

Indian Ocean echinoderms collected during the *Sindbad Voyage* (1980–81): 3. Ophiuroidea and Echinoidea

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SYNOPSIS. At least 44 ophiuroid and 11 echinoid species are recorded from echinoderm collections made during an international expedition, the *Sindbad Voyage*, from Oman to China. Sampling localities include the little known Lakshadweep (Laccadive), Islands and Pula Wé (Sumatra) from which 71% of the species were recorded. Following the zoogeographic subdivisions of Clark & Rowe (1971), range extensions are recorded for ten of the ophiuroids: W. India (*Anphioplus* (*Lymanella*) sp.); Sri Lanka (*Ophiactis modesta*, *Ophiarachna robillardi*, *Ophiodyscira instratus*); Maldives area (*Cryptopelta granulifera*, *Ophiochaeta hirsuta*); and Indonesia / East Indies (*Amphiura* (*Amphiura*) *dejectoides*, *Amphiura* (*Amphiura*) *micra*, *Anphioplus* (*Anphioplus*) *stenaspis*, *Ophiogymna pellicula*). In addition to the taxonomic treatment, ecological information for each echinoderm species (habitat types, depth range) is provided and broadly analysed.

INTRODUCTION

The systematics and distribution of Indian Ocean ophiuroids and echinoids are treated in detail by Clark & Rowe (1971). Regions for which limited information is available include the Lakshadweep (Laccadive) Islands, Sumatra and other parts of SE Asia. Recent studies including the systematics and zoogeography of ophiuroids and echinoids for the Lakshadweeps include Nagabhushanam & Rao (1972) and James (1989), the latter yielding many new species records for both echinoderm classes, which fill in gaps in the distribution records of Clark & Rowe (1971). Recent work has also been undertaken in SE Asia, including Indonesia (Aziz, 1981) and the west coast of Thailand (Bussarawit & Rowe, 1985; Bussarawit, in prep.).

This paper reports on collections of ophiuroids and echinoids from these areas and other localities during an international, transdisciplinary voyage across the Indian Ocean from Oman to China. The expedition, *Sindbad Voyage*, was undertaken in 1980–81 aboard a replica of an ancient Arab sailing vessel, 'Sohar'. In addition to a systematic account, the zoogeographic significance of the results and the ecology of each species are broadly assessed. Details of the holothurian collections (Price & Reid, 1985) and asteroid collections (Marsh & Price, 1991) resulting from the expedition have already been published. Details of the crinoids collected are also being prepared (Marshall & Price, in prep.), and a detailed analysis of the ecology and biogeography of all five echinoderm classes will follow.

MATERIALS AND METHODS

Specimens were collected by one of us (A.R.G.P.) and other expedition members from localities at Muscat, Oman; Chetlat, Lakshadweeps (Laccadives); SW India; SW Sri Lanka; and Pula Wé, Sumatra. Details of the sampling localities are shown in Figure 1. Sampling was undertaken principally on coral reefs using scuba. At each locality details of habitat type and depth range were recorded, along with the number of individuals of each species. The number of specimens collected is placed in parenthesis after each station number in the Material lists for each species.

Material was fixed and preserved using standard methods (Lincoln & Shields, 1979). Although several specimens (inadvertently included with the asteroid collections) had been identified earlier by L.M. Marsh and a few preliminary identifications were made in the field by A.R.G.P., specimens were mostly identified by and all species confirmed by F.W.E.R. who is also responsible for taxonomic comments. The ophiuroid and echinoid collections are deposited at the Natural History Museum, London, where the holothurian collection (Price & Reid, 1985) and a representative collection of the asteroids (Marsh & Price, 1991) have also been lodged.

Following recent practice (e.g. Sloan, Clark & Taylor, 1979), systematic references are kept to a minimum by citing major works when possible (e.g. Clark & Rowe, 1971; Clark & Courtman Stock, 1976; Cherbonnier & Guille, 1978; Rowe & Gates, 1995) from which the original species descriptions, recent authoritative diagnoses and taxonomic decisions can be traced. In some instances, further references are given (e.g. Sloan *et al.*, 1979) to provide additional systematic or biological information.

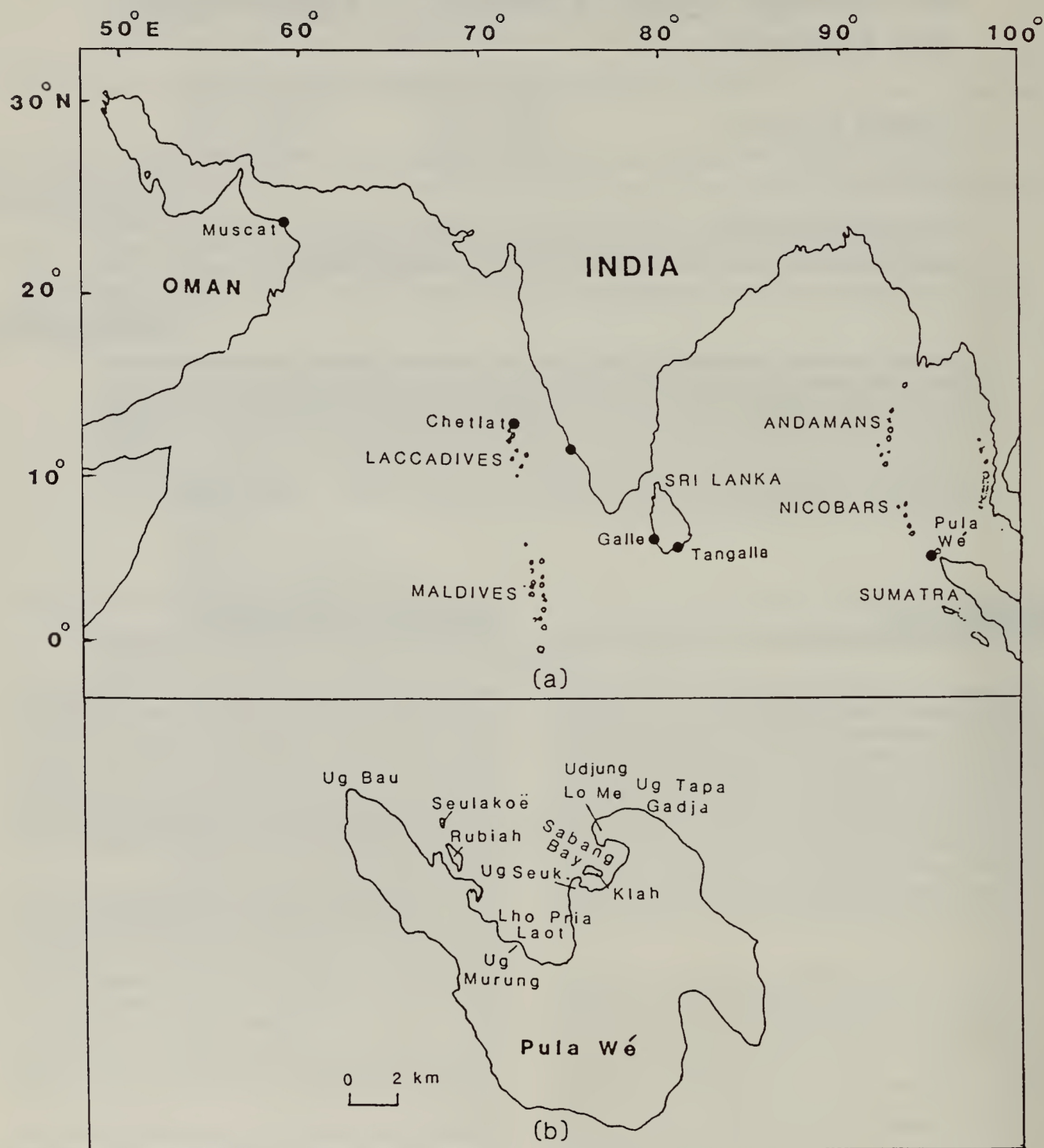


Fig. 1. (a) Map of northern Indian Ocean showing sampling areas (●) during Sindbad Voyage, with insert (b) for Pula Wé Sumatra.

RESULTS

Class Ophiuroidea**Family GORGONOCEPHALIDAE****1. *Astroboa nuda* (Lyman, 1874)**

SEE. Clark & Rowe, 1971: 78; 92; Clark & Courtman Stock, 1976: 108; 130; Baker, 1980: 60; Rowe & Gates, 1995: 364.

MATERIAL. 810504D/3 (1), 810504D/4 (1).

COLLECTION SITES. NW Klah, Pula Wé, Sumatra.

