

**ATOLL RESEARCH BULLETIN**

**NO. 411**

**CHAPTER 13**

**ECHINODERMS OF THE COCOS (KEELING) ISLANDS**

**BY**

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**ISSUED BY**  
**NATIONAL MUSEUM OF NATURAL HISTORY**  
**SMITHSONIAN INSTITUTION**  
**WASHINGTON, D.C., U.S.A.**  
**FEBRUARY 1994**

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**INTRODUCTION**

The first extensive collection of echinoderms of the Cocos (Keeling) Islands was made by C.A. Gibson-Hill who was Resident Medical Officer at the Cable Station on Direction Island (Pulu Tikus) between December 1940 and November 1941. Prior to this Gibson-Hill was Resident Medical Officer at Christmas Island from September 1938 to December 1940, where he also made extensive natural history collections. His specimens and field notes were deposited in the Raffles Museum, Singapore in 1941. One of Gibson-Hill's aims was to be able to compare the fauna of the Cocos (Keeling) Islands with that of Christmas Island. His other aim was to document the terrestrial and reef fauna of the Cocos (Keeling) Islands as it stood at that time.

Unfortunately some of his notes and collections were lost during the wartime occupation of Singapore. Among the marine invertebrates the specimens and field notes of soft corals and anemones and most holothurians were lost but a copy of the field catalogue of the holothurians remained (Gibson-Hill 1950a, b).

A.H. Clark (1950) described Gibson-Hill's echinoderm collection and included his very useful field notes. Clark notes that specimens of the family Linckiidae (Ophidiasteridae) were sent to Dr H. Engel of Amsterdam who was preparing a monograph on this family for the Siboga expedition reports. Unfortunately neither the 'Linckiidae' of the Siboga Expedition nor those of Cocos (Keeling) were published.

The present collection numbers 82 species collected from 13 reef flat sites, nine outer slope sites and 13 lagoon sites (Chapter 1, Fig. 2). It consists of 2 species of Crinoidea, 15 Asteroidea, 17 Ophiuroidea, 14 Echinoidea and 34 Holothurioidea listed at the end of this report. Most are widespread Indo-West Pacific species but there are several westward extensions of range from Indonesia or Christmas Island and one south-eastward extension from Sri Lanka. When added to the species recorded by Clark (1950) the total known echinoderm fauna is now 89 species (4 crinoids, 17 asteroids, 17 ophiuroids, 17 echinoids and 34 holothurians).

**Crinoidea**

Clark (1950) noted that crinoids were rare on the accessible portions (reef platforms) of the Cocos (Keeling) Islands. From the present survey I can confirm this and note that they are also rare on the outer slopes. Crinoids were only collected at four sites, three on the outer slopes and one in the northern part of the lagoon. Only two species were represented, one of which was also recorded by A.H. Clark (1950). Colin (1977) notes that in five weeks of collecting (fishes) in 1974 only a single small crinoid was found.

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\* Western Australian Museum, Francis Street, Perth, Western Australia, 6000.

The crinoid fauna is even more depauperate than that of Christmas Island where eight species were recorded (Marsh 1988). This compares with 38 species found at Ashmore Reef (Marsh et al. in press) and 17 at the Rowley Shoals and Scott Reef (Marsh 1986) off north-western Australia and five from the isolated Western Indian Ocean atoll of Aldabra (Sloan et al. 1979). Clark and Taylor (1971) did not record any crinoids from Diego Garcia in the central Indian Ocean.

Coral reef crinoids have a short larval life (Mortensen 1938) and few species are widely distributed in the Pacific and Indian Oceans. The species found at the Cocos (Keeling) Islands are among those whose distribution extends from the Red Sea or Western Indian Ocean to the western Pacific Ocean, apart from *Stephanometra spinipinna* (recorded by A.H. Clark), which is known only from Indonesia and northern Australia.

