

The *Ophiocoma* species (Ophiurida: Ophiocomidae) of South Africa

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Abstract—This study raises the number of *Ophiocoma* species recorded in South Africa from four to eight. All species are briefly discussed in terms of taxonomy, geographic distribution and ecology. In addition, the juvenile of *O. brevipes*, found on the underside of adult *Ophiocoma brevipes* specimens, is described in detail. A neotype is designated for *O. scolopendrina*.

INTRODUCTION

The circumtropical family Ophiocomidae holds some of the more dominant and conspicuous ophiuroid species present on coral and rocky reefs. The family is rich, with eight genera, two of which were relatively recently reviewed by Devaney (1968; 1970; 1978). One of these, *Ophiocoma* Agassiz, 1836, is well represented in the tropical to subtropical waters of KwaZulu-Natal in South Africa and its constituent species are documented here.

Ophiocoma species are difficult to identify since some of the distinctive taxonomic characters, such as the shape of the oral and dental plates and their associated papillae (see Devaney 1970), are not easily assessed or can change during growth, as is also the case for the number of arm spines, the disc armament and the size of the dorsal arm plates (Sumida *et al.* 1998; Stöhr 2005; Stöhr *et al.* 2008). In addition, some species can change their colouration from day to night (Hendler 1984).

The Indo-Pacific distribution of *Ophiocoma* has been dealt with by several authors (e.g. Clark & Rowe 1971; Cherbonnier & Guille 1978; Rowe & Gates 1995). Clark and Rowe (1971) listed 11 species from the Indo-West Pacific (including the Red Sea and the Persian Gulf). Since then, a few new species have been added (Rowe & Pawson 1977; Bussarawit & Rowe 1985; Soliman 1991; Benavides-Serrato & O'Hara 2008), bringing the total number of valid species in the Indo-Pacific to 13¹. The ophiuroid fauna of southern Africa have been studied by many specialists (Bell 1905; 1909; Clark 1923; Mortensen 1925; 1933; Balinsky 1957; 1969; Clark 1974; 1977; 1980; Clark & Courtman-

¹ *Ophiocoma anaglyptica* Ely; *O. aegyptiaca* Soliman, 1991, *O. brevipes* Peters, *O. cynthiae* Benavides-Serrato & O'Hara, *O. dentata* Müller & Troschel, *O. endeani* Rowe & Pawson, *O. erinaceus* Muller & Troschel, *O. occidentalis* Clark, *O. pica* Müller & Troschel, *O. pusilla* (Brock), *O. schoenleinii* Müller & Troschel, *O. scolopendrina* (Lamarck), *O. valenciae* Müller & Troschel.

Stock 1976) but, since Clark and Courtman-Stock's (1976) work, no *Ophiocoma* species have been added to the fauna of southern Africa. Samyn and Thandar (2003), however, mention that *de novo* sampling along the coast of KwaZulu-Natal revealed many new ophiuroid records. Unfortunately, the latter authors did not include their species list.

Until now, only four species of *Ophiocoma* have been recorded in South Africa (Clark & Courtman-Stock 1976): *O. erinaceus* Müller & Troschel 1842, *O. pica* Müller & Troschel 1842, *O. scolopendrina* (Lamarck 1816) and *O. valenciae* Müller & Troschel 1842. Recent sampling along the north-east coast of South Africa (see also Samyn & Thandar 2003), yielded four additional *Ophiocoma* species. Moreover, we

discovered an undocumented association between individuals which we believe to be adult and juvenile *O. brevipes*.

Abbreviations:

A.L.	Arm length
D.D.	Disc diameter
KZN	KwaZulu-Natal
MHNG	Museum d'Historie Naturelle, Genève, Switzerland
MNHN	Museum national d'Historie Naturelle, Paris, France
RMCA	Royal Museum for Central Africa, Tervuren, Belgium
NHM	Natural History Museum, London, United Kingdom
SAM	iZiko South African Museum, Cape Town, South Africa
ZMB	Museum für Naturkunde an der Universität Humboldt zu Berlin, Berlin, Germany

MATERIALS and METHODS

Specimens were collected by hand in the intertidal zone and by SCUBA diving up to 32 m depth, during six expeditions (August 1999, July 2000, February 2001, July 2003, January 2010 and October 2010) at several localities along the coast of KZN, South Africa (Fig. 1).