HABITAT AND DEPTH. Subtidal rock/coral; 13 m.

Family AMPHIURIDAE**2. *Amphiura (Amphiura) dejectoides* H.L. Clark, 1939**

SEE. Clark & Rowe, 1971: 80; 97; Cherbonnier & Guille, 1978: 33.

MATERIAL. 810501E/8 (4); 810428D/5 (2).

COLLECTION SITES. Ug Tapa Gadjá & Ug Seukundo, Pula Wé, Sumatra.

HABITAT AND DEPTH. Subtidal rock / coral, coral reef; 10 & 15 m.

REMARKS. The specimens from stn 810501E/8 appear to accord well with the original description (Clark, 1939) of the species and descriptions in Clark & Rowe (1971) and Cherbonnier & Guille (1978). The 2 specimens from stn 810428D/5 differ in their firmer disc, with coarser ventral scaling and in having 6 arm spines proximally instead of fine ventral scaling and 5 proximal arm spines. They are identified as *A. dejectoides* with reservation. Clark (in Clark & Rowe, 1971) suspected *Amphiura inhacensis* Balinsky may be conspecific with *A. dejectoides* H.L. Clark, a conclusion confirmed by Cherbonnier & Guille (1978). The records included herein extend the distribution of this species eastwards across the Indian Ocean from the Red Sea, East Africa and Madagascar to the Indo-Malayan region. In the latter region it may prove to be widespread.

3. *Amphiura (Amphiura) micra* H.L. Clark, 1938

SEE. Clark & Rowe, 1971: 80; 97; Cherbonnier & Guille, 1978: 46; Rowe & Gates, 1995: 350.

MATERIAL. 810423B/2 (1).

COLLECTION SITES. Ug Bau, Pula Wé, Sumatra.

HABITAT AND DEPTH. Coral, coral reef; 10–30 m.

REMARKS. This species is recorded across the tropical coast of Australia and from Madagascar. Its discovery at Pula Wé suggests a wider distribution in the Indo-Malayan region for this very small species.

4. *Amphiura (Amphichilus) ochroleuca* (Brock, 1888)

SEE. Clark & Rowe, 1971: 78; 100; Rowe & Gates, 1995: 344.

MATERIAL. 810502C/1 (1), 810427B/3 (1).

COLLECTION SITES. SE Klah, SE Lho Pria Laot, Pula Wé, Sumatra.

HABITAT AND DEPTH. In sponge and on subtidal rock; 0–10 m.

REMARKS. This species is known from the Indo-Malayan region and more or less circumscribes the Australian continental coastline (Rowe & Gates, 1995). Pula Wé appears to be the most westerly point of its distribution known to date.

5. *Amphioplus (Amphioplus) stenapsis* H.L. Clark, 1938

SEE. Clark & Rowe, 1971: 78; 101; Rowe & Gates, 1995: 344.

MATERIAL. 810422B/4 (1).

COLLECTION SITES. Nr. Klah / Seukundo, Pula Wé, Sumatra (disc only).

HABITAT AND DEPTH. Coral reef, 2–8 m.

REMARKS. Although the single specimen comprises only a complete disc with the bases of 2 arms (6 & 9 segments respectively), there is little doubt of its identity. This record extends the range of the species to Pula Wé from its type locality, Darwin, N Australia. The record of *A. stenapsis* from Madagascar by Cherbonnier & Guille (1978) is almost certainly based on a misidentification, judging by the very small size of the radial shields of their specimens. The confirmation of this species in the western Indian Ocean therefore requires confirmation.

6. *Amphioplus (Lymanella)* sp.

MATERIAL. 810109A/1b (2).

COLLECTION SITES. Beypore, India (west coast).

HABITAT AND DEPTH. Subtidal mud, 9 m.

REMARKS. Only the mouthparts and bases of the arms are available to identify this taxon, which clearly represents a species of *Amphioplus (Lymanella)*. The dorsal arm plates are trilobed, suggesting either species *A. (L.) andreae* (Lütken, 1872) or *A. (L.) laevis* (Lyman, 1874) in the key provided by Clark & Rowe (1971: 102). Cherbonnier & Guille (1978) indicate that *laevis* has a wide range in the Indian Ocean and Indo-Malay region, whereas Clark & Rowe (1971) record *andreae* only from the Malay region. Without complete specimens it is not possible to determine the species nor indeed whether *andreae* and *laevis* are taxonomically separable.

Family OPHIACTIDAE**7. *Ophiactis modesta* Brock, 1888**

SEE. Clark & Rowe, 1971: 105; Rowe & Gates, 1995: 379.

MATERIAL. 810206A/8 (3).

COLLECTION SITES. Negombo, Sri Lanka.

HABITAT AND DEPTH. Coral/rock; 5 m.

REMARKS. The 3 specimens were collected in a batch of 6 from stn 810206A/8 with 3 specimens of *O. savignyi*. They run unequivocally to the species *O. modesta* in the key provided by Clark & Rowe (1971: 105) where the relationship with other congeners is discussed by A.M. Clark (notes 25–27, pp. 103–105). Rowe (in Rowe & Gates, 1995) preferred to follow the views of Clark & Rowe (1971) regarding recognising the validity of the species *O. modesta*, a course also followed herein, rather than accept the sweeping synonymy of *O. savignyi*, which includes *O. modesta*, given by Cherbonnier & Guille (1978).

8. *Ophiactis savignyi* (Müller & Troschel, 1842)

SEE. Clark & Rowe, 1971: 82; 103; Clark & Courtman Stock, 1976: 164; Cherbonnier & Guille, 1978: 125; Sloan *et al.*, 1979: 102; Price, 1983: 61; Rowe & Gates, 1995: 380.

MATERIAL. 810206A/3 (5), 810206A/8 (3), 810426A/2 (1), 810501E/1 (1), 810501G/3 (1), 810501I/2 (1), 810502F/4 (2).

COLLECTION SITES. Negombo, Sri Lanka; W Rubiah, Ug Seukundo, E Klah, Pula Wé, Sumatra.

HABITAT AND DEPTH. Sponge, coral/rock, subtidal rock, coral reef; 5–14 m.

REMARKS. The specimens identified here are fissiparous and 6-armed with trilobed dorsal arm plates and proximally 6 arm spines, according well with the key characters given in Clark & Rowe (1971).

Family OPHIOTRICHIDAE

9. *Gymnolophus obscura* (Ljungman, 1867)

SEE. Clark & Rowe, 1971: 82; 117; Rowe & Gates, 1995: 411.

MATERIAL. 810124A/11 (1), 810125A/2 (1), 810430A/20d (2).

COLLECTION SITES. Ala Gala & Deumba Gala, Galle, Sri Lanka; Ug Seukundo, Pula Wé, Sumatra.

HABITAT AND DEPTH. Coral reef and epizoic on crinoids on subtidal rock; 8–15 m.

REMARKS. This species is commonly epizoic on comasterid crinoids, the host species for which have not been identified for the specimens recorded herein.

10. *Ophiothela danae* Verrill, 1869

SEE. Clark & Rowe, 1971: 84; 116; Clark & Courtman Stock, 1976: 141; Price, 1983: 63; Rowe & Gates, 1995: 419.

MATERIAL. 810125B/1 (3), 810206A/3/?8 (4), 810425F/8 (10+), 810428A/2 (7), 810428A/14 (3), 810501A/3 (30+), 810501A/4 (1), 810428B/1 (2), 810428D/3c (3), 810501E/9 (15+).

COLLECTION SITES. Ala Galla, Galle & Negombo, Sri Lanka; N. Udjung Lo Me (NE Sabang Bay), Ug Bau, Ug Seukundo, Ug Tapa Gadja, Pula Wé, Sumatra

HABITAT AND DEPTH. Epizoic on macroalgae, gorgonian, fire coral (*Millepora* sp.) sponge and on holothurians (*Thelenota ananas*), all on rock /coral; 2–30 m.

11. *Ophiothrix exigua* Lyman, 1874

SEE. Clark & Rowe, 1971: 84; 110; Cherbonnier & Guille, 1978: 140; Rowe & Gates, 1995: 422.

MATERIAL. 810206A/8 (5), 810502C/1 (2), 810502E/2 (3).

COLLECTION SITES. Negombo, Sri Lanka; E Klah, Pula Wé, Sumatra.

HABITAT AND DEPTH. Coral/rock, sponge on coral reef and subtidal rock; 5–10 m.

REMARKS. One specimen from stn 810206A/8, both from 810502C/1 and two from 810502E/3 are very juvenile specimens.