### Asteroidea

Clark (1950) recorded only four species of starfishes from Gibson-Hill's collection but these did not include any members of the family Ophidiasteridae (Linckiidae), the family generally best represented on coral reefs. Gibson-Hill collected 141 specimens of this family, which were sent to Engel in Amsterdam who was currently working on a collection of the same family from Indonesia. Unfortunately Engel did not complete either project. I had been told that the Cocos specimens were still at the Natural History Museum in Amsterdam but on a recent visit there the collection could not be found. Neither is it in the University Museum collection in Singapore (formerly the Raffles Museum Collection). There is therefore no historical record of Ophidiasterids from the Cocos (Keeling) Islands.

The present collection contains 15 species of Asteroidea and a further two were recorded by Clark (1950). This is the same number as that recorded from the Rowley Shoals (Marsh 1986), however only 11 species are in common. If the Rowley Shoals, Scott Reef and Ashmore Reef are taken together, 15 species are in common with Cocos, the same number as are in common between Cocos and Indonesia; however, Ashmore Reef has a much richer fauna (28 species) including four Oreasterids, generally regarded as 'continental' species. Cocos has more asteroid species (17) than Christmas Island (13) with only eight species in common, probably due in part to the more extensive reef flats at Cocos. When compared with the isolated atoll of Aldabra, in the Western Indian Ocean only seven of Aldabra's 19 species are in common with the Cocos Islands. A single species, *Culcita schmidiana*, is recorded from Diego Garcia, in the central Indian Ocean (Clark and Taylor 1971).

As at Christmas Island and Aldabra the small *Linckia multifora*, which reproduces asexually by autotomy, is the most common asteroid and is found in all habitats at Cocos (Keeling), from the outer slopes (6 sites) and reef flats (6 sites), where it is usually small, to the lagoon where exceptionally large individuals (for the species) were found at site 35.

Most other species were found at only two or three sites but *Ophidiaster granifer* was unexpectedly found on the outer slope, on reef flats and in the lagoon. This species is usually confined to reef flats.

*Nardoa tuberculata*, usually found in the open on reef flats, was only found in lagoon holes on coral rubble.

Several species were only found at one site and it is possible that other uncommon species may be found in areas not sampled in this survey.

*Acanthaster planci* (crown-of-thorns starfish) was found on the outer slope, on a reef flat and in the lagoon but was only seen at three sites. In a lagoon hole, south of Direction Island about 20 individuals were observed but the greatest number (> 50) were seen on the outer slope of Turk Reef (stn 15) at 10-45 m, where there was very little coral. The following records indicate that large populations of *A. planci* have been present more than once in the past. Clark (1950) quoted from Gibson-Hill's field notes stating that "*A. planci* is very conspicuous on the atoll but not very common. It occurs among coral rocks near the low tide level over the centre and outer portions of the barrier. It is most plentiful on the north and east coasts of the atoll". In 1971 a former resident of Cocos (Keeling) reported to the Western Australian Museum that the reef off Ujong Tanjong, at the north end of West Island, which had been a flourishing coral reef in 1963 was, by the end of 1969, considerably damaged by *A. planci* predation and there was a very large population of young specimens from about 100 to 320 mm in diameter. She did not find any near Pulu Beras where Gibson-Hill had collected them in 1941. There is no record of any observations on the outer slopes during this period. Ms Anne Waldron, who collected echinoderms on the reef flats at a number of localities around West Island in January 1972, did not find any *A. planci*, but noted that residents of West Island said they were present but not in large numbers. During the course of an ichthyological survey of the Cocos reefs in 1974 Colin (1977) found extensive areas of dead coral on the outer slopes to a depth of 45 m which he attributed to *Acanthaster* predation. Large *A. planci* were abundant at depths of 15-30 m on the outer slopes, at a density of about 1 per 200-400 m<sup>2</sup> but few small individuals were seen. He also noted 'islands' of living coral on some of the buttresses of the outer slope while adjacent areas were dead. It seems likely therefore that recurring high levels of *Acanthaster* predation are responsible for the low level of coral cover on the outer reef slopes.

