinidae														
<i>Astropecten polyacanthus</i>										C ₃			1	
Goniasteridae														
<i>Monachaster sanderi</i>											R ₂		1	
Oreasteridae														
<i>Culcita schmideliana</i>					C ₁								1	
<i>Pentaceraster mammillatus</i>							C					X	2	
<i>Protoreaster lincki</i>					C ₁	A ₁						X ₁	3	
<i>P. nodosus</i>					R ₁								1	
Ophidiasteridae														
<i>Gomphia egyptiaca egeriae</i>						R ₂							1	
<i>Leiaster coriaceus</i>											R ₁		1	
<i>L. glaber</i>											A ₁		1	
<i>Linckia guildingi</i>							X _d	A _m			A		3	
<i>L. laevigata</i>					A ₁						A ₁	X _{sl}	A	4
<i>L. multiflora</i>						A					A _C		2	
<i>Nardoa variolata</i>											A	A	2	
<i>Ophidiaster</i> sp. (? <i>O. hemprichi</i>)												X _d	1	
Asteropseidae														
<i>Asteropsis carinifera</i>						C ₂							1	
Asterinidae														
<i>Asterina burtoni</i>												R ₂	1	
? <i>Paranepanthis</i> sp.							X ₂					X ₂	2	
Acanthasteridae														
<i>Acanthaster planci</i>							R ₁					R ₁	2	
Echinasteridae														
<i>Echinaster purpureus</i>					A ₁	A ₁₂							2	
OPHIUROIDEA														
Ophiomyxidae														
<i>Ophiomyxa australis</i>												R ₂	2	

	1	2	3	4	5	6	7	8	9	10	11	12	Habitats per species
Amphiuridae													
<i>Amphipholis squamata</i>			R ₂										1
<i>Amphiura</i> sp. aff. <i>A. crispa</i>											R ₂		1
<i>Amphiura luetkeni</i>						R?				X _d			2
<i>Ophiocentrus dilatatus</i>										X _d			1
Ophiactidae													
<i>Ophiactis picteti</i>										X _d	X		2
<i>O. savignyi</i>					C ₂		C _{sp}			C _{spd}			3
Ophiothrichidae													
<i>Macrophiothrix demessa</i>						R				X _d			2
<i>M. propinqua</i>				X ₄						X _d			2
<i>Ophiothela danae</i>							X ₁						1
<i>O. venusta</i>					X ₂					X _d			2
<i>O. tigris</i>										X _d			1
<i>Ophiothrix echinotecta</i>					X _{sp2}						X ₂	X ₂	3
<i>O. savignyi</i>					R ₂								1
<i>O. trilineata</i>							X _{sp2}			X _d			2
<i>O. (Acanthophiothrix) pupurea</i>										X _d			1
Ophiocomidae													
<i>Ophiarthrum elegans</i>			C	C ₂			C _{2c}				C ₂		4
<i>O. brevipes</i>			C	A ₂	C ₂			X _{sp}		C			5
<i>O. doederleini</i>				A _{sp}	A _m								2
<i>O. erinaceus</i>				C	A ₂		C _c	C		X _d			5
<i>O. pusilla</i>				X ₄	X ₄					X _d			3
<i>O. scolopendrina</i>	A ₂	A ₂						X ₂	X ₂			X ₄	5
<i>O. valenciae</i>	A ₂	A ₂	A	C	A ₂		X _{sp}	X _{sp}		X _d	A ₂		9
<i>Ophiocomella sexradia</i>				X ₄									1
<i>Ophiomastix koehleri</i>			C ₂		X								2
<i>O. venosa</i>				X	X ₂			X ₂	X				4
Ophionereidae													
<i>Ophionereis dubia</i>					X ₂								1
<i>Ophionereis</i> sp. (? <i>O. dubia</i>)			X										1
<i>O. porrecta</i>			X		X _{2m}					X _d			3
<i>O. vivipara</i>			X										1
Ophiodermatidae													
<i>Ophiarachnella gorgonia</i>					X ₂		X						2
<i>O. septemspinosa</i>					R ₂	R							2
<i>Ophiopeza fallax</i>					C ₂	C				X _d			3

	1	2	3	4	5	6	7	8	9	10	11	12	Habitats per species
Spatangiidae													
<i>Maretia planulata</i>					R?								1
Schizasteridae													
<i>Schizasterid</i> sp.			R										1
Brissidae													
<i>Brissus latecarinatus</i>				X			?C ₂	?C ₂					3
<i>Metalia sternalis</i>										X			1

HOLOTHURIOIDEA

Holothuriidae													
<i>Actinopyga echinites</i>					R		R ₂						2
<i>A. mauritiana</i>					R ₂								1
<i>A. miliaris</i>							X						1
<i>Actinopyga</i> sp.										A ₁			1
<i>Bohadschia koellikeri</i>			R ₁							A ₁			2
<i>B. marmorata</i>			C ₁	X	X						X ₁		4
<i>Labidodemas semperianum</i>											X ₂		1
<i>Holothuria (Halodeima) atra</i>			A ₁	A ₁									2
<i>H. (Lessonothuria) pardalis</i>				X			A ₁	A ₁					3
<i>H. (Mertensiothuria) fuscocinerea</i>											R ₁		1
<i>H. (Mertensiothuria) leucospilota</i>					C ₂		C ₂	C ₂					3
<i>H. (Mertensiothuria) pervicax</i>						R ₁	R ₁						2
<i>H. (Metriatyla) scabra</i>							A _{SC}	A _{S3}		A ₁			3
<i>H. (Microthele) nobilis</i>					R ₁		R ₁						2
<i>H. (Semperothuria) cinerascens</i>		A ₂				A ₂	A						3
<i>H. (Thymiosycia) hilla</i>						C ₂							1
<i>H. (Thymiosycia) impatiens</i>							C ₂	C ₂				C ₂	3
Stichopodidae													
<i>Stichopus variegatus</i>							R ₁	R ₁					2
<i>Thelenota ananas</i>								R ₁					1
Phyllophoridae													
<i>Afroccucumis africana</i>					A ₂		A ₂	A ₂					3
Synaptidae													
<i>Opheodesoma</i> sp. prob.													
<i>O. spectabilis</i>					X ₂								1
<i>Synapta maculata</i>								R ₁					1

Table 2a. - Synopsis of distribution of echinoderms by habitat

Class	Habitats												Mean number of habitats per species	Number of species
	1	2	3	4	5	6	7	8	9	10	11	12		
Crinoids	0	0	0	0	0	1	0	0	0	1	1	0	1.50	2
Asteroids	0	0	5	3	6	1	6	2	1	3	2	3	1.68	19
Ophiuroids	2	2	11	12	18	1	8	6	2	18	4	4	2.50	36
Echinoids	6	2	11	6	8	1	8	4	2	8	4	1	2.18	28
Holothurians	1	0	3	6	7	0	11	8	0	3	2	2	1.95	22
All echinoderms	9	4	30	27	39	4	33	20	5	33	13	10	2.14	107
Species present/Species available	0.08	0.04	0.28	0.25	0.36	0.04	0.30	0.18	0.05	0.30	0.12	0.09		

(*) Refer to key in table 1.