12. *Ophiothrix savignyi* (Müller & Troschel, 1842)

SEE. Clark & Rowe, 1971: 84; 109; Cherbonnier & Guille, 1978: 142; Price, 1983: 65.

MATERIAL. 801114B/1 (1).

COLLECTION SITES. Muscat, Oman (1 specimen).

HABITAT AND DEPTH. Coral reef; 2 m.

13. *Ophiothrix trilineata* Lütken, 1869

SEE. Clark & Rowe, 1971: 84; 111; Clark & Courtman Stock, 1976: 145; Sloan *et al.*, 1978: 103; Rowe & Gates, 1995: 423.

MATERIAL. 810420A/5 (2), 810422B/3 (3), 810426A/2 (1), 810428A/9 (2), 810428C/7 (1), 810428D/3a&b (6&2), 810430A/8 (1), 810430A/18 (1), 810430A/21c (1), 810501D/2 (1), 810501E/2 (3), 810501E/5 (1), 810501E/8 (1), 810501E/9 (2), 810501E/11 (1), 810502F/2 (1), 810501F/3 (1), 810501G/1 (2), 810501G/3 (1 & 1 juvenile), 810501G/5 (3), 810502C/2 (1 very juvenile), 810502D/4 (4), 810502E/3 (4 juvenile), 810502F/2 (2 juvenile), 810502G/3 (2 juvenile).

COLLECTION SITES. Klah / E Klah, Nr. Seukundo, Ug Seukundo, Pula Wé, Sumatra, W Rubiah, Ug Bau, Ug Tapa Gadja, Pula Wé, Sumatra.

HABITAT AND DEPTH. Coral reef, soft coral / gorgonian, subtidal rock, sponge/subtidal rock, sponge; 2–30 m.

REMARKS. The majority of specimens exhibit the characteristic arm colour pattern of 5 longitudinal lines alternating white and dark blue. However, a few specimens bear a wide median pale longitudinal line along the arms, and at least one specimen (810501E/2) is distinctively patterned with cream blotches, the linear pattern being discernable only near the ends of the arms (see Clark & Rowe, 1971: 111). Next to *O. (A.) purpurea*, this is the most common ophiuroid species collected.

14. *Ophiothrix (Acanthophiothrix) armata* Koehler, 1905

SEE. Clark & Rowe, 1971: 84; 111; Rowe & Gates, 1995: 423.

MATERIAL. 810422B/4 (15+), 810502F/6 (2).

COLLECTION SITES. Klah / Nr. Seukundo, Pula Wé, Sumatra.

HABITAT AND DEPTH. Coral reef, 2–8 m.

REMARKS. This species is recorded from the Indo-Malay region, tropical Australian coasts and the South Pacific (Clark & Rowe,

1971). The present record is the most westerly so far known for the species.

15. *Ophiothrix (Acanthophiothrix) purpurea* von Martens, 1867

SEE. Clark & Rowe, 1971: 86; 112; Cherbonnier & Guille, 1978: 148; Sloan *et al.*, 1978: 103; Rowe & Gates, 1995: 423.

MATERIAL. 810204A/4 (3), 810421A/2 (1), 810421A/9 (1 juvenile), 810421B/1 (1), 810422D/3 (2), 810423A/4 (1), 810423B/2 (1), 810425D/2 (1), 80425D/4b (1), 810425F/7 (7), 810425F/8 (1), 810426A/2 (3), 810427A/2 (2), 810428A/2 (2), 810428A/7 (3), 810428A/8 (4), 810428A/9 (2), 810428D/3f (23), 810430A/3 (1), 810430A/21c (6), 810430A/22b (1), 810430A/26 (5), 810501A/1 (1), 810501A/2 (1 juvenile), 810501A/4 (1 juvenile), 810501A/6 (9), 810501E/7 (2), 810501E/9 (1), 810501E/14 (1), 810501E/15 (1), 810504B/2 (1).

COLLECTION SITES. SW Kalpitiya, Sri Lanka; Ug Bau, Rubiah, Ug Seukundo, Ug Tapa Gadj, N Klah, ?N. Ujung Lo Me, NE Sabang Bay, Pula Wé, Sumatra.

HABITAT AND DEPTH. Coral reef, soft coral, fire coral (*Millepora* sp.), subtidal rock/coral (epizoic on soft coral / gorgonian & crinoid, sponge); 2–30 m.

REMARKS. The most common ophiuroid species collected.

16. *Ophiothrix (Acanthophiothrix) spinosissima* Koehler, 1905

SEE. Clark & Rowe, 1971: 86; 112.

MATERIAL. 810422B/4 (4), 810501G/5 (2), 810502F/6 (1).

COLLECTION SITES. Ug Seukundo, Klah / Ug Seukundo, Pula Wé, Sumatra.

HABITAT AND DEPTH. Coral reef, 2–8 m.

REMARKS. The specimens run down well to *O. (A.) spinosissima* in the key provided by Clark & Rowe (1971). However, 2 specimens from stn 810422B/4 have a single dark line running the length of the dorsal side of the arms, rather than a series of dark spots.

17. *Macrophiothrix aspidota* (Müller & Troschel, 1842)

SEE. Clark, 1968: 285; Clark & Rowe, 1971: 114; Clark & Courtman Stock, 1976: 137; Hoggett, 1992: 91.

MATERIAL. 810123B/6 (1), 810124A/8 (1), 810206A/6 (1), 810206A/7 (1).

COLLECTION SITES. Negombo, Cloisenburg Point, Galle, Ala Gala, Galle, Sri Lanka.

HABITAT AND DEPTH. Subtidal rock, coral / rock; 5–15 m.

18. *Macrophiothrix demessa* (Lyman, 1861)

SEE. Clark, 1968: 289; Clark & Rowe, 1971: 82; 114; Hoggett, 1991: 1089; 1992: 117; Rowe & Gates, 1995: 412.

MATERIAL. 801212B/1 (1), 810424B/4 (2).

COLLECTION SITES. Chetlat, Lakshadweep (Laccadive) Islands; Seulakoe, Pula Wé, Sumatra.

HABITAT AND DEPTH. Coral rubble, coral reef; 8 m & 20–30 m.

REMARKS. A.M. Clark (1968) transferred this species to the genus *Macrophiothrix* referring *Ophiothrix (Amphiophiothrix)* H.L. Clark, 1946, of which *demessa* is type (and only) species to the synonymy of *Macrophiothrix* H.L. Clark, 1938.

19. *Macrophiothrix elongata* (H.L. Clark, 1938)

SEE. Clark, 1968: 291; Clark & Rowe, 1971: 82; 114; Price, 1983: 61; Hoggett, 1992: 125.

MATERIAL. 801111A/5 (1), 801114A/5 (2), 801114B/2 (1).

COLLECTION SITES. Muscat harbour, Oman.

HABITAT AND DEPTH. Coral reef, subtidal rock/coral/sand; 0.5–3 m.

20. *Macrophiothrix longipeda* (Lamarck, 1816)

SEE. Clark, 1968: 300; Clark & Rowe, 1971: 82; 114; Clark & Courtman Stock, 1976: 139; Hoggett, 1991: 1103; Hoggett, 1992: 151; Rowe & Gates, 1995: 413.

MATERIAL. 801212B/3 (1), 810206A/5 (1), 810430A/24a (1).

COLLECTION SITES. Chetlat, Lakshadweep (Laccadive) Islands; Negombo, Sri Lanka; Ug Seukundo, Pula Wé, Sumatra.

HABITAT AND DEPTH. Coral/rock, coral rubble; 5–10 m.

21. *Macrophiothrix lorioli* A.M. Clark, 1968

SEE. Clark, 1968: 302; Clark & Rowe, 1971: 82; 115; Hoggett, 1991: 1108; Hoggett, 1992: 161; Rowe & Gates, 1995: 414.

MATERIAL. 810502D/2 (1), 810502E/1 (1).

COLLECTION SITES. E Klah, Pula Wé, Sumatra.

HABITAT AND DEPTH. Coral reef, coral reef/subtidal rock; 5 & 10 m.

22. *Macrophiothrix nereidina* (Lamarck, 1816)

SEE. Clark & Rowe, 1971: 86; 107 (as *Ophiothrix (Keystonea) nereidina*); Hoggett, 1992: 228 (as *Macrophiothrix*); Rowe & Gates, 1995: 426 (as *O. (Keystonea) nereidina*).

MATERIAL. 810421A/4 (1), 810422B/3 (2), 810430A/20d (1), 810430A/21c (2), 810430A/22b (1), 810501E/6 (1).