Of great interest was the finding of several specimens of *Tegulaster ceylanicus*, on the outer slope of the Home Island reef. This species was previously known only from Sri Lanka and the Lakshadweep Islands, although a congener has been collected on the Great Barrier Reef, Queensland. The two species differ slightly but, as both are described from single specimens it is not possible to determine whether they are variations of the one species.

The collections made on the Cocos (Keeling) reefs have extended the known distribution of several species: *Celerina heffernani* for which the only previous Indian Ocean locality was Christmas Island (Western Australian Museum coll.); it is also known from Indonesia (Guille and Jangoux 1978) and the Western Pacific. Similarly, the range of *Neoferdina cumingi*, is extended westward from Christmas Island; published records are from the Central Pacific to Christmas Island (Jangoux 1973). *Ophidiaster granifer* has not previously been recorded from the Indian Ocean although there is a specimen in the Western Australian Museum collection from Madagascar; previous records are from the western Pacific to Indonesia. *Nardoa tuberculata* is a common species on reef flats in Indonesia and northern Australia but the only previous record from the Indian Ocean is Andrews (1900) record from Christmas Island. However, this species was not found there by the Western Australian Museum in 1987 and its occurrence may be sporadic.

## Ophiuroidea

Clark (1950) recorded only eight species of Ophiuroids, most of these being large species common on the reef flats. The present collection numbers 17 species (including all the species recorded by Clark) a low number compared with Christmas Island (33) (Marsh 1988), the Rowley Shoals (28), Scott Reef (38) (Marsh 1986), Ashmore Reef (42) (Marsh et al. in press), Aldabra (39) (Sloan et al. 1979) and Diego Garcia (10) (Clark and Taylor 1971).

The low number of species may to some extent reflect less collecting effort on the outer slopes than at Christmas Island. However, extensive sampling of lagoon and reef flat habitats including sand sifting, examination of weed mats and breaking up rocky substrate yielded very few small species. Large ophiocomids were common and in some cases abundant under boulders on the reef flats. *Ophiocoma scolopendrina* and *Ophiomastix annulosa* were the most abundant, often with 4-5 of the latter under almost every boulder. *O. scolopendrina* was found under boulders but also occupied crevices in the reef from which it extended 3-4 arms which turn upside down to sweep the surface scum on the incoming tide. *Ophiocoma brevipes* was moderately common among seagrasses on sandy areas of the reef flats while *O. erinaceus* was found under boulders on the mid and outer reef flats. *O. anaglyptica* was found on the mid and outer reef flats, exposed to surf.

The only new record for the Indian Ocean is *Ophiarachnella similis* whose range is extended westward from Indonesia. Fifteen of the 17 species are in common with Christmas Island and all occur off north-western Australia and Indonesia. Eleven are in common with Aldabra and six with Diego Garcia.

## Echinoidea

A.H. Clark (1950) recorded 15 species of echinoid of which we failed to find three, but added another two making a total of 17 species now known from the Cocos (Keeling) Islands. The species are all widespread throughout the Indo-West Pacific including north-western Australia. Twelve species are in common with Christmas Island which apparently lacks all but one of the sand-dwelling Brissids and the Clypeasterid but has several species on surf-swept rocky shores, not found at Cocos, giving it a total of 18 species. In comparison with north-western Australian reefs there are more species than at the Rowley Shoals, where 14 are recorded although 22 have been found on the Rowley Shoals and Scott Reef combined and 23 on Ashmore Reef. Fourteen of the species are in common with Aldabra which has a total of 31 species (Sloan et al. 1979) and eight of Diego Garcia's nine species are in common with Cocos (Keeling).

The brissids and clypeasterid were found only in the South Passage area and no live specimens were taken apart from one freshly predated specimen of *Metalia spatagus*. Extensive observation of the sand flats at the south end of the lagoon failed to find any others. Clark (1950) reports that Gibson-Hill found brissids near passages on the eastern side of the atoll but we were unable to examine this area.