Table 2b. - Synopsis of proportional distribution of echinoderms by habitat

Habitat class	Habitat											
	1	2	3	4	5	6	7	8	9	10	11	12
Crinoids	-	-	0.16	0.09	0.19	0.03	0.19	0.06	0.03	0.09	0.06	0.09
Asteroids	0.02	0.02	0.12	0.15	0.20	0.01	0.09	0.07	0.02	0.20	0.04	0.04
Ophiuroids	0.10	0.03	0.18	0.10	0.13	0.02	0.13	0.07	0.03	0.13	0.07	0.02
Echinoids	0.02	-	0.07	0.14	0.16	-	0.26	0.19	-	0.07	0.05	0.05
Holothurians	0.04	0.02	0.13	0.12	0.17	0.02	0.14	0.09	0.02	0.14	0.06	0.04
All echinoderms												

Proportion of species
per taxon in habitat

SYSTEMATIC ACCOUNT

Throughout the nomenclature follows CLARK and ROWE (1971) unless it has subsequently been changed. As there are a number of recent papers on Indian Ocean echinoderms containing full references, I have, for brevity, excluded most of them. The systematics, geographical distribution and keys may be found fully referenced in CLARK and ROWE (1971) and ROWE and DOTY (1977). Extensive notes and references to the biology of echinoderms from Aldabra Atoll, Seychelles, are given in SLOAN, CLARK and TAYLOR (1979) and cover most of the species referred to here. In addition the ophiuroids are covered in detail by CHERBONNIER and GUILLE (1978).

CLASS CRINOIDEA

Comasteridae

Commissia hartmeyeri A.H. CLARK, 1912

Extremely abundant beneath cobbles in the surf zone on the reef front and in *Halomeida* sp. mats, beneath encrusting corals especially *Millepora* spp. and boulders of Watamu and Malindi Marine Parks.

Range extended from Red Sea.

Colour in life : very variable with predominant colour ranging from black to fawn. This may pale progressively along arms to light fawn or yellow and arms may have several alternating pale and dark regions giving banded appearance.

Tropiometridae

Tropiometra carinata (LAMARCK, 1816)

One specimen taken at 10 m in daylight on Funga Chawamba reef, Zanzibar.

SUBCLASS ASTEROIDEA

Astropectinidae

Astropecten polyacanthus MÜLLER & TROSCHER, 1842

Abundant in mud at 3 m in Mida Creek north of Kiripwe Island in flowing water.

Colour in life : paxillae vary from cream through grey-green to brown, usually with darker patterning variable in extent and form, periphery is generally white but may darken distally, occasional, or groups of, supero marginal spines may be dark brown basally, white or fawn adorally.

Goniasteridae

Monachaster sanderi (MEISSNER, 1892)

One specimen taken from beneath rock in coral area near Whale Island, Watamu Marine Park.

Colour in life : slate grey with purplish borders to supero-marginals, medreporite with circle of ten purplish spots, adoral surface mid-grey with centre of plates paler, furrow spines white to red.

Oreasteridae

Culcita schmideliana (RETZIUS, 1805)

Sparsely distributed in backreef areas in the north of Watamu Marine Park particularly in the marine angiosperm beds. Always sublittoral to about 10 m and found free on surface of substrate not hidden as on Aldabra (SLOAN *et al.*, 1979).

Colour in life : dark grey background with small irregular pink patches mostly adjacent to black tubercles, madreporite some shade of orange being the same colour as the intertubercular areas at the arm tips.

Often with carapid fish commensal in stomach, sometimes with polynoid *Gastrolepidia clavigera* SCHMARD, 1861 and usually with commensal shrimp *Periclimenes soror* NOBILI (Palaemonidae).

Pentaceraster mammillatus (AUDOUIN, 1826)

One taken on the reef flats at Kikambala but abundant on Pange Reef, Zanzibar below 3 m in coral and coral rubble areas adjacent to patch reef. Its absence in Watamu Marine Park is notable.

Colour in life : interradial spines green with orange tubercles.

Protoreaster lincki (de BLAINVILLE, 1834)

Sparsely distributed in calmer northern areas of Watamu Marine Park especially in areas of marine angiosperms.

Numerous amongst rubble adjacent to patch reefs at Malindi Marine Park and few inshore of rock reef at Ras Ngomeni. Up to 0.7/100 m² on transects in backreef areas of Watamu Marine Park. Also taken on reef flats at Kikambala.

Colour in life : red on pink or grey background, furrow spines white with pink tube feet, juveniles mottled blue-green or grey-green.

Commonly with commensal carapid fish and palaemonid shrimps, *Periclimenes soror*.

Protoreaster nodosus (LINNAEUS, 1758)

Scarce in angiosperm beds in north of Watamu Marine Park but not in surf zones inshore or at reef edge.

Colour in life : tubercles yellow with orange tips, papular areas blue-grey with papulae green; remainder of aboral surface deep green, marginals pale yellow, ambulacral spines white, tube feet pink

with purple centre, adoral side purple with white plates showing through. K.M. BRANDER and P.C. FRASER reported from the south end of Wasin Island, Shimoni that in a channel with sandy substrate there were $1/m^2$ of *Protoreaster* sp. ($R \approx 150$ mm) with 20 colour varieties. Predated by Gnathophilid *Hymenocera elegans*.

Ophiasteridae

Gomphia egyptiaca egeriae A.M. CLARK, 1967

Single specimen from beneath rock reef at centre of Watamu Marine Park.

Colour in life : background fawn-grey with two to three irregular dark brown bands (including tubercles) across arms becoming paler towards tips, some of the larger tubercles, especially interradially, reddish surrounded by narrow black band, adorally, three or four sections of eight to ten furrow spines on each arm are pink.