COLLECTION SITES. Ug Seukundo, Pula Wé, Sumatra.

HABITAT AND DEPTH. Coral reef, coral / rock; 2–10 m.

REMARKS. The species *nereidina* (which was placed in the subgenus *Ophiothrix (Keystonea)* by A.M. Clark, 1967) is included herein in the genus *Macrophiothrix*. Hoggett (1991) stated that 'it is particularly difficult to determine the respective boundaries between *Macrophiothrix* H.L. Clark, 1938 and two subgenera of *Ophiothrix*, *O. (Placophiothrix)* H.L. Clark, 1938 and *O. (Keystonea)* A.M. Clark, 1967.' The differences between these taxa have traditionally relied principally on arm length, shape of dorsal arm plates, relative spinular armament of the disc plates including cover of the radial plates (see A.M. Clark, 1967; Clark & Rowe, 1971). The difficulty in recognising the supraspecific limits of these taxa is made all the more obvious by the treatment of the species *Macrophiothrix*

propinqua, placed in the subgenus *Keystonea* by A.M. Clark (1967), whilst Devaney (1974) described *O. (Placophiothrix) westwardi* which has been considered conspecific with *propinqua* by Hoggett (1991). Later, in a far-reaching and critical treatment of *Macrophiothrix*, Hoggett (1992: PhD thesis) commits both the taxa *Placophiothrix* and *Keystonea* to the synonymy of *Macrophiothrix*, transferring the included species of the former two taxa to the latter taxon and to whom this move is herein credited.

23. *Macrophiothrix propinqua* (Lyman, 1861)

SEE. Clark & Rowe, 1971: 86; 107 (as *Ophiothrix (Keystonea) propinqua*); Clark, 1980: 537; Hoggett, 1991: 1130; Hoggett, 1992: 204; Rowe & Gates, 1995: 415.

MATERIAL. 810428D/5 (5), 810501C/3 (1 juvenile), 810501D/1 (1 juvenile), 810501E/13 (1), 810501DF/1 (1 juvenile), 810501G/1 (1), 810501G/5 (3), 810501I/2 (2), 810502F/3 (1), 810502G/3 (1).

COLLECTION SITES. Ug Tapa Gadj, Ug Seukundo, E Klah, Pula Wé, Sumatra.

HABITAT AND DEPTH. Subtidal rock/coral, coral rubble, coral reef, soft coral; 2–20 m.

REMARKS. This species was first transferred to the genus *Macrophiothrix* H.L. Clark, 1938 by A.M. Clark (1980) from *Ophiothrix (Keystonea)* A.M. Clark, 1967.

24. *Macrophiothrix variabilis* (Duncan, 1887)

SEE. Clark, 1968: 308; Clark & Rowe, 1971: 115; Hoggett, 1991: 1138; Hoggett, 1992: 218; Rowe & Gates, 1995: 416.

MATERIAL. 810206A/4 (1).

COLLECTION SITES. Negombo, Sri Lanka.

HABITAT AND DEPTH. Coral / rock, 5 m.

25. *Macrophiothrix virgata* (Lyman, 1861)

SEE. Clark & Rowe, 1971: 86; 113 (as *Ophiothrix (Placophiothrix) virgata*); Hoggett, 1992: 236.

MATERIAL. 810423D/2 (1).

COLLECTION SITES. Ug Bau, Pula Wé, Sumatra.

HABITAT AND DEPTH. Coral reef; 2–8 m.

REMARKS. See remarks under *Macrophiothrix nereidina*.

26. *Ophiogymna pellicula* (Duncan, 1876)

SEE. Clark & Rowe, 1971: 84; 117; Clark & Courtman Stock, 1976: 140 (as *O. fulgens*); Rowe & Gates, 1995: 417.

MATERIAL. 810504B/2 (1).

COLLECTION SITES. Rubiah, Pula Wé, Sumatra.

HABITAT AND DEPTH. Soft coral; 10 m.

REMARKS. The single specimen has a d.d. = 2.7 mm, a.l. = c. 20 mm. The disc is mottled cream and pink, and the arms are banded with wide pink and narrow cream bands. An irregular longitudinal line of cream spots is evident along the dorsal midline of the arms. The disc is covered (except for the radial shields) with minute,

pointed granules with larger, conical spines interradially towards the edge of the disc. Clark & Courtman Stock (1976) include *Placophiothrix phrixa* H.L. Clark as a synonym of *O. fulgens* (Koehler) which in turn is included in the synonymy of *O. pellicula* by Rowe (in Rowe & Gates, 1995). The species therefore appears to be distributed from the Gulf of Aden to the Indo-Malay region and the NW coast of Australia in depths of 10–116 m.

27. *Ophiopteron elegans* Ludwig, 1888

SEE. Clark & Rowe, 1971: 84; 115; Rowe & Gates, 1995: 419.

MATERIAL. 810428D/3e (2), 810428D/5 (8).

COLLECTION SITES. Ug Tapa Gadj, Pula Wé, Sumatra.

HABITAT AND DEPTH. Coral reef, subtidal rock/coral; 15 m.

Family OPHIOCOMIDAE

28. *Ophiarthrum pictum* Müller & Troschel, 1842

SEE. Clark & Rowe, 1971: 86; 121; Rowe & Gates, 1995: 385.

MATERIAL. 810502H/1 (1).

COLLECTION SITES. E Klah, Pula Wé, Sumatra.

HABITAT AND DEPTH. Subtidal rock, 2m.

29. *Ophiocomella sexradia* (Duncan, 1887)

SEE. Clark & Rowe, 1971: 86; 118; Devaney, 1974: 162; Cherbonnier & Guille, 1978: 179; Rowe & Gates, 1995: 389.

MATERIAL. 81042D8/3d (1).

COLLECTION SITES. Ug Tapa Gadj, Pula Wé, Sumatra.

HABITAT AND DEPTH. Coral reef; 15 m.

REMARKS. The single specimen from Pula Wé measures d.d. = 3 mm; a.l. = 10+ mm (broken near tip). With the exception that the uppermost of the 4 arm spines is distinctly longer than the lower ones, the character separating *Ophiomastix sexradiata* A.H. Clark 1952 (known only from its type locality: Bikini Atoll, Marshall Is, SW Pacific) from *Ophiocomella sexradia* (Duncan) (identified throughout the Indo-West Pacific region and possibly tropicopolitan) in Clark & Rowe's (1971) key, all other skeletal characters of the present specimen accord with those described as fitting *O. sexradia* (note 65, p. 118) by A.M. Clark. Cherbonnier & Guille (1978), following their study of Malagasy material, concur with the comments expressed by A.M. Clark (in Clark & Rowe, 1971) and tentatively consider *Ophiomastix sexradiata* to be conspecific with *Ophiocomella sexradia* simultaneously agreeing with A.M. Clark that the status of the genus *Ophiocomella* as distinct from *Ophiocoma* remains doubtful. Although the present specimen does nothing to clarify the generic status of *Ophiocomella*, it does support strongly the view that the two nominal species are conspecific and confirm the synonymy proposed by Cherbonnier & Guille (1978).

30. *Ophiocoma dentata* Müller & Troschel, 1842

SEE. Devaney, 1970: 13; Clark & Rowe, 1971: 86; 119; Rowe & Gates, 1995: 386.

MATERIAL. 810502H/2b (1).

COLLECTION SITES. E Klah, Pula Wé, Sumatra.

HABITAT AND DEPTH. Subtidal rock, 2m.

REMARKS. This single specimen (d.d. c. 11.3 mm, distorted) exhibits two of the described colour forms for the species. At the centre of the dorsal surface of the disc is a cream spot (c. 1.1 mm diameter). This is surrounded by an irregular ring (c. 2.2 mm wide) which is uniformly dusky/grey with darker spots. The remainder of the disc dorsally and ventrally is reticulated dusky/grey on a cream background.

31. *Ophiocoma erinaceus* Müller & Troschel, 1842

SEE. Clark & Rowe, 1971: 114;119; Clark & Courtman Stock, 1976: 173; Sloan *et al.*, 1979: 106; Bussarawit & Rowe, 1985: 1 (as *O. similanensis* n. sp.); Rowe & Gates, 1995: 387.

MATERIAL. 801212A/3 (1), 810422B/3 (10), 810427B/1 (1), 810427D/5 (1), 810428C/6 (2 juveniles), 810428E/5 (1 juvenile), 810430A/3 (2), 810501F/1 (1), 810501G/5 (3), 810501G/6 (2), 810501K/1 (2).