Despite the extensive die-off of lagoon fauna in 1983 (see Woodroffe and Berry, this volume) we found *Parasalenia gratiosa* to be abundant under dead coral slabs in lagoon

holes in the same habitat as that described by Gibson-Hill (1950). This was the only habitat in which this species was found.

### Holothurioidea

As noted in the introduction, Gibson-Hill's collection of holothurians from the Cocos (Keeling) Islands was destroyed during World War II in Singapore.

The present collection is thus the only record of holothurians from the islands. The Cocos (Keeling) Islands have a fairly rich fauna of holothurians, including most of the species used for trepang (Bêche-de-mer). Thirty four species were collected compared with 16 at Christmas Island, 28 at Scott Reef/Rowley Shoals (Marsh 1986), 47 at Ashmore Reef (Marsh et al. in press) and 35 species at Aldabra (Sloan et al. 1979).

Although the extensive sand flats in the lagoon might be regarded as suitable habitat for holothurians, the majority (30 species) were found either on reef flats or in sandy areas adjacent to reef flats, as at South Passage. Only four species were found on the outer slopes. Ten species were found at lagoon sites but only one of these (*Synaptula recta*) was not found in other habitats.

All but three of the holothurians are species widespread in the Indo-West Pacific, the exceptions are *Holothuria (Acanthotrapeza) coluber*, *H. (Metriatyla) aculeata* and *Chiridota rigida* the range of which is extended westward from Indonesia and north-western Australia to the Cocos (Keeling) Islands.

The zonation of common reef flat species near the settlement on West Island is shown in Figure 1.

### Trepang (Bêche-de-mer species)

Species of a large size with a thick body wall are the only ones suitable for processing for food. At the Cocos (Keeling) Islands seven species of commercial value have been found. No estimates of population size could be made in the time available but indications are given of the sites where the commercial species were most common.

The most valuable species are the teal fish, *Holothuria (Microthele) nobilis*, and other species of the subgenus. *H. (Microthele)* spp. are nowhere common but individuals were seen or collected at five reef flat and two lagoon sites (List of echinoderms). *Thelenota ananas* (prickly red fish) is another large, valuable species but this was only found at one outer slope site. Other commercial species, their value depending to some extent on size, are two species of *Actinopyga* (*A. echinates* and *A. mauritiana*), both common to abundant on reef flats particularly at West Island; another commercial species *A. miliaris* may occur at Cocos but was not found during the survey. Several less valuable commercial species were also found: *Bohadschia marmorata* (chalky fish), *Holothuria (Metriatyla) scabra* (sand fish) and *H. (Halodeima) atra*. *B. marmorata* and *H. scabra* were found on the lagoon side of South Passage near Pulu Maria where the former was moderately common. *B. marmorata* was also seen in the lagoon south of Direction Island. *H. atra* is the most widespread of any species at Cocos and was common in all habitats but it is of very little commercial value unless individuals are of a very large size; it is a highly toxic species. *Bohadschia argus* (leopard or tiger fish), although of fairly large size, and common on some of the sandy reef flats has a very low commercial value partly because of

the toxic cuvierian tubules ejected when the animal is touched. None of the other species listed is believed to have any commercial value. Little is known of growth rates of commercial species and any attempt at exploitation of the populations should be carefully monitored and certain areas reserved from exploitation. Quantitative population studies need to be made of the potentially commercial species before any fishing takes place and on-going studies of recruitment and growth should be initiated.

It should be noted that all the commercial species have water soluble toxins in the body wall and can only be eaten after correct preparation.

#### ACKNOWLEDGEMENTS

I am very grateful to Ms Anne Waldron who collected echinoderms for the Western Australian Museum from various localities during a visit to West Island in 1972 and to Ms Diana Applehof for her observations of *Acanthaster* at the Cocos (Keeling) Islands.