Leiaster coriaceus PETERS, 1852

Rare in the outflow channel from Mida Creek free on substrate, and in rubble between angiosperm beds in Watamu Marine Park.

Colour in life : variable, from harlequin deep purple, red orange and pink with orange yellow tips to arms, through red with orange arm tips and white furrow spines, to deep brown with large irregular brown marking and pale brown adoral surface.

Leiaster glaber PETERS, 1852

Common on rock reef at mouth of Mida Creek free on substrate.

Colour in life : burgundy with irregular pink markings on arms, madreporite and patch at tip of each arm purple, adoral surface has pink border along the furrow which merges with pink areas aborally.

Linckia guildingi GRAY, 1840

Abundant at mouth of Mida Creek with numerous juveniles on rock reef at Big Three Caves. Dredged from 18 m on sand and coral substrate at Mwana wa Mwana, Zanzibar Channel.

Colour in life : uniformly fawn.

Linckia laevigata LINNAEUS, 1758

Widespread and locally abundant. Found on the outer half of marine angiosperm beds of Watamu Marine Park, the channel to Mida Creek, on sand in lower Mida Creek, and the patch reefs of Malindi Marine Park. Arm number variable (3 - 5) although not suffering from obvious recent predation.

Colour in life : uniformly blue, grey, pink, purple or fawn. This contrasts with Pacific specimens from Palao examined by A.M. CLARK where they were all shades of blue.

Linckia multifora (LAMARCK, 1816)

Common on rocky substrates in backreef areas of Watamu Marine Park and on wavecut platform at Kibirijini point as well as on coral encrusted areas at the mouth of Mida Creek.

Colour in life : background blue-green with deep blue markings, deep fawn with brown markings or pale fawn with purple markings, always paler adorally.

Few with commensal polynoid *Hololepidella nigropuntata* (HORST, 1915), also found on specimens from Aldabra.

Nardoa variolata (RETZIUS, 1805)

Extremely abundant in main drainage channels of Mida Creek right out to Big Three Caves.

Colour in life : granules between plates mid brown, rest black, abactinal surface light grey-brown.

Eaten by shrimp *Hymenocera elegans* (Gnathophyllidae) which sits on the aboral surface and eats the arm tips.

Ophidiaster sp. (? *O. hemprichi*, MÜLLER & TROSCHER, 1842)

One specimen dredged from coral substrate (15 m) on Levin Bank, Zanzibar Channel.

Asteropseidae

Asteropsis carinifera (LAMARCK, 1816)

Common beneath rocks below LWS on rock reef near Big Three Caves.

Colour in life : pale grey with irregular brown markings, uniformly pale grey below.

Some with commensal polynoid *Hololepidella nigropuntata*.

Asterinidae

Asterina burtoni (GRAY, 1840)

From *Lithothamnion* sp. reefs sublittoral at Kibirijini Point. On boulder near backreef coral heads in Watamu Marine Park and on rock reef in Turtle Bay. Uncommon.

Colour in life : deep pink centre to disc grading through white to light purple arm tips.

? *Paranepanthia* sp.

See footnote in CLARK and ROWE, 1971.

Widespread taken sublittorally at Ras Ngomeni, Kibirijini Point, beneath rocks on rock reef near Big Three Caves, rock platforms at Kilifi, *Halimeda* sp. mats in surf zone of Watamu Marine Park and wave cut platform on Kibirijini Point and most rock platforms of Turtle Bay.

Found eating *Clypeaster reticulatus* (LINNAEUS) which was fully exposed after the rock covering it had been removed.

Acanthasteridae

Acanthaster planci (LINNAEUS, 1758)

Photographed by P. SAUL on patch reef in Malindi Marine Park early in 1969 and reported scarce in the area.

K.M. BRANDER and P.C. FRASER photographed two specimens at Shimoni in September 1969; a large specimen (r = 225 mm) off Kisiti Island and a smaller one off Wasin Island. Examined the latter specimen.

Colour in life : deep brown above with deep red tips to spines, tube feet fawn.

Echinasteridae

Echinaster purpureus (GRAY, 1840)

Widespread and locally abundant on the angiosperm beds of Watamu Marine Park, wave cut platform at Kibirijini Point and Ras Ngomeni and beneath rocks at LWS near Big Three Caves.

Colour in life : golden brown to dark brown with large irregular brown markings transversely on arms.

SUBCLASS OPHIUROIDEA

Ophiomyxidae

Ophiomyxa australis LÜTKEN, 1869

Single specimen from beneath encrustation of *Millipora* sp. on the reef flats of Watamu Marine Park.

Gorgonocephalidae

P. SAUL described a member of this family seen on the patch reefs at Malindi Marine Park.

Amphiuridae

Amphipholis squamata D. CHIAJE, 1829

Single specimen from marine angiosperm beds in Mida Creek.

Amphiura sp. aff. *A. crispa* MORTENSEN, 1940

Outer surf zone in Watamu Marine Park extending to at least 30 m.

Amphiura luetkeni DUNCAN, 1879

Two specimens dredged from coral substrate at 15 m on Levin Bank, Zanzibar Channel and a doubtful small specimen from rock reef in Watamu Marine Park.

Ophiocentrus dilatatus (KOEHLER, 1905)

One specimen taken by dredge at 15 m from coral substrate on Levin Bank, Zanzibar Channel.

Ophiactidae

Ophiactis picteti (de LORIOI, 1893)

See SLOAN, CLARK and TAYLOR (1979, p.101) for discussion of *O. hemiteles* in relation to this species and the specimens referred to here.

Coral heads in backreef areas of Watamu Marine Park, taken by dredge in the Zanzibar Channel on sand and coral substrate at 18 m from Mwana wa Mwana and on coral at 15 m on Levin Bank, Zanzibar Channel.

Ophiactis savignyi MÜLLER & TROSCHER, 1842

Common and widespread but often large congregations in sponges. In sponge in channel to Mida Creek, beneath rocks on rock reef near Big Three Caves, from sponges on Pange Reef Zanzibar, from sand and coral substrate at 18 m, Mwana wa Mwana, Zanzibar Channel, and from 15 m from coral substrate on Levin Bank, Zanzibar Channel.

Colour in life : green background, disc with more or less regular dark and light green markings, arms similarly banded, ventrally white with some green markings on arms.

Ophiotrichidae

Macrophiothrix demessa (LYMAN, 1861)

Beneath rocks on rock reef near Big Three Caves, uncommon. Dredged from coral substrate at 15 m on Levin Bank, Zanzibar Channel.