COLLECTION SITES. Chetlat, Lakshadweep (Laccadive) Islands; Ug Seukundo, Ug Bau, Lho Pria Laot, Ug Murung, Ug Tapa Gadja, Pula Wé, Sumatra.

HABITAT AND DEPTH. Coral reef, coral conglomerate, coral rubble, subtidal rock; 2–25 m.

REMARKS. This is the commonest species of *Ophiocoma* collected. The collection comprises some 26 specimens, ranging in size from d.d. = 3.6–22.2 mm, which show clearly both colour changes and development of disc granulation with growth. Juveniles up to d.d. = c. 5 mm bear no granules and are usually marked radially across each radial shield with a cream line, as described by Bussarawit & Rowe (1985) for their new species *O. similanensis*. By d.d. = 5.7 mm granules are developed at the centre of the disc and along 10 radiating lines to the edge of the disc where an irregular line of granules is developed around the periphery joining these radiating lines and thus leaving bare the dorsal interradial and radial portions of the disc. By d.d. = c. 11 mm granules are developed over the interradial but not radial regions of the disc, but granules are still not developed ventrally. By d.d. = 12.5 mm granules cover the whole surface of the disc except for the radial shields which remain bare, while granules begin to extend in a wedge shape, on the ventral side of the disc. This arrangement may remain in specimens up to d.d. = 14 mm but generally from about d.d. = > 13 mm the radial shields become covered by granules. In specimens up to d.d. = 12.5 mm some central and peripheral granules may be more prominent by their slightly more elongate shape, but in larger specimens granules are more evenly rounded and more or less evenly sized. The cream colour pattern disappears with increased d.d. and is absent in specimens with d.d. > 11 mm.

It is very clear that *Ophiocoma similanensis* Bussarawit & Rowe, 1985 is based on juvenile specimens of *O. erinaceus*, to the synonymy of which *O. similanensis* is herein committed.

32. *Ophiocoma pica* Müller & Troschel

SEE. Devaney, 1970: 25; Clark & Rowe, 1971: 86; 118; Clark & Courtman Stock, 1976: 173; Sloan *et al.*, 1979: 106; Rowe & Gates, 1995: 387.

MATERIAL. 801212A/3 (1).

COLLECTION SITES. Chetlat, Lakshadweep (Laccadive) islands.

HABITAT AND DEPTH. Coral reef; 20 m.

33. *Ophiocoma pusilla* (Brock, 1888)

SEE. Devaney, 1970: 25; Clark & Rowe, 1971: 86; 118; Clark & Courtman Stock, 1976: 174; Sloan *et al.*, 1979: 106; Rowe & Gates, 1995: 388.

MATERIAL. 810422E/4 (1), 810425C/2 (1), 810430A/21c (1), 810501E/3 (1), 810501K/4 (1).

COLLECTION SITES. N Klah island, Sabang Bay, Ug Seukundo, Pula Wé, Sumatra.

HABITAT AND DEPTH. Coral/sand, coral conglomerate, coral reef; 2–10 m.

REMARKS. The 5 specimens range in size from d.d. = 3–7.5 mm. The characteristic, enlarged, tissue-covered arm spines (see Clark & Rowe, 1971) appear on specimens from d.d. > 5 mm.

34. *Ophiomastix annulosa* (Lamarck, 1816)

SEE. Clark & Rowe, 1971: 86; Rowe & Gates, 1995: 390.

MATERIAL. 810123A/3 (1), 810212A/3 (2), 810213A/4 (1).

COLLECTION SITES. Kakoni rocks, Pigeon Island & Unawatuna, Galle, Tangalla, Sri Lanka.

HABITAT AND DEPTH. Coral reef, subtidal rock/coral, subtidal rock; 3–10 m.

35. *Ophiomastix caryophyllata* Lütken, 1869

SEE. Clark & Rowe, 1971: 86; 120; Cherbonnier & Guille, 1978: 185; Rowe & Gates, 1995: 390.

MATERIAL. 810425C/1 (2), 810428C/7 (1/2), 810430A/21b (2).

COLLECTION SITES. E Sabang Bay, Ug Bau, Ug Seukundo, Pula Wé, Sumatra

HABITAT AND DEPTH. Coral reef, coral/rock; 3–10 m.

Family OPHIONEREIDAE

36. *Ophionereis dubia* (Müller & Troschel, 1842)

SEE. Clark & Rowe, 1971: 122; Clark & Courtman, 1976: 179; Price, 1983: 67; Rowe & Gates, 1995: 408.

MATERIAL. 810502D/5 (1).

COLLECTION SITES. E Klah, Pula Wé, Sumatra.

HABITAT AND DEPTH. Subtidal rock/sand; 10 m.

37. *Ophionereis fusca* Brock, 1888

SEE. Clark, A.M. 1953: 69; 78; Clark & Rowe, 1971: 88; 122; Rowe & Gates, 1995: 408.

MATERIAL. 810421B/2 (1).

COLLECTION SITES. Nr. Seukundo, Pula Wé, Sumatra.

HABITAT AND DEPTH. Subtidal sand; 10–20 m.

Family OPHIODERMATIDAE

38. *Cryptopelta granulifera* H.L. Clark, 1909

SEE. Clark & Rowe, 1971: 88; 128; Rowe & Gates, 1995: 394.

MATERIAL. 801212B/1 (1).

COLLECTION SITES. Chetlat, Lakshadweep (Laccadive) Islands.

HABITAT AND DEPTH. Coral rubble; 8 m.

REMARKS. Originally described from Mauritius. Rowe & Gates (1995) describe the distribution as including tropical Australia, the Indo-Malayan region and Philippine Islands. The specimen is identified here from the Laccadive Islands for the first time.

39. *Ophiarachna affinis* Lütken, 1869

SEE. Clark & Rowe, 1971: 88; 123; Sloan *et al.*, 1979: 111; Rowe & Gates, 1995: 395.

MATERIAL. 810425C/1a,b (1).

COLLECTION SITES. E. Sabang Bay, Pula Wé, Sumatra.

HABITAT AND DEPTH. Coral conglomerate; 3–6 m.

REMARKS. A.M. Clark (in Clark & Rowe, 1971: Note 83, p. 123) describes in detail colour variation in *Ophiarachna affinis* and *O. mauritiensis* de Loriol, concluding that specific distinction between the two is difficult to make. In the present specimens with d.d. = 22 mm, the disc is uniformly brownish-grey and the dorsal side of the arms has a broad longitudinal central dusky band either side of which is a narrower pale band, the 3 bands being demarcated by 4 irregular, very narrow longitudinal dark bands. This corresponds to A.M. Clark's form C colour pattern. If *O. affinis* and *O. mauritiensis* are conspecific the species is clearly widely distributed in the Indo-West Pacific region.

40. *Ophiarachna robillardi* de Loriol, 1893

SEE. Clark & Rowe, 1971: 88; 123.

MATERIAL. 810126B/4 (1), 810213A/3 (2).

COLLECTION SITES. Galle, Tangalla, Sri Lanka.

HABITAT AND DEPTH. Coral reef, 3–5 m.

REMARKS. This is a significant extension of range for this species described from Mauritius. The species is recorded as having 5 arm spines (H.L. Clark, 1909; size not recorded) but the present 3 specimens have 7–9 arm spines at d.d. = 21.5 mm; 9–10 arm spines at d.d. 31.5 mm and 10–11 arm spines at d.d. = 36.5 mm.

41. *Ophiochaeta hirsuta* Lütken, 1869

SEE. Clark & Rowe, 1971: 88; 127; Sloan *et al.*, 1979: 115; Rowe & Gates, 1995: 398.

MATERIAL. 801212B/1 (1), 810425C/2 (1).

COLLECTION SITES. Chetlat, Lakshadweep (Laccadive) Islands; E. Sabang Bay, Pula Wé, Sumatra.

HABITAT AND DEPTH. Coral rubble, 3–8 m.

REMARKS. Sloan *et al.* (1979) concluded that variation in the

occurrence of spinelets on the discs of 4 specimens from Aldabra, western Indian Ocean and 2 specimens from Palau in the western Pacific Ocean which they examined suggested that *Ophiochaeta boschmai* A.H. Clark, 1964 is a synonym of *Ophiochaeta hirsuta* Lütken, 1869. They pointed out that Cherbonnier & Guille, 1978, had described a new species, *O. crinita*, based on a single specimen, from Madagascar, but did not comment further. In the present collection the specimen from the Lakshadweep Islands accords with the description of *boschmai* in that the disc is granule-covered dorsally but bears spinelets on its ventral surface. The specimen from Pula Wé, on the other hand, accords with the description of *crinita* in that the disc is covered dorsally and ventrally by elongate spines. Considering the comments by Sloan *et al.* (1979), the two specimens reported herein are referred to *O. hirsuta*, with the implication that *O. crinita* Cherbonnier & Guille should also be referred to the synonymy on the basis that it exhibits the extreme spiny form of *O. hirsuta*.