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## LIST OF ECHINODERMS

### KEY TO SYMBOLS:

C	=	A.H. Clark, 1950 (C) species by another name
+	=	Spec. from various sources in Western Australian Museum
eg 6	=	Western Australian Museum 1989 station numbers
V	=	Visual records
*	=	New records
#	=	Extension of distribution

Echinodermata	Previous Records	Collection Station
<b>Crinoidea</b>		
COMASTERIDAE		
* <i>Comaster multifidus</i> (Müller, 1841)	-	15,19
MARIAMETRIDAE		
<i>Stephanometra indica</i> (Smith, 1876)	C	-
<i>S. spicata</i> (Carpenter, 1881)	C	13,23
<i>S. spinipinna</i> (Hartlaub, 1890)	C	-
<b>Asteroidea</b>		
OREASTERIDAE		
<i>Culcita schmideliana</i> (Retzius, 1805)	(C)	7,12
OPHIDIASTERIDAE		
#* <i>Celerina heffernani</i> (Livingstone, 1931)	-	7,25
* <i>Cistina columbiae</i> Gray, 1840	-	25
* <i>Dactylosaster cylindricus</i> (Lamarck, 1816)	-	11,12,24
* <i>Fromia milleporella</i> (Lamarck, 1816)	-	13,32
* <i>Linckia guildingii</i> Gray, 1840	-	4,19
* <i>L. laevigata</i> (Linnaeus, 1758)	-	12,30V
* <i>L. multifora</i> (Lamarck, 1816)	-	3,4,6,7,10,12,13,14, 15,19,30,32,35
#* <i>Nardoa tuberculata</i> Gray, 1840	-	29,36
* <i>N. galatheae</i> (Lütken, 1864)	-	7,9,19,23
#* <i>Neoferdina cumingi</i> (Gray, 1840)	-	13,22
#* <i>Ophidiaster granifer</i> (Lütken, 1872)	-	4,6,26,27,29,30
* <i>O. cribrarius</i> Lütken, 1872	-	8

<b>MITHRODIIDAE</b>				
<i>Mithrodia clavigera</i> (Lamarck, 1816)	C	-	-	
<b>ASTERINIDAE</b>				
#* <i>Tegulaster ceylanicus</i> (Döderlein, 1889)	-	-	33	
<b>ACANTHASTERIDAE</b>				
<i>Acanthaster planci</i> (Linnaeus, 1758)	C	-	8,9V,15V	
<b>ECHINASTERIDAE</b>				
<i>Echinaster luzonicus</i> (Gray, 1840)	C	-	-	
<b>Ophiuroidea</b>				
<b>AMPHIURIDAE</b>				
* <i>Amphipholis squamata</i> (Delle Chiaje, 1829)	-	-	24,35,37	
<b>OPHIACTIDAE</b>				
* <i>Ophiactis savignyi</i> (Müller and Troschel, 1842)	-	-	9,12,20,28,32,35	
<b>OPHIOTRICHIDAE</b>				
<i>Macrophiothrix longipeda</i> (Lamarck, 1816)	C	-	1,12,13,14,24,32	
<b>OPHIOCOTIDAE</b>				
<i>Ophiarthrum elegans</i> Peters, 1851	C	-	13	
* <i>Ophiocoma anaglyptica</i> Ely, 1944	-	+	1,12,14,24,27,30	
* <i>O. brevipes</i> Peters, 1851	-	+	1,5,10,14,24,27,30	
<i>O. dentata</i> Müller and Troschel, 1842	C	+	1,10,12,13,14,20,24,27	
<i>O. erinaceus</i> Müller and Troschel, 1842	C	-	1,6,8,9,12,13V,20,24,27,30,32	
<i>O. pica</i> Müller and Troschel, 1842	C	-	13,14,27,32	
* <i>O. pusilla</i> (Brock, 1888)	-	-	32	
<i>O. scolopendrina</i> (Lamarck, 1816)	C	+	1,6,10,12,20,24,27	
* <i>O. schoenleini</i> Müller and Troschel, 1842	-	-	9	
* <i>Ophiocomella sexradia</i> (Duncan, 1887)	-	+	3,20,24,35	
<i>Ophiomastix annulosa</i> (Lamarck, 1816)	C	-	1,3V,12,20,24,27,30	
<b>OPHIONEREIDIDAE</b>				
* <i>Ophionereis porrecta</i> Lyman, 1860	-	-	9	
<b>OPHIODERMATIDAE</b>				
#* <i>Ophiarachnella similis</i> (Koehler, 1905)	-	-	32	
<i>Ophiopeza spinosa</i> (Ljungman, 1867)	C	-	14	
<b>Echinoidea</b>				
<b>CIDARIDAE</b>				
<i>Eucidaris metularia</i> (Lamarck, 1816)	C	+	7,12,25,32	