Macrophiothrix propinqua (LYMAN, 1861)

New combination of generic and specific names proposed by CLARK (1979).

Colonized dead coral rock in sandy channel of backreef area of Watamu Marine Park; single specimen dredged from coral substrate at 15 m from Levin Bank, Zanzibar Channel.

Ophiothela danae VERRILL, 1869

See CLARK and ROWE (1971), p. 116, note 63.

Numerous specimens from red gorgonian growing beneath overhang in the channel to Mida Creek at 10 m below ELWS. Arm number varied some with 6, 5, 4 + 4 regenerating and 1 + 5 regenerating.

Colour in life : colour dimorphism, disc uniformly bright orange or with radial shields white, dorsal arm surface orange near disc becoming abruptly paler orange about one disc diameter from disc and then fading to white towards tips, arms ventrally off white, some arms dorsally pale throughout others purple with purple and white banded arms, purple bands wider (2 - 5 segments) than white bands (1 - 2 segments).

Extension of African range northwards from Inhaca Island, Moçambique, found in most other zoogeographical areas.

Ophiothela venusta (de LORIO, 1900)

Sublittoral, beneath rocks in Watamu Marine Park and dredged from sand and coral substrate at 18 m on Mwana wa Mwana, Zanzibar Channel.

Ophiothela tigris LYMAN, 1871

Dredged from sand and coral substrates at 18 m at Mwana wa Mwana and from 15 m on coral from Levin Bank in the Zanzibar Channel. Forms intermediate in colour pattern and disc armament between *O. tigris* and *O. venusta* taken from Watamu Marine Park on reef flat adjacent to surf zone are discussed by CLARK (1979).

Ophiothrix echinotecta BALINSKY, 1957

Beneath encrusting *Millepora* sp. in backreef areas of Watamu Marine Park. In sponges and beneath rocks in the channel to Mida Creek

and beneath rocks on Big Three Caves, and fringing reef of Watamu Marine Park.

Colour in life : generally grey-green, dorsal arm plates with narrow off-white border.

Ophiothrix savignyi (MÜLLER & TROSCHER, 1842)

Single juvenile specimen from beneath rocks on rock reef near Big Three Caves, Watamu Marine Park. There is a faint double dark line on arms and a few small thorns on the dorsal arm plates; the small size may account for the dearth of these.

Ophiothrix trilineata LÜTKEN, 1869

Seven specimens dredged from Zanzibar Channel on sand and coral substrate at 18 m on Mwana wa Mwana and coral substrate at 15 m from Levin Bank. Also collected from sponge and beneath rock deep in Mida Channel.

Colour in life : disc dark blue, arms blue or blue green with fine characteristic median lines alternating dark blue and white, arm spines glassy, reddish and often with a dark line, ventrally white overall.

Ophiothrix (Acanthophiothrix) purpurea von MARTENS, 1867

Single specimen dredged from 18 m on sand and coral substrate at Mwana wa Mwana, Zanzibar Channel. CHERBONNIER and GUILLE (1978) similarly found this species only in dredge samples.

Colour in life : agrees with SLOAN *et al.* (1979).

Ophiocomidae

Ophiarthrum elegans PETERS, 1851

Found commonly beneath rocks on fringing reef of Watamu Marine Park and commonly amongst the coral *Montipora fructicosa* in Mida Creek and beneath rocks in the boulder zone at Ras Ngomeni.

Colour in life : disc uniformly deep slate grey, brown or mottled, arms cream with transverse red markings fringed with black, ventral arms surface and borders of genital slits cream with dorsal red markings sometimes extending to tentacle pore.

Ophiocoma brevipes PETERS, 1851

Found widely beneath rocks on sand and rock substrates on massive coral heads and amongst marine angiosperm roots in Watamu Marine Park, on wave cut platform beneath rocks at Kibirijini and from sponge in Mida Creek.

Ophiocoma doederleini de LORIOU, 1899

Many specimens taken from a sponge in deep backreef areas in centre of Watamu Marine Park, and from beneath rocks at Big Three Caves.

Colour in life : disc grey with hexagonal paler areas, or uniformly grey-brown above with five single white dorsal arm plates spaced along arm, genital slits and oral shields with pale grey borders.

Ophiocoma erinaceus MÜLLER & TROSCHEL, 1842

Widespread and locally common; boulder zone at Ras Ngomeni, rubble areas of Watamu Marine Park, in the Channel to Mida Creek and from *Montipora fruticosa* in Mida Creek. Dredged from coral substrate at 15 m from Levin Bank, Zanzibar Channel.

Colour in life : all black, some with white trim to ventral arm plates, most with bright orange podia.

Ophiocoma pusilla (BROCK, 1888)

Colonized rock near coral heads in backreef area of Watamu Marine Park and taken from *Montipora fruticosa* in Mida Creek. Dredged from 15 m on coral substrate for Levin Bank, Zanzibar Channel.

Confirms CHERBONNIER and GUILLE's (1978) range extension to East Africa and Madagascar (*sensu* CLARK and ROWE, 1971).

Ophiocoma scolopendrina (LAMARCK, 1816)

Abundant in upper eulittoral at Ras Ngomeni inshore from rock reef and through the boulder zone inshore. Unlike Madagascar (CHERBONNIER and GUILLE, 1978) and Aldabra the species was nowhere else abundant. Found beneath rocks adjacent to the fish pens in Malindi, in cobbles in backreef areas, and in crevices in massive *Porites* sp. head of Watamu Marine Park, extends well into Mida Creek beneath rocks.

Colour in life : very varied, disc uniformly black to pale brown to black variegated pattern, dorsal arm plates brown or paler brown regions several segments wide.

Ophiocoma valenciæ MÜLLER & TROSCHEL, 1842

Easily the most abundant ophiocomid on the coast. In and beneath rocks on wave cut platform throughout Watamu Marine Park in surf zone on reef from *Halimeda* sp. mats, in backreef areas from rubble to corals, from amongst roots of angiosperm beds, and algal mats at Kibirijini. Beneath *Millepora* sp. encrusting corals, from *Montipora fruticosa* and sponges in Mida Creek and channel. Also dredged from

coral substrate at 15 m on Levin Banks, Zanzibar Channel.

Colour in life : very varied, arms commonly green or green brown and banded by darker areas but banding may be deep brown or cream. Disc uniformly dull green to dark brown. Very fragile.