42. *Ophiodyscrita instratus* (Murakami, 1944) n. comb.

SEE. Murakami, 1944: 272 (as *Ophiostegastus instratus*); A.M. Clark, 1968: 320 (as *Ophiostegastus instratus*; discussion)

MATERIAL. 810124A/4 (1).

COLLECTION SITES. Ala Gala, Galle, Sri Lanka.

HABITAT AND DEPTH. Subtidal rock, 10–15 m.

REMARKS. This specimen, apart from its smaller size and fewer naked disc plates, accords so well with Murakami's (1944) description of *Ophiostegastus instratus* that its identity is in no doubt. The species is, however, transferred to the genus *Ophiodyscrita* H.L. Clark, 1938 (type-species *O. acosmeta* H.L. Clark), with *Ophiostegastus* Murakami, 1944 (of which *instratus* is the type-species) reduced to a junior synonym of *Ophiodyscrita*. The distinctness of two genera has been questioned by A.M. Clark (1968) and Guille & Vadon (1985) on the grounds of variation of granulation with increased specimen size. Tabulation of measurements (Table 1) taken from original species descriptions and similar details of the specimens from Sri Lanka, shows an interesting picture. From this table it becomes apparent that only two species can be recognised: a) *Ophiodyscrita instratus* (Murakami, 1943)(d.d. = 7 mm) of which the larger *Ophiostegastus novaecaledoniae* Guille & Vadon (d.d. = 9–11 mm) is a synonym, being an extreme form of *instratus* in which many disc plates, including the radial shields, have become prominent (convex) and naked of granules; this species possesses supplementary oral shields (granule covered in small specimens < 7 mm d.d.) and b) *O. acosmeta* H.L. Clark (d.d. = 5 mm) with which *O. pacifica* (Murakami, 1943)(d.d. 4 mm) and *Ophiostegastus compsus* A.M. Clark (1968) type locality Bahrain (d.d. = 8–10.5 mm) appear to be conspecific. *O. acosmeta* has an even covering of granules over the disc which are gradually lost only from the oral shields (as in the type of *acosmeta*; d.d. = 5 mm) and adoral plates (as in the type series of *compsus*; d.d. = 8–10.5 mm; though A.M. Clark (1968) does note that the largest paratype of *compsus* (d.d. = 10.5 mm) has a small bare patch dorsally at the base of 4 of the arms). Supplementary oral shields are absent from *compsus*, according to A.M. Clark, and are not recorded for either *acosmeta* or *pacifica*. In both *instratus* and *acosmeta*, as recognised herein, it is clear that arm spine number increases with size.

There is clearly insufficient justification for recognising *Ophiodyscrita* and *Ophiostegastus* as separate genera on the basis of the extent of disc granulation, for it is clear (see Clark & Rowe, 1971) that such differences occur between species included within

Table 1. Details of species *Ophiodyscrita acosmeta* H.L. Clark* and *O. instratus* (Murakami)*

Taxon	d.d. (mm)	a.sp.	l.a.sp.	s.o.s.	Granulation (disc)
<i>Ophiocryptus*</i> <i>pacificus</i> Murakami, 1943	4.00	6–5	1/3 seg.	– ?	Complete cover dorsal and ventral
<i>Ophiodyscrita*</i> <i>acosmeta</i> H.L. Clark, 1938 Sindbad spec.*	5.0	8(7)	1/2 seg.	– ?	Complete cover dorsal and ventral except 2 oral shields (Clark & Rowe (1971: 135))
<i>Ophiostegastus*</i> <i>instratus</i> Murakami, 1944	7.00	7	1/3 seg.	+ (granule covered) + (naked)	Complete cover dorsal and ventral except radial plate at base of each arm, each mid marginal plate and ventrally, each of the oral shields
<i>Ophiostegastus*</i> <i>compus</i> A.M. Clark, 1968	8–10.5	9	<1/2 seg.	–	Complete except 3 plates at base of each arm; each mid marginal; each oral shield and supplementary oral shield
<i>Ophiostegastus*</i> <i>novaecaledoniae</i> Guille & Vadon, 1985	9–11	9–10	<1/2 seg.	+ (naked)	Complete except each oral shield and adoral shield (A.M. Clark notes a small bare patch as base of 4 arms of <i>one</i> paratype d.d. = 10.5 mm) Many dorsal plates, including radial shields, marginal plates and ventral plates including oral, supplementary oral and adoral shields bare of granules

d.d. = disc diameter; a.sp. = number of arm spines; l.a.sp. = length of arm spines; s.o.s. (+/-) = presence/absence of supplementary oral shields.

the recognised limits of other ophiidermatid genera (e.g. *Ophiopeza* & *Ophiarachnella*). Similarly, the occurrence of supplementary oral shields is also a variable character. The recognition of *Ophiodyscrita* within the family appears, therefore, to rely, more or less solely, on the extension of granulation along the arms. The genus is closely related to *Ophiopeza* with which it shares the possession of a triangle of 3 plates between the radial shields (see Vail & Rowe, 1989). The record of *O. instratus* from Sri Lanka greatly extends the known distribution of the species from Japan and New Caledonia (S.W. Pacific). The distribution of the genus, *Ophiodyscrita* (syn: *Ophiostegastus*) is clearly widespread in the Indo-West Pacific region.

43. *Ophiopsammus yoldii* (Lütken, 1856)

SEE. A.M. Clark, 1968: 317; Clark & Rowe, 1971: 90; 127; Vail & Rowe, 1989: 277; Rowe & Gates, 1995: 402.

MATERIAL. 810430A/22b (1).

COLLECTION SITES. Ug Seukundo, Pula Wé, Sumatra.

HABITAT AND DEPTH. Coral rubble; 9 m.

REMARKS. Nearly half of the disc of this small specimen has been lost leaving the remaining disc (d.d. = c. 6 mm) and three of the original arms, which are also damaged (a.l. = c. 17 mm; d.d./a.l. = c. 3+ : 1). Arising from the damaged edge of the disc are three new, minute arms at slightly different stages of growth judging by the relative development of the ventral arm plates on each arm. These arms are also damaged but the longest is judged to have been not more than c. 3–4 mm in length. Following Vail & Rowe's (1989) revision of the genus *Ophiopsammus*, there is no reason for not identifying the specimen from Pula Wé as *O. yoldii*, for it appears to match their criteria for the species even though it is of small size. The species is not known to be fissiparous. Although this may be the first observation of fissiparity in *O. yoldii*, the development of six arms, in this case, may be an unusual response to severe damage, rather than being related to an asexual reproductive strategy. This matter requires further investigation.

Family **OPHIURIDAE**

44. *Ophiolepis cincta* Müller & Troschel, 1842

SEE. Clark & Rowe, 1971: 90; 129; Clark & Courtman Stock,

1976: 189; Sloan *et al.*, 1979: 115–117; Rowe & Gates, 1995: 399.

MATERIAL. 801212B/1 (1).

COLLECTION SITES. Chetlat, Lakshadweep (Laccadive) Islands.

HABITAT AND DEPTH. Coral rubble; 8 m.

Class **Echinoidea**

Family **CIDARIDAE**

1. *Eucidaris metularia* (Lamarck, 1816)

SEE. Clark & Rowe, 1971: 140; 150; Clark & Courtman Stock, 1976: 215; Sloan *et al.*, 1979: 117; Rowe & Gates, 1995: 195.

MATERIAL. 810426A/4 (1), 810501E/12 (1).

COLLECTION SITES. Rubiah, Ug Seukundo, Pula Wé, Sumatra.

HABITAT AND DEPTH. Coral reef, coral aggregate; 10 & 14 m.

Family **DIADEMATIDAE**

2. *Diadema setosum* (Leske, 1778)

SEE. Clark & Rowe, 1971: 140; 153; Clark & Courtman Stock, 1976: 226; Sloan *et al.*, 1979: 118; Price, 1983: 73; Rowe & Gates, 1995: 207.

MATERIAL. 801027A/1 (1), 801030A/1a,b (4), 810212A/1 (1), 810420A/1 (1), 810420A/4 (1), 810426A/3 (1), 810426B/5 (2), 810426B/12 (1), 810427D/5 (1 juvenile), 810428D/4 (2), 810501G/4 (1 juvenile), 810501I/1 (1), 810502D/1 (1, broken).