Specimens were anaesthetized by placing them in freshwater and gently manipulating them so that their arms were extended as far as possible until they ceased moving. Thereafter, they were put in 100 % buffered alcohol for one day and transferred to 70 % buffered alcohol for transport to the laboratory where they were dried for permanent storage. The specimens were photographed after preservation.

Specimens are deposited in the collections of the RMCA (Belgium) and in the SAM (South Africa). These collections were examined together with other vouchers in the RMCA (e.g. from Kenya, the Seychelles and Inhaca; see also Clark 1980; 1984) as well as some ophiocomids from the Indo-Pacific Ocean in the MNHN (France).

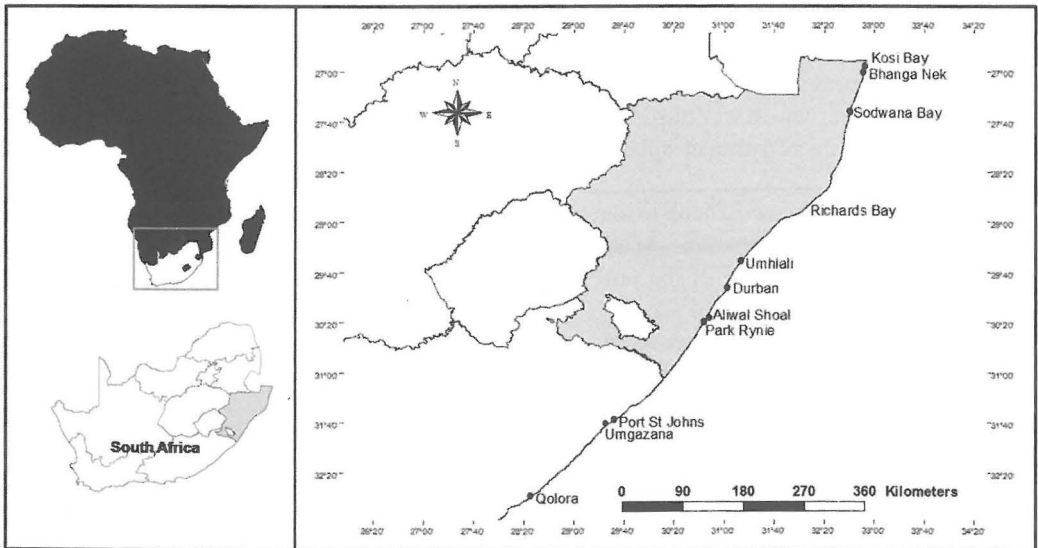


Figure 1. Sites where *Ophiocoma* species have been recorded in South Africa.

Table 1. Records of the present South African collection of *Ophiocoma* species, showing location, depth, museum collection numbers and the number of specimens.