Ophiocomella sexradia (DUNCAN, 1887)

Found only as in fauna of dead coral rocks both in angiosperm beds and the deeper backreef channels containing large coral heads. This restricted habitat agrees well with SLOAN *et al.* (1979).
Aldabra.

Ophiomastix koehleri DEVANEY, 1977

Found commonly and solely under microatolls of *Porites* on the angiosperm beds at southern end of the Watamu Marine Park.

Colour in life : disc spineless, uniformly dark purple with white edges, dorsal arm plates off-white with large irregular purple patches over most of some pairs of plates giving dark arm band two segments wide in every five, pale or purple mottled clavate dorsal arm spines, small arm spines with purple and white annulations, tentacle scales banded, oral shields with large dark purple blotches, podia red.

Ophiomastix venosa PETERS, 1851

Uncommon beneath rocks in boulder zone of backreef area at Ras Ngomeni and Watamu Marine Park, and on flats adjacent to the channel to Mida Creek.

Colour in life : variable either grey shields with radiating wavy pattern on disc, radial shields with black petaloid pattern, arm spines with longitudinal dark stripe on one side or basically yellow with details as in SLOAN *et al.* (1979).

Ophionereidae

Ophionereis dubia (MÜLLER & TROSCHEL, 1842)

Kiberijini Point, algal mats on wave cut platform.
CHERBONNIER and GUILLE (1978) took it only at depth (10 m) on Madagascar.

Ophionereis sp. (? *O. dubia*) from marine angiosperm root mats in Watamu Marine Park.

Ophionereis porrecta LYMAN, 1860

Taken from beneath rocks in the entrance to Mida Creek, found washed up in marine angiosperms. Dredged from Zanzibar Channel at 18 m

from coral and sand substrate at Mwana wa Mwana and 15 m from coral substrate on Levin Banks.

Colour in life : disc grey with irregular dark markings, dark pattern more prominent in smaller specimens, arms mottled white and grey with dark spots, short spines white, ventrally off-white with grey blotches overall.

Ophionereis vivipara MORTENSEN, 1933

Single specimen taken from marine angiosperm beds of Watamu Marine Park.

Ophiidermatidae

Ophiarachnella gorgonia (MÜLLER & TROSCHER, 1842)

Found beneath rocks at LWS on rock reef near Big Three Caves. Also taken from wave cut platform at Kilifi inlet, south of Watamu.

Colour in life : disc off-white but dominated by almost black markings, one major one along each pair of radial shields and 1 - 3 minor marks inter-radially, arms off-white with dark brown bands 1 - 3 segments wide both above and below, ventral surface of arms not darker distally as at Aldabra (SLOAN *et al.*, 1979).

Ophiarachnella septemspinosa (MÜLLER & TROSCHER, 1842)

Rare, taken from beneath encrusting *Millepora* sp. in deep channels of backreef area in Watamu Marine Park and from beneath rocks sublittoral at Kilifi inlet.

Colour in life : uniformly mid-grey, radial shields dark grey, ventrally arms and oral region paler.

Ophiopeza fallax PETERS, 1851

Found in coral rubble in backreef areas of Watamu Marine Park and the boulder zone of Ras Ngomeni; also dredged from sand and coral substrate at 18 m on Mwana wa Mwana in Zanzibar Channel.

Colour in life : mostly agrees with SLOAN *et al.* (in press) but some lateral interrational areas red-brown and bands of this colour on the arms may extend over three segments.

Ophiuridae

Ophiolepis cineta MÜLLER & TROSCHER, 1842

Occurred amongst marine angiosperm roots in backreef areas of Watamu Marine Park and in the shelter of raised limestone reef amongst boulders at Ras Ngomeni.

Ophiolepis superba H.L. CLARK, 1938

Scarce; in deeper parts of the channel into Mida Creek beneath rocks, in very eroded marine angiosperm beds over sand in Watamu Marine Park, on patch reefs at Malindi Marine Park and dredged from coral and sand substrate at 18 m from Mwana wa Mwana, Zanzibar Channel.

Colour in life : as in frontispiece of CLARK and ROWE (1971).

Ophioplocus imbricatus (MÜLLER & TROSCHER, 1842)

In algal mats on wave cut platform at Kibirijini, amongst coral heads on patch reefs at Malindi Marine Park and reef flats off Kilifi town.

Colour in life : dark grey-green dorsal surface with paler irregular patches on disc and pale bands on arms alternating equally with dark bands three to four segments wide, ventral arm surface mid-brown with grey-green banding as on dorsal surface with paler irregular patches on disc and pale bands on arms alternating equally with dark bands three to four segments wide, ventral arm surface mid-brown with grey-green banding as on dorsal surface. Other individuals grey-brown disc and arms with dark grey-green transverse arm bands 1 - 5 segments wide, paler but similar below.

CLASS ECHINOIDEA

Cidaridae

Eucidaris metularia (LAMARCK, 1816)

Common amongst encrusting corals in the deeper parts of the channel into Mida Creek. Also dredged from coral and sand substrate at 18 m on Mwana wa Mwana, Zanzibar Channel and coral substrate at 15 m on Levin Bank. It is not widespread where coral and sea grass occur together, as on Aldabra (SLOAN *et al.*, 1979).

Prionocidaris baculosa (LAMARCK, 1816)

Found only on the outer reef slope at Kibirijini Point.

Colour in life : overall chocolate brown, primary spines pale brown where not encrusted.

Prionocidaris verticillata (LAMARCK, 1816)

Sparse under coral and boulders in marine grass areas of Watamu Marine Park, more common in similar habitats at the entrance to Mida Creek.

Colour in life :jungle green with surrounding whorl of secondary spines grey.

Diadematidae

Astropyga radiata (LESKE, 1778)

Single test taken from sand patch in marine angiosperm bed in Watamu Marine Park; several found in sand patch of backreef area at Ras Ngomeni.

Diadema savignyi MICHELIN, 1845

Well distributed on the outer half of reef flats at Watamu Marine Park (2/100 m²) in and under coral and coral rock on marine angiosperm beds, dense aggregations on the top of patch reefs at Malindi Marine Park.

Diadema setosum (LESKE, 1778)

A few dense aggregations of large specimens in channel to Mida Creek on surface or in crevices up to 60/m² out of main currents and with spines exposed at ELWS. Rare on rock reefs of Watamu Marine Park.

Colour in life : black, red ring around anus and white spot over each genital pore.

One specimen with eight parasitic eulimid gastropods *Echinulima mittrei* (PETIT, 1951).