COLLECTION SITES. Muscat, Oman; Unawatuna, nr Galle, Sri Lanka; Rubiah, Klah, Ug Murung, Ug Tapa Gadja, Ug Seukundo, Pula Wé, Sumatra.

HABITAT AND DEPTH. Subtidal rock, subtidal rock / sand, subtidal rock / coral, coral reef; 0–20 m.

REMARKS. A number of these specimens are juveniles, as small as 10 mm h.d., and with banded spines. The characteristic elongate, tridentate pedicellariae of *D. setosum* (see Clark & Rowe, 1971) are

absent from all specimens examined. The remaining character of the red (or in some cases a faded, cream) ring on the anus is the only means of distinguishing this species from *D. savignyi*. In the field the two species are easily distinguished by the colour pattern, *D. savignyi* lacking the red ring and having characteristic, iridescent blue lines along the upper interamulacra.

3. *Echinothrix calamaris* (Pallas, 1774)

SEE. Clark & Rowe, 1971: 140; 153; Clark & Courtman Stock, 1976: 226; Rowe & Gates, 1995: 208.

MATERIAL. 801111A/2 (1), 810422B/1 (1), 810425C/4 (1), 810426B/4 (1), 810426B/13 (1), 810501K/2 (1), 810501K/3 (1).

COLLECTION SITES. Muscat, Oman; S. Sabang Bay (to S. of Klah), E. Sabang Bay, Rubiah, Ug Seukundo, Pula Wé, Sumatra.

HABITAT AND DEPTH. Subtidal rock, subtidal rock / coral / sand, coral reef; 0–20 m.

Family STOMECHINIDAE

4. *Stomopneustes variolaris* (Lamarck, 1816)

SEE. Clark & Rowe, 1971: 140; 153; Clark & Courtman Stock, 1976: 228; Sloan *et al.*, 1976: 118; Rowe & Gates, 1995: 246.

MATERIAL. 810123B/4 (1).

COLLECTION SITES. Galle, Sri Lanka.

HABITAT AND DEPTH. Subtidal rock; 5 m.

Family TEMNOPLEURIDAE

5. *Mespilia globulus* (Linnaeus, 1758)

SEE. Clark & Rowe, 1971: 140; 155; Rowe & Gates, 1995: 250.

MATERIAL. 810502F/5 (1).

COLLECTION SITES. Klah, Pula Wé, Sumatra.

HABITAT AND DEPTH. Subtidal rock; 5 m.

6. *Microcyphus ceylanicus* Mortensen, 1942

SEE. Clark & Rowe, 1971: 140; 156.

MATERIAL. 820204A/11 (1).

COLLECTION SITES. SW Kalpitiya, Sri Lanka.

HABITAT AND DEPTH. Coral reef; 3–5 m.

7. *Salamacis bicolor* L. Agassiz, 1846

SEE. Clark & Rowe, 1971: 140; 156; Clark & Courtman Stock, 1976: 232.

MATERIAL. 810126B/1 (1).

COLLECTION SITES. Galle, Sri Lanka.

HABITAT AND DEPTH. Coral reef; 4–5 m.

Family TOXOPNEUSTIDAE

8. *Toxopneustes pileoleus* (Lamarck, 1816)

SEE. Clark & Rowe, 1971: 142; 156; Clark & Courtman Stock, 1976: 234; Rowe & Gates, 1995: 258.

MATERIAL. 801114C/1 (1); 810424A/1 (1).

COLLECTION SITES. Muscat, Oman; W. Klah, Pula Wé, Sumatra.

HABITAT AND DEPTH. Coral reef; 10–12 m.

Family PARASALENIIDAE

9. *Parasalenia gratiosa* A. Agassiz, 1863

SEE. Clark & Rowe, 1971: 142; 157; Rowe & Gates, 1995: 233.

MATERIAL. 810422B/5 (2).

COLLECTION SITES. S. Sabang Bay (to S. of Klah), Sumatra.

HABITAT AND DEPTH. Coral conglomerate; 2–8 m.

Family ECHINOMETRIDAE

10. *Echinometra mathaei* (de Blainville, 1825)

SEE. Clark & Rowe, 1971: 142; 157; Clark & Courtman Stock, 1976: 239; Sloan *et al.*, 1979: 119; Price, 1983: 76; Rowe & Gates, 1995: 211.

MATERIAL. 801111A/1 (5), 810204A/10 (1).

COLLECTION SITES. Muscat, Oman; SW Kalpitiya, Sri Lanka.

HABITAT AND DEPTH. Coral reef, rock / coral / sand; 0–5 m.

REMARKS. Two forms of this species are represented. The specimen from Sri Lanka is relatively large, with h.d. = 48.7 mm. It has 4 pore-pairs per arc, the spines are uniformly pale blue/green and the test, when cleaned, is whitish in colour. The 5 specimens from Muscat, Oman are smaller, ranging in size from h.d. = 10–21 mm. They have 5 pore-pairs per arc, the spines are dark olive green tipped with lilac/brown and the test, when cleaned, is greenish in colour. *Echinometra mathaei* is clearly a complex species which is in need of critical investigation to determine whether, as it is currently identified, it comprises a single species or more than one closely related species (see Mortensen, 1943; Tsuchiya & Nishira, 1984).

11. *Echinostrephus molaris* (de Blainville, 1825)

SEE. Clark & Rowe, 1971: 142; 157; Clark & Courtman Stock, 1976: 239–240; Sloan *et al.*, 1979: 119; Rowe & Gates, 1995: 212.

MATERIAL. 801210B/6 (1), 810423A/5 (1), 810427B/3 (1), 810427D/5 (1), 810502G/4 (1)

COLLECTION SITES. Chetlat, Lakshawep (Laccadive) Islands; Ug Bau, Lho Pria Laot, Ug Murung, Klah, Pula Wé, Sumatra.

HABITAT AND DEPTH. Coral reef, subtidal rock, subtidal rock / coral; 0–40 m.

DISCUSSION

Echinoderm collections from the *Sindbad Voyage* have yielded at least 44 species of ophiuroids and 11 species of echinoids. Species totals for each area sampled, with the corresponding zoogeographic subdivision used by Clark & Rowe (1971), are given in Table 2. Despite the small size of Pula Wé (c. 20 km x 12 km), 32 ophiuroids and 7 echinoids (71% of all species recorded) were encountered at, although not necessarily restricted to, this island. This high species richness is partly a reflection of the sampling intensity in Pula Wé, but is equally or more an indication of high biodiversity known for coral reefs in the SE Asia region (Sheppard, 1987; Wells & Price, 1992).

Of the ophiuroids collected, *O. (A.) purpurea* and *O. trilineata* were the most common, occurring in more than 20% of the ophiuroid

Table 2. Ophiuroid and echinoid species numbers for each area of the Indian Ocean sampled during the *Sindbad Voyage*. (total ophiuroid species recorded for all regions = 44; total echinoid species recorded for all regions = 11)

Sampling area and equivalent zoogeographic subdivision	No. of species recorded	
	OPHIUROIDS	ECHINOIDS
Oman (SE Arabia)	2	4
S India (W. India & Pakistan)	1	0
Laccadive (Maldive area)	7	1
Sri Lanka (Sri Lanka area)	7	1
Sumatra (Indonesia / East Indies)	31	7

Of the 44 ophiuroid species collected, ten result in new area records (Table 3), as follows: W India (*Amphioplus (Lymanella)* sp.); Sri Lanka (*Ophiactis modesta*, *Ophiarachna robillardii*, *Ophiodyscrita instratus*); Maldives area (*Cryptopelta granulifera*, *Ophiochaeta hirsuta*); and Indonesia / East Indies (*Amphiura (Amphiura) dejectoides*, *Amphiura (Amphiura) micra*, *Amphioplus (A.) stenaspis*, *Ophiogymna pellicula*).