## DIADEMATIDAE

<i>Diadema savignyi</i> Michelin, 1845	C	-	1,12,30V
<i>Echinothrix calamaris</i> (Pallas, 1774)	C	-	30
<i>E. diadema</i> (Linnaeus, 1758)	C	-	1,12,24V,27V,30V

## TEMNOPLEURIDAE

<i>Mespilia globulus</i> (Linnaeus, 1758)	C	-	16,29
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## TOXOPNEUSTIDAE

<i>Toxopneustes pileolus</i> (Lamarck, 1816)	C	-	-
<i>Tripneustes gratilla</i> (Linnaeus, 1758)	C	-	1,3V,9,12V,30

## PARASALENIIDAE

<i>Parasalenia gratiosa</i> A. Agassiz, 1863	C	-	16,17V,36
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## ECHINOMETRIDAE

<i>Echinometra mathaei</i> (de Blainville, 1825)	C	-	1,12,24
* <i>Echinostrephus molaris</i> (de Blainville, 1825)	-	-	27
<i>Heterocentrotus mammillatus</i> (Linnaeus, 1758)	C	+	4, 12, 19

## ECHINONEIDAE

<i>Echinoneus cyclostomus</i> Leske, 1778	C	-	-
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## CLYPEASTERIDAE

<i>Clypeaster reticulatus</i> (Linnaeus, 1758)	C	-	12
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## BRISSIDAE

* <i>Brissus latecarinatus</i> (Leske, 1778)	-	-	12,16
<i>Metalia dicrana</i> H.L. Clark, 1917	C	-	12
<i>M. spatagus</i> (Linnaeus, 1758)	C	-	12
<i>M. sternalis</i> (Lamarck, 1816)	C	-	-

## Holothurioidea

## HOLOTHURIIDAE

* <i>Actinopyga echinates</i> (Jaeger, 1833)	-	-	1,3V,12,24V,27V, 30V
* <i>A. mauritiana</i> (Quoy and Gaimard, 1833)	-	+	1,3V,5V,10V,12V, 20V,24,27V,30V
* <i>Bohadschia argus</i> Jaeger, 1833	-	+	5V,8V,12,30V
* <i>B. graeffei</i> (Semper, 1868)	-	-	19
* <i>B. marmorata</i> Jaeger, 1833	-	-	9V,12
* <i>Labidodemas semperianum</i> Selenka, 1867	-	-	12
#* <i>Holothuria (Acanthotrapeza) coluber</i> Semper 1868	-	-	9V,12
* <i>H. (Cystipus) rigida</i> (Selenka, 1867)	-	-	1
* <i>H. (Halodeima) atra</i> Jaeger, 1833	-	+	1,2,3V,5V,6V, 9V, 12V, 16, 18V, 19, 20V, 24V, 27V, 30V, 34V,36V,37V
* <i>H. (H.) edulis</i> Lesson, 1830	-	-	9,16,19,30
* <i>H. (Lessonothuria) lineata</i> Ludwig, 1875	-	-	3,12