Echinothrix calamaris (PALLAS, 1774)

Scarce in crevices and beneath rocks on wave cut platform at Kibirijini Point, aggregations in crevices and beneath rocks and corals on rock reef at mouth to Mida Creek, near Big Three Caves, and on reef flats at Kilifi at ELWS.

Colour in life : purplish-brown, inter-ambulacral spines with fine to broad transverse white bands, tissue at base of spines light maroon.

Echinothrix diadema (LINNAEUS, 1758)

Few present in the deep channel into Mida Creek.

Stomechinidae

Stomopneustes variolaris (LAMARCK, 1816)

Extremely numerous and widespread ranging from holes along lower eulittoral on the medium energy shore at Kilifi to sublittoral fringe on the sheltered angiosperm beds in Watamu Marine Park. Occur also in rock reef at mouth of Mida Creek and in *Turbinaria* sp. mats at Kibirijini.

Toxopneustidae

Tripneustes gratilla (LINNAEUS, 1758)

Very abundant on the reef flats of Watamu Marine Park. More abundant in deeper water near reef edge (3.5/m²). Associated with angiosperm beds but also dense just inside surf zone with rocky substrate. Does not occur on sandy substrate if root mat is too eroded. May be rolled around continuously by the surf at low tide. Maximum density recorded 4.15/m² (mean of 50, 0.25 m² quadrats) 30 m inside surf zone then gradually declining for the next 150 m towards the shore. In all areas they were significantly aggregated.

Echinometra mathaei has peak density inshore and declines towards the surf zone. Dense aggregations on top of patch reef in Malindi Marine Park where they cover themselves with coral rubble; in Watamu Marine Park, where marine angiosperms are common, they cover themselves with leaves (see also *Toxopneustes pileolus*). Does not occur in Mida Creek or the entrance channel. *T. gratilla* grazes on *Cymodocea* sp. plants and several individuals may be seen grazing high up on a single plant. Wet weight 219 g \pm 40 s.d. (n = 16).

Colour in life : spines white, surface dark brown in ambulacral and interambulacral areas except along rows of tube feet where it appears mid brown. Primary spines normally inclined radially towards adjacent ambulacrum leaving clear test surface over most interambulacrum giving the general appearance of a pentaradiate brown cross.

Toxopneustes pileolus (LAMARCK, 1816)

Occurs widely over the reef flats of Watamu Marine Park but only on rubble or rocky substrate inside the surf zone with a mean density of 1.1/100 m². Dense aggregations on top of patch reef in Malindi Marine Park. In both areas they cover themselves mostly with coral rubble and shells but use some angiosperm leaves when they are present such as at Watamu. Usually with commensal shrimp *Gnathophylloloides mineri* SCHMITT (Crustacea : Gnathophyllidae).

Appearance in life : large petaloid pedicellariae pale pink with white rim, spines pinkish-maroon with white tips.

Parasalenidae

Parasalenia gratiosa A. AGASSIZ, 1863

Abundant in substrate of algal cemented area of fringing reef of Watamu Marine Park.

Echinometridae

Colobocentrotus atratus (LINNAEUS, 1758)

Abundant in the lower eulittoral of the medium energy cliff face at Ras Ngomeni. In dense aggregations in notches of rock with *Echinometra mathaei*, *Stomopneustes variolaris*, *Heterocentrotus mammillatus* and *H. trigonarius*.

Colour in life : black to deep purple-brown, peristome reddish-brown.

Echinometra mathaei (de BLAINVILLE, 1825)

Associated with all marine angiosperm root mats in Watamu Marine Park reaching maximum density of 2.1/m² (mean of 50, 0.25 m² quadrats) about 60 m offshore and declining towards the surf zone on the fringing reef. Numerous on cliffs of medium energy shore at Ras Ngomeni and on the top of the rock reef there. Occurs associated with coral debris, coral micro-atolls and on rock reefs in all areas examined either in rock crevices or free on surface. Also on the high energy shore at Kilifi, Ranges from just above ELWS to at least 30 m.

Colour in life : variable, spine colour purple/green spines with purple tips and grey-green base or jungle green spines with purple tips.

Has commensal shrimp *Athanas areteformi* COUTIERE (Crustacea : Alpheidae) which also occurs on *Toxopneustes pileolus* and *Tripneustes gratilla* and parasitic molluscs.

Echinostrephus molaris (de BLAINVILLE, 1825)

Common in burrows on cliffs of medium energy shore at Ras Ngomeni, in burrows on rock reefs in Watamu Marine Park at low water and abundant in deep burrows in encrusting corals and algae off the channel entrance to Mida Creek. Also dredged from sand and coral substrate at 15 m on Levin Bank, Zanzibar Channel.

Polynoid *Lepidonotus purpurea* commensal in burrows.

Heterocentrotus mammillatus (LINNAEUS, 1758)

Abundant in the mid eulittoral of cliffs on medium energy shore at Ras Ngomeni in crevices. See *Colobocentrotus atratus* for associated species.

Colour in life : uniformly mid brown.

Heterocentrotus trigonarius (LAMARCK, 1816)

Abundant in crevices in the mid eulittoral on cliffs of medium energy shore at Ras Ngomeni. See *Colobocentrotus atratus* for associated species.

Colour in life : uniformly mid brown. The different spine development in the *Heterocentrotus* spp. was not obvious to me in the field at my only meeting with them.

Echinoneidae

Echinoneus cyclostomus (LESKE, 1778)

Rare beneath rocks at the sublittoral fringe on rock reef near Big Three Caves.

Colour in life : deep red unlike Aldabra specimens which are green.

Clypeasteridae

Clypeaster fervens KOEHLER, 1922

Taken on marine angiosperm beds over sand to the north of Watamu Marine Park.

Clypeaster rarispinus de MEIJERE, 1902

Dredged from fine grey mud with associated rich bivalve population at 50 m at Tumbatu, Zanzibar Channel.

Clypeaster reticulatus (LINNAEUS, 1758)

Rare; test taken beneath rocks amongst coral heads near Whale Island. Beneath rock on wave cut platform at Kibirijini and dredged from sand and coral at 18 m on Mwana wa Mwana, Zanzibar Channel. One individual found being eaten by *Paranepanthia* sp.

Laganidae

Laganum depressum LESSON in L. AGASSIZ, 1841

In sand from sheltered backreef areas of Watamu Marine Park, angiosperm beds on reef flats to the north of Kilifi River outlet and beneath rocks at the fish pens in Malindi.