Table 3. New area records and previously known distribution of ophiuroid species recorded in the Indian Ocean during the *Sindbad Voyage*

Species	New area record	Previously known distribution
<i>Amphiura (Amphiura) dejectoides</i>	Indonesia/East Indies	Red Sea; E. Africa (Madagascar)
<i>Amphiura (Amphiura) micra</i>	Indonesia/East Indies	N. Australia and possibly E. Africa/Madagascar
<i>Amphioplus (A.) stenaspis</i>	Indonesia/East Indies	N. Australia and possibly E. Africa/Madagascar
<i>Amphioplus (Lymanella)</i> sp.	West India (Beyport)	<i>A. (L.) andreae</i> from Indonesia/East Indies, and <i>A. (L.) laevis</i> from Indo-West Pacific
<i>Ophiactis modesta</i>	Sri Lanka	W. India & Pakistan, and eastwards from Bay of Bengal to Hawaiian Is. but not Philippines, and possibly also E. Africa/Madagascar
<i>Ophiogymna pellicula</i>	Indonesia/East Indies	Bay of Bengal and N. Australia
<i>Cryptopelta granulifera</i>	Maldives	Mascarene Is. (Mauritius, Réunion, Rodrigues group) and N. Australia
<i>Ophiarachna robillardii</i>	Sri Lanka	Mascarene Is.
<i>Ophiochaeta hirsuta</i>	Maldives	Is. of W. Indian Ocean, Indonesia/East Indies, N. Australia and S. Pacific Is.
<i>Ophiodyscrita instratus</i>	Sri Lanka	Japan and New Caledonia (SW Pacific)

samples. These species also occupied a wide range of substrata and depths (2–30m). Other species occurred in less than 10% of the ophiuroid samples, and generally occupied fewer habitats and a narrower depth range. The echinoid fauna was less diverse, although some species were very common, in particular *D. setosum*, *E. calamaris* and *E. nolaris* (a coral rock borer), which occurred in 36%, 19% and 14% of the echinoid samples respectively. These echinoids were found in a wide range of habitats and depths, up to 40 m in the case of *E. nolaris*. A more comprehensive ecological analysis of echinoderms of Pula Wé, Sumatra is to be undertaken following completion of the taxonomic appraisal of the crinoids.

ACKNOWLEDGEMENTS. We wish to thank the staff at the Natural History Museum, London, for access to the collections and other facilities. We are grateful of Dr R. Dalley, P. Hunnam, P. Dobbs and D. Tattle for their considerable assistance during field work. One of us (A.R.G.P.) would also like to thank T. Severin, leader of the *Sindbad Voyage*, for the kind invitation to participate in the expedition which was made possible by generous support from the Ministry of Natural Heritage and Culture, Sultanate of Oman. Thanks are due to L. Marsh for identifying several ophiuroids. Financial assistance to A.R.G.P. from the Leverhulme Trust is gratefully acknowledged.

REFERENCES

- Aziz, A. 1981. Fauna echinodermata dari Terumbu Karang Pulau Pari, Pulau-Pulau Seribu. *Oceanologi di Indonesia* 14: 41–50.
- Baker, A.N. 1980. Euryalinid Ophiuroidea (Echinodermata) from Australia, New Zealand and the south-west Pacific. *New Zealand Journal of Zoology* 7: 11–83.
- Bussarawit, S. & Rowe, F.W.E. 1985. A new species in the ophiocomid genus *Ophiocoma* (Echinodermata: Ophiuroidea) from the west coast of Thailand, Andaman Sea. *Phuket Marine Biological Center Research Bulletin* 35: 1–6.
- Bussarawit, S. in prep. Taxonomic study of echinoderms (other than Holothuroidea) from Phuket Island and along the west coast of Thailand. *Phuket Marine Biological Center Research Bulletin*.
- Cherbonnier, G. & Guille, A. 1978. *Faune de Madagascar*. 48. Ophiurides. Centre De La Recherche Scientifique, Paris: CNRS.
- Clark, A.M. 1953. A revision of the genus *Ophiomeris*. *Proceedings of the Zoological Society of London* 123(1): 65–94.
- 1967. Notes on the family Ophiotrichidae (Ophiuroidea). *Annals and Magazine of Natural History* 9: 637–655.
- 1968. Notes on some tropical Indo-Pacific ophiotrichids and ophiodermatids (Ophiuroidea). *Bulletin of the British Museum (Natural History)*, Zoology 16(7): 275–322.
- Clark, A.M. & Courtman-Stock, J. 1976. *Echinoderms of Southern Africa*. 277 p. London: British Museum (Natural History), London.
- Clark, A.M. & Rowe, F.W.E. 1971. *Monograph of Shallow-Water Indo-West Pacific Echinoderms*. 238 p. British Museum (Natural History), London.
- Clark, H.L. 1938. Echinoderms from Australia. *Memoirs of the Museum of Comparative Zoology, Harvard* 55: 1–596.
- Devaney, D.M. 1970. Studies on ophiocomid brittlestars. 1. A new genus (*Clarkcoma*) of Ophiocominae with evaluation of the genus *Ophiocoma*. *Smithsonian Contributions to Zoology* No. 51: 1–41.
- 1974. Shallow-water asterozoans of southeastern Polynesia 2. Ophiuroidea. *Micronesica* 10: 105–204.
- Guille, A. & Vadon, C. 1985. Les ophiures littorales de Nouvelle-Calédonie. *Bulletin du Muséum National d'Histoire Naturelle, Paris* (4)7, Sect. A., no. 1: 61–72.
- Hoggett, A.K. 1991. The genus *Macrophiolithrix* (Ophiuroidea: Ophiotrichidae) in Australian waters. *Invertebrate Taxonomy* 4: 1077–1046.
- 1992. Taxonomic and systematic position of the brittlestar genus *Macrophiolithrix* H.L. Clark (Echinodermata: Ophiuroidea). PhD Thesis, University of Queensland. xviii + 412pp.
- James, D.B. 1989. Echinoderms of Lakshadweep and their zoogeography. *Bulletin of the Centre for Marine Fisheries Research Institute* 43: 97–144.
- Lincoln, R.J. & Shields, J.G. 1979. *Invertebrate Animals: Collection and Preservation*. 150 p. British Museum (Natural History) & Cambridge University Press.
- Marsh L.M. & Price, A.R.G. 1991. Indian Ocean echinoderms collected during the *Sindbad Voyage* (1980–81): 2. Asteroidea. *Bulletin of the British Museum (Natural History)*, Zoology 57(1): 61–70.

- Mortensen, T. 1943. A Monograph of the Echinoidea. III. Echinidae, Strongylocentridae, Paraseleniidae, Echinometridae. Reitzel, Copenhagen, pp. 1–446.
- Murakami, S. 1943. Reports on the ophiurans of Palao, Caroline Islands. *Journal of the Department of Agriculture, Kyūsyū Imperial University* 7(4): 159–204.
- Murakami, S. 1944. Note on the ophiurans of Amakusa, Kyūsyū. *Journal of the Department of Agriculture, Kyūsyū Imperial University* 7(8): 259–280.
- Nagabhushanam, A.K. & Rao, G.C. 1972. An ecological survey of the marine fauna of Minicoy Atoll (Laccadive Archipelago Arabian Sea). *Mitteilungen Zoologisches Museums Berlin* 48(2): 265–324.
- Price, A.R.G. 1983. Echinoderms of Saudi Arabia. Echinoderms of the Arabian Gulf coast of Saudi Arabia. *Fauna of Saudi Arabia* 5: 28–108.
- Price A.R.G. & Reid, C.E. 1985. Indian Ocean echinoderms collected during the Sindbad Voyage (1980–81): 1. Holothurioidea. *Bulletin of the British Museum (Natural History)*, Zoology 48(1): 1–9.
- Rowe, F.W.E. & Gates, J. 1995. Echinodermata. In Wells, A. (ed.) *Zoological Catalogue of Australia* Vol. 3. CSIRO, Melbourne, Australia xiii, pp. 1–510.
- Sheppard, C.R.C. 1987. Coral species of the Indian Ocean and adjacent seas: a synonymized compilation and some regional distributional patterns. *Atoll Research Bulletin* 307: 1–32.
- Sloan N.A., Clark A.M. & Taylor, J.D. 1979. The echinoderms of Aldabra and their habitats. *Bulletin of the British Museum (Natural History)*, Zoology 37(2): 81–128.
- Tsuchiya, M. & Nishihara, M. 1984. Ecological distribution of two types of the sea-urchin *Echinometra mathaei* (Blainville), on Okinawa reef flat. *Galaxea* 3: 131–143.
- Vail, L.L. & Rowe, F.W.E. 1989. Status of the genera *Ophiopeza* and *Ophiopsammus* (Echinodermata: Ophiuroidea) in Australian waters, with the description of a new species. *Proceedings of the Linnean Society of New South Wales* 110(3): 267–288.
- Wells, S.M. & Price, A.R.G. 1992. *Coral Reefs – Valuable but Vulnerable*. 40 p. WWF – World Wide Fund for Nature, Gland, Switzerland.