*	<i>H. (L.) pardalis</i> Selenka, 1867	-	-	1,30
*	<i>H. (Mertensiorthuria) leucospilota</i> (Brandt, 1835)	-	-	10,12
*	<i>H. (Metriatyla) scabra</i> Jaeger, 1833	-	-	12
#*	<i>H. (M.) aculeata</i> Semper, 1868	-	-	12
*	<i>H. (Microthele) nobilis</i> (Selenka, 1867)	-	-	1,12,24,27,36V
	<i>H. (M.) sp.</i>	-	-	12,14,23
*	<i>H. (Platyperona) difficilis</i> Semper, 1868	-	-	1,24,27
*	<i>H. (Semperothuria) cinerascens</i> (Brandt, 1835)	-	+	1, 20, 24, 27
*	<i>H. (Stauropora) pervicax</i> Selenka, 1867	-	-	3
*	<i>H. (Thymiosycia) hilli</i> Lesson, 1830	-	+	8,12,23,30V
*	<i>H. (T.) impatiens</i> (Forskål, 1775)	-	+	8,9,12
 STICHOPODIDAE				
*	<i>Stichopus chloronotus</i> Brandt, 1835	-	+	1,3V,5V,6V,9, 12, 27V, 30V,34V,36V
*	<i>S. horrens</i> Selenka, 1867	-	+	12V,16
*	<i>S. variegatus</i> Semper, 1868	-	-	5
*	<i>Thelenota ananas</i> (Jaeger, 1833)	-	-	19
 PHYLLOPHORIDAE				
*	<i>Afrocucumis africana</i> (Semper, 1868)	-	-	1,3,6,14,24,27
 SYNAPTIDAE				
*	<i>Euapta godeffroyi</i> (Semper, 1868)	-	-	1
*	<i>Opheodesoma grisea</i> (Semper, 1868)	-	-	12
*	<i>Synapta maculata</i> (Chamisso and Eysenhardt 1821)	-	-	5,12V
*	<i>Synaptula recta</i> (Semper, 1868)	-	-	35,37
 CHIRIDOTIDAE				
#*	<i>Chiridota rigida</i> Semper, 1868	-	-	1,12
*	<i>Polycheira rufescens</i> (Brandt, 1835)	-	-	10

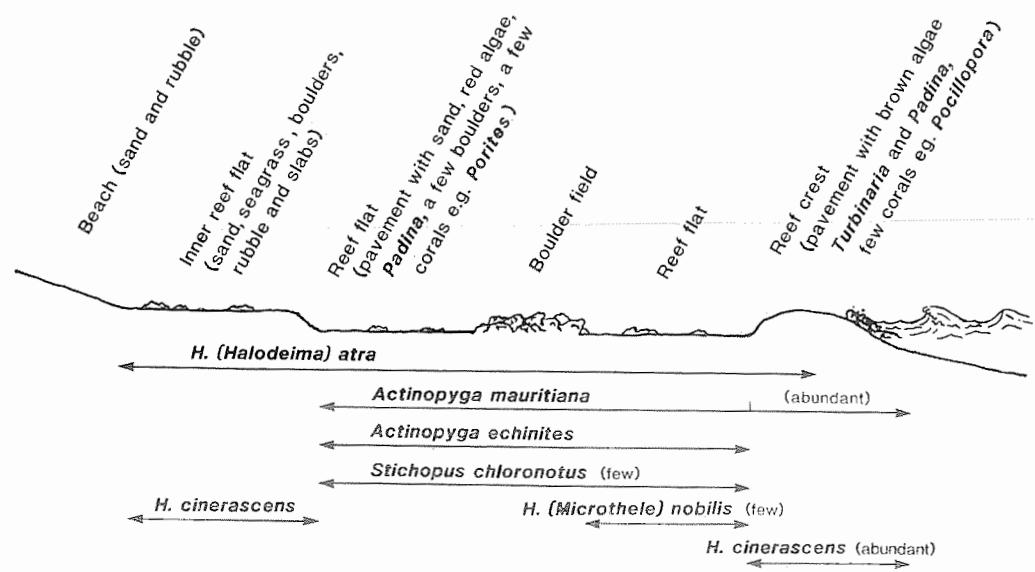


Figure 1. Zonation of holothurians on reef flat near settlement, West Island.