Colour in life : background off-white with pale purplish-brown blotches, dark pigment surrounding mouth and anus.

Laganum joubini KOEHLER, 1922

Dredged from sand and coral substrate at 18 m on Mwana wa Mwana, Zanzibar Channel.

Astriclypeidae

Echinodiscus bisperforatus LESKE, 1778

Taken by Mr. N. KELLY washed up in large numbers on gently sloping sand beach at Lamu, August 1969.

Spatangidae

Maretia planulata (LAMARCK, 1816)

Test only taken from rock pool in rock reef near Big Three Caves.

Schizasteridae

Schizasterid sp., damaged. Taken from the angiosperm beds in Watamu Marine Park.

Brissidae

Brissus latecarinatus (LESKE, 1778)

Tests common deep in channel to Mida Creek beneath rocks and few on reef flats to the north of Kilifi inlet; no live specimens taken.

Metalia sternalis (LAMARCK, 1816)

Single specimen taken from Pange Reef, Zanzibar Harbour.

CLASS HOLOTHURIOIDEA

Holothuriidae

Actinopyga sp. prob. *echinites* or *miliaris*

Taken from beneath a rock in the channel to Mida Creek and on wave cut platform at Kibirijini Point. Carried commensal polynoid

Gastrolepidia clavigera.

Actinopyga mauritiana (QUOY & GAIMARD, 1833)

Beneath rocks on rock reef near Big Three Caves.

Carried commensal polynoid *Gastrolepidia clavigera*.

Colour in life : when contracted is deep chocolate brown and creviced surface; crevices bordered with light grey border; uniformly deep brown immediately surrounding cloaca; grey below.

Actinopyga miliaris (QUOY & GAIMARD, 1833)

Found only in main channel of the Mida Creek inlet at 3 m.

Appearance in life : mid brown surface with cruched appearance like dried mud, sole white sharply demarcated from brown dorsal surface.

Actinopyga sp.

Abundant on sea floor adjacent to patch reefs at Malindi Marine Park. Has commensal portunid crab *Lissocarcinus orbicularis* DANA.

Bohadschia koellikeri (SEMPER, 1868)

Abundant on the top of the patch reefs at Malindi Marine Park and scarce on reef flat angiosperm back of Watamu Marine Park.

Colour in life : bold camouflage pattern in deep brown and beige, tube feet spread over surface give white dotted surface and often hold marine angiosperm leaves over the surface of the animal (cf. *Tripneustes gratilla*).

Commensals include *Lissocarcinus orbicularis*, *Gastrolepidia clavigera* and small white ophiuroid (not determined).

Bohadschia marmorata JAEGER, 1833

Widespread in Mida Channel and throughout Watamu Marine Park.

Colour in life : well defined cream coloured sole with white longitudinal band about 1/6th width running longitudinally along ventral surface. Rest of surface cream background mostly obscured by bold charcoal-grey and brown blotches or speckles.

Carried portunid crab *Lissocarcinus orbicularis* and polynoid *Gastrolepidia clavigera*.

Labidodemas semperianum SELENKA, 1867

Beneath rock on reef flats near surf zone in Watamu Marine Park. Extension of Range from Bay of Bengal and Pacific.

Colour in life : white with pale purple-brown anterior and posterior ends.

Holothuria (Halodeima) atra (JAEGER, 1833)

Abundant in angiosperm beds and rubble areas of Watamu Marine Park.

The commensal polynoid *Gastrolepidia clavigera* SCHMARDA, 1861 common, frequently 2 or 3 per host. The portunid crab *Lissocarcinus orbicularis* also commonly associated with usually 1 or 2 per host.

Holothuria (Lessonothuria) pardalis SELENKA, 1867

See comments in SLOAN *et al.* (1979).

Abundant in the channel to Mida Creek, on the rock reefs near Big Three Caves and associated with limestone cobbles of Watamu Marine Park.

Colour in life : grey-brown to green-brown sometimes with globular appearance.

Holothuria (Mertensiothuria) fuscocinerea JAEGER, 1833

Single specimen taken from cobble ridge in surf zone of fringing reef in the north of Watamu Marine Park.

Colour in life : mid brown above with gnarled appearance.

Holothuria (Mertensiothuria) leucospilota (BRANDT, 1835)

Found widely beneath rocks and coral in Mida Creek and in the deeper backreef channels of Watamu Marine Park. Not found in eu-littoral as on Aldabra.

Colour in life : deep charcoal-grey over all surfaces only relieved on the sole by pale grey tube feet.

Holothuria (Mertensiothuria) pervicax SELENKA, 1867

Not common, found on rock reefs at night inshore in Watamu Marine Park and in the channel to Mida Creek.

Holothuria (Metriatyla) scabra JAEGER, 1833

Abundant on sand on sea floor adjacent to patch reef at Malindi Marine Park, also deep into Mida Creek (4 km from sea) 3/4 buried in fine mud off Suda Island.

Colour in life : brown with small white spots dorsally, or a few pale blotches, sides becoming pale and sole milky white.

Often with commensal portunid *Lissocarcinus orbicularis* varying from brown carapuce to large brown reticulation on white background, usually 2 - 4 individuals; also usually with commensal polynoid *Gastrolepidia clavigera* SCHMARDA.

Aldabra specimen from Passe du Bois had commensal carapid fish *Carapus neglectus* and the palaemonid shrimp *Periclimenes imperator* BRUCE.

Holothuria (Microthele) nobilis (SELENKA, 1867)

Scarce in sand areas near corals heads of Watamu Marine Park and in fast current in the deeper parts of the channel to Mida Creek.

Colour in life : dark chocolate brown with large raised white areas adjacent to sole, tube feet milk white but background brown.

Some with commensal polynoid *Gastrolepidia clavigera* SCHMARDA, 1861 with mottled black and white scales.

Holothuria (Semperothuria) cinerascens (BRANDT, 1835)

Abundant in the channel to Mida Creek in deeper waters and at Kibirijini beneath ledges and cobbles on the wave cut platform.

Holothuria (Thymiosycia) hilla LESSON, 1830

Common beneath rocks on rock reef near Big Three Caves.

Appearance in life : shaggy tentacles white in reflected light and pale blue in transmitted light, tube feet light cream with yellow discs. Background colour of ventral and dorsal surfaces mid brown with white papillae, where body wall expanded the papillae expand to translucent white patches.