Valid species name	Location	Depth (m)	Collection number (no. of specimens)
<i>Ophiocoma brevipes</i>	Aliwal Shoal	20	RMCA MT 2199 (1)
	Sodwana Bay	14	RMCA MT 2207 (1)
	Sodwana Bay (2 mile reef)	15	RMCA MT 2175 (1)
	Sodwana Bay (Mbibbi)	15	RMCA MT 2215 (1)
	Sodwana Bay (2 mile reef)	11	RMCA MT 2191 (1)
	Sodwana Bay (2 mile reef)	11	RMCA MT 2157 (1)
	Sodwana Bay (9 mile reef)	6	RMCA MT 2192 (1)
	Sodwana Bay (9 mile reef)	6	RMCA MT 2225 (1)
	Sodwana Bay (2 mile reef)	15	RMCA MT 2222 (1)
	Sodwana Bay (Mabibi)	16	RMCA MT 2194 (1)
	Aliwal Shoal	13	RMCA MT 2195 (1)
	Sodwana Bay (Diep Gat)	10	RMCA MT 2198 (2)
	Sodwana Bay (2 mile reef)	11	RMCA MT 2179 (1)
	Sodwana Bay (2 mile reef)	15	RMCA MT 2212 (1)
	Sodwana Bay (2 mile reef)	14	RMCA MT 2193 (1)
	Aliwal Shoal	13	RMCA MT 2148 (3)
	Sodwana Bay	?	RMCA MT 2208 (2)
	Bhanga Nek	16	RMCA MT 2203BIS (2)
	Aliwal Shoal	20	RMCA MT 2199 (1)
	Sodwana Bay (2 mile reef)	14	SAM A 28111 (1)
Sodwana Bay (2 mile reef)	15	RMCA MT 2341 (2, Juvenile)	
Sodwana Bay (2 mile reef)	14	SAM A 28112 (2, Juvenile)	
<i>Ophiocoma cf. dentata</i>	Sodwana Bay	20	RMCA MT 2380 (1)
<i>Ophiocoma doederleini</i>	Bhanga Nek (Saxon Reef)	20	RMCA MT 2249 (1)
	Sodwana Bay (2 mile reef)	15	RMCA MT 2250 (1)
	Bhanga Nek	16	RMCA MT 2203BIS (2)
<i>Ophiocoma erinaceus</i>	Sodwana Bay (5 mile reef)	18	RMCA MT 2136 (3)
	Bhanga Nek (Saxon Reef)	20	RMCA MT 2142 (2)
	Sodwana Bay (2 mile reef)	15	RMCA MT 2253 (1)
	Bhanga Nek	20	RMCA MT 2155 (1, juvenile)
	Sodwana Bay (1/4 mile reef)	10	RMCA MT 2220 (1, juvenile)
	Sodwana Bay (7 mile reef)	17	RMCA MT 2349 (1)
<i>Ophiocoma pica</i>	Qolora, Eastern Cape	Intertidal	SAM A 23248 (2)
<i>Ophiocoma pusilla</i>	Aliwal Shoal	20	RMCA MT 2345 (1)
	Sodwana Bay (2 mile reef)	13	RMCA MT 2219 (1)
	Sodwana Bay (2 mile reef)	13	RMCA MT 2200 (1)
	Sodwana Bay (2 mile reef)	15	RMCA MT 2346 (1)
	Bhanga Nek	20	RMCA MT 2337 (1)
	Sodwana Bay (2 mile reef)	15	RMCA MT 2217 (1)
	Sodwana Bay (2 mile reef)	14	RMCA MT 2214 (1)
	Aliwal Shoal	16	RMCA MT 2218 (1)
	Sodwana Bay (Deep sponge)	32	RMCA MT 2380 (1)
	Aliwal Shoal	13	RMCA MT 2153 (1)
	Sodwana Bay (2 mile reef)	10	RMCA MT 2221 (1)
	Sodwana Bay (2 mile reef)	10	RMCA MT 2149 (1)
	Sodwana Bay (2 mile reef)	14	RMCA MT 2381 (1)
	<i>Ophiocoma scolopendrina</i>	Umgazana, Eastern Cape	?
<i>Ophiocoma valenciae</i>	Park Rynie	Intertidal	RMCA MT 1754 (3)
	Park Rynie	Intertidal	RMCA MT 1755 (1)
	Sodwana Bay (5 mile reef)	18	RMCA MT 1748 (1)
	Sodwana Bay (5 mile reef)	16	RMCA MT 1749 (1)
	Sodwana Bay (5 mile reef)	18	RMCA MT 1750 (3)
	Aliwal Shoal	16	RMCA MT 1756 (1)
	Aliwal Shoal	13	RMCA MT 1751 (1)
	Aliwal Shoal	13	RMCA MT 1753 (1)
	Aliwal Shoal	13	RMCA MT 1752 (1)
	Aliwal Shoal	13	RMCA MT 1747 (1)
	Durban	Intertidal	SAM A 23250 (1)
	Durban	Intertidal	SAM UCT ECOL COLL. D 178(1)
	Port St Johns	Intertidal	SAM MEIRING NAUDE COLL. J 9_1 (6)
	Umhlali	Intertidal	SAM UCT ECOL COLL. U 23A (1)

RESULTS

Details of the collection of different *Ophiocoma* species sampled along the KZN coast of South Africa are presented in Table 1.

SYSTEMATIC ACCOUNT

We provide a taxonomic description and detailed geographical distribution for *Ophiocoma* species that are new records for South Africa. For the other well-known species, we only provide a summary and cite major works which provide detailed information on their taxonomy and distribution.

Order Ophiurida Müller & Troschel, 1840

Family Ophiocomidae

Ljungman, 1867

Subfamily Ophiocominae

Matsumoto, 1915

Genus *Ophiocoma* Agassiz, 1836

(Type species *Ophiura echinata* Lamarck, 1816 (by subsequent designation of Clark 1915)).

Diagnosis

(after Devaney 1970: 9; Clark & Courtman-Stock 1976: 172-173).

Majority of species large with D.D. often exceeding 20 mm; three to seven generally smooth, stout arm spines, sometimes alternating three and four on successive arm segments or on opposite sides of same segment; lower arm spines sometimes flattened and spatulate while upper ones cylindrical or cigar-shaped. Disc generally covered with granules, occasionally concealing scaling on disc and sometimes extending into ventral interradial regions. Oral shields without granules or spines, triangular with three to four, rarely five, contiguous oral papillae, outer one usually widest. Tooth papillae always present, few to numerous, with superficial ones in series with oral papillae. Oral shields large, oval, hexagonal or pentagonal.

When distal lobe angular, proximal end usually more or less truncated to match interradial separation of adoral shields. Dorsal arm plates wider than long, fan-shaped, oval or hexagonal. Ventral arm plates more or less square-shaped, proximal side straight, distal side straight to concave. Two tentacle scales, at least in first arm segments, sometimes only one towards tip.

Ophiocoma brevipes Peters, 1851

(Plate 1A-G, 2A-C)

Ophiocoma brevipes Peters 1851: 466; Marktanner-Turneretscher 1887: 303; de Loriol 1893: 25, 26, pl. 23, Fig. 4; Clark 1908: 296; Clark 1911: 256; Koehler 1922: 319-322, pl. 72,

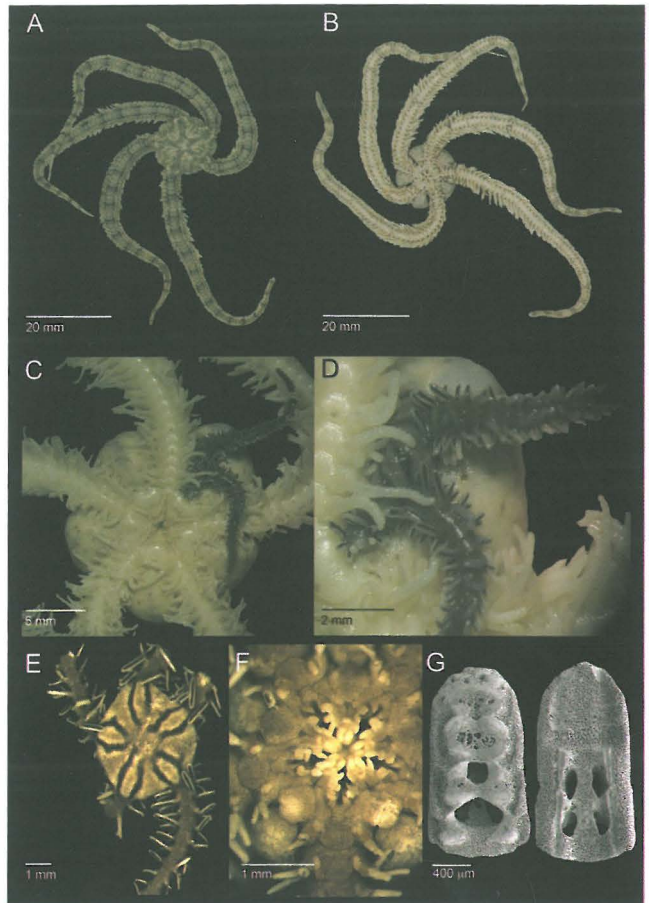


Plate 1. Dorsal (A) and ventral (B) views of *Ophiocoma brevipes*; position of juvenile *O. brevipes* within the bursal slit of an adult *O. brevipes* (C & D); dorsal view of juvenile *O. brevipes* (E); ventral view of juvenile *O. brevipes* (F); dental plates (internal and external view) of adult *O. brevipes* (G).

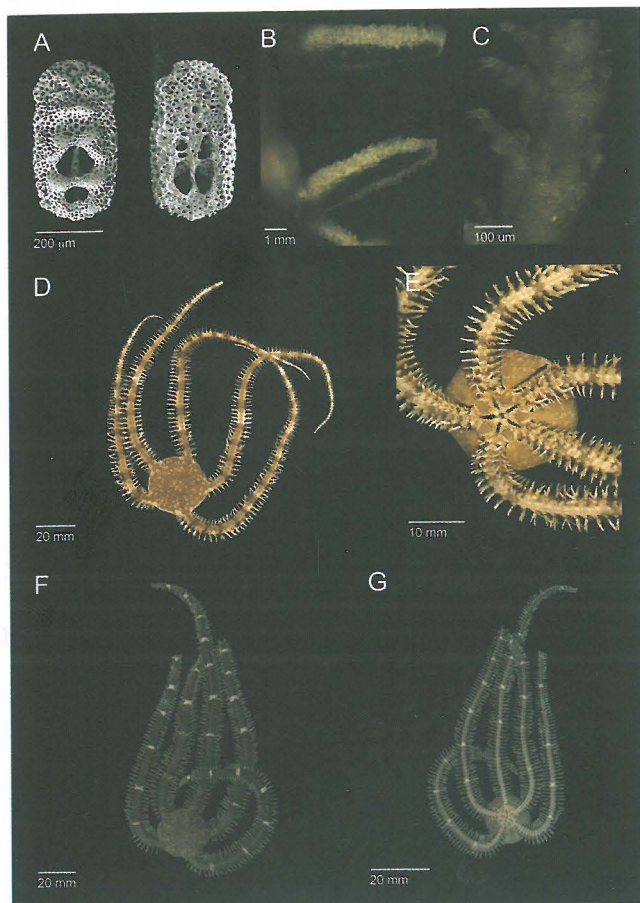


Plate 2. Dental plates of juvenile *Ophiocoma brevipes* (A); arm spines of juvenile *O. brevipes* (B); distal tip of arms of juvenile *O. brevipes* (C); dorsal view of *Ophiocoma* cf. *dentata* (D); ventral view of *O. cf. dentata* (E); dorsal view of *Ophiocoma doederleini* (F); ventral view of *O. doederleini* (G)..

Figs. 6-9; Devaney 1968: 45; Devaney 1970: 13; Clark & Rowe 1971: 86, 119; Devaney 1974: 151-152; Cherbonnier & Guille 1978: 168-169, pl. X, Figs. 3,4; Sloan *et al.* 1979: 104; Clark 1980: 534; Tortonesi 1980: 125, Fig. 11; Humphreys 1981: 10, 23; James 1982: 39-40, pl. IIB; Clark 1984: 100; Rowe & Gates