Holothuria (Thymiosycia) impatiens (FORSKAAL, 1775)

Abundant cryptic species beneath rocks in Mida Creek and beneath microatolls, boulders and corals of Watamu Marine Park. Also abundant in boulder zone inshore of rock reef at Ras Ngomeni.

Colour in life : variable, grey, yellow beneath with orange apexed papillae covering surface, or grey-brown or purple brown with yellow papillae.

Stichopodidae

No *Stichopus chloronotus* BRANDT, 1835 were found at any sampling site, despite its epifaunal habit and abundance on reef flats at Aldabra and Mauritius. Aldabra specimens had immature *Lissocarcinus orbicularis* and an undescribed eulimid mollusc *Melanella* sp.

Stichopus variegatus (SEMPER, 1868)

Found rarely in the channel to Mida Creek as well as deep into Mida Creek adjacent to the mangroves in flowing water of drainage channels.

Colour in life : grey-green with deep, mostly transverse, folding above, below pinkish overall most obviously between three longitudinal bands of tube feet.

Thelenota ananas (JAEGER, 1833)

Single specimen found in the deep section of Mida Channel on sand next to mangroves. Range extended from Islands of Western India Ocean, the Maldive Islands and Mascarene Islands.

Appearance in life : shaggy, orange-brown above, light red band of tube feet about half the width of sole running longitudinally, lateral podia and oral tentacles orange-yellow, stems of podia deep red.

Had three *Lissocarcinus orbicularis* DANA, 1852 and carapid fish. Specimens from Aldabra also had commensal shrimps *Periclimenes imperator*.

Specimens from Aldabra and Watamu had commensal carapid fish *Carapus neglectus*.

Phylloporidae

Afrocucumis africana (SEMPER, 1868)

Abundant beneath rocks in Mida Creek on the foreshore of Watamu Marine Park and on Kibirijini in crevices on the wave cut platforms and rock reefs.

Colour in life : pinkish blue overall.

Synaptidae

Opheodesoma sp. prob. *O. spectabilis* FISCHER, 1907

Tentacular crown lost; taken from beneath rocks inshore of raised rock reef at Ras Ngomeni. If the identification is correct it extends the range from Western Pacific.

Colour in life : deep brown above becoming greyish below, in contracted state becomes red-brown.

Synapta maculata (CHAMISSO & EYSENHARDT, 1821)

Rare in channel of Mida Creek and in sheltered water along the mangrove fringe of Mida Creek.

Colour in life : grey tentacles, body apparently with broad longitudinal bands of fawn and mid brown, closer examination shows effect caused by irregular patches of black over beige background.

ACKNOWLEDGEMENTS

The Royal Society, East African Wildlife Society and Ministry for Overseas Development provided major financial support and one hundred and fifty individuals and institutions contributed to the success of the Bangor-Watamu Expedition in the innumerable ways mentioned in the preliminary report (JONES, 1971). The collection was made jointly by all members of the expedition and with permission of the Kenyan Ministry for Tourism and Wildlife. Ailsa CLARK provided facilities and patient help over many years, identified or confirmed much material and with Norman SLOAN's help prodded me into this belated report. For confirmation or identification of the non-echinoderm material, I have been fortunate to have the assistance of Peter GIBBS (Polychaetes), Anders WARREN (Molluscs), Janet HAIG (Portunids) and Mary WICKSTEN (Shrimps) at whose institutes the material is deposited. The East African Marine Fisheries Research Organisation provided dredging facilities.

- BALINSKY, R. (1971) - *Natural History*, Publ. n° 190, 1-238.
- CLARK, A.M. (in press) - *Some Ophiuroidea from the Seychelles Islands and Idhaca, Mozambique*. - *Seas Zool. off.*
- HERRING, F.C. (1972) - *Observations of the distribution and feeding habits of some littoral echinoids from Zanzibar*. - *J. mar. Biol. Ass. U.K.* 52, 159-175.
- JONES, D.E. (ed) (1971) - *Preliminary report of the Bangor-Watamu Expedition*. - Bangor-Watamu Expedition, Bangor.
- ROWE, F.W.C. (and DUTY) (1977) - *The shallow-water holothurians of Guam*. - *Marine Biology* 43 (2), 217-230.
- SLOAN, N.A., CLARK, A.M. and TAYLOR, J.D. (1979) - *The Echinoderms of Aldabra and their habitats*. - *Bull. Br. Mus. Nat. Hist. (Zool.)* 17 (2), 51-128.
- STODDART, D.E. (ed) (1967) - *Biology of Aldabra Atoll, Indian Ocean*. - *Bull. Br. Mus. Nat. Hist.* 13, 1-41.

REFERENCES

- BALINSKY, B.I. (1958) - The Echinoderms, pp. 96-107, *in* MACNAE, W and KALK, M. (eds). - Natural History of Inhaca Island, Moçambique. - Johannesburg.
- BRANDER, K.M., McLEOD, A.A.Q.R. and HUMPHREYS, W.F. (1971) - Comparison of species diversity and ecology of reefliving invertebrates on Aldabra Atoll and at Watamu, Kenya. - *Symp. Zool. Soc. Lond.*, n° 28, 397-431.
- CHERBONNIER, G. and GUILLE, A. (1978) - Echinodermes : Ophiurides. - *Faune de Madagascar*, Paris (C.N.R.S.), n° 48, 1-272, 77 figs., 17 pls.
- CLARK, A.M. and ROWE, F.W.E. (1971) - *Monograph of shallow-water Indo-Pacific echinoderms*. British Museum (Natural History), Publ. n° 690, 1-238.
- CLARK, A.M. (in press) - Some Ophiuroidea from the Seychelles Islands and Inhaca, Mozambique. - *Revue Zool. afr.*
- HERRING, P.J. (1972) - Observations of the distribution and feeding habits of some littoral echinoids from Zanzibar. - *J. nat. Hist.*, 6, 169-175.
- JONES, D.A. (ed) (1971) - *Preliminary report of the Bangor-Watamu Expedition*. - Bangor-Watamu Expedition, Bangor.
- ROWE, F.W.E. and DOTY (1977) - The shallow-water holothurians of Guam. - *Micronesica* 13 (2), 217-250.
- SLOAN, N.A., CLARK, A.M. and TAYLOR, J.D. (1979) - The Echinoderms of Aldabra and their habitats. - *Bull. Br. Mus. Nat. Hist.*, (Zool.), 37 (2), 81-128.
- STODDART, D.R. (ed) (1967) - Ecology of Aldabra Atoll, Indian Ocean. - *Atoll Res. Bull.*, 118, 1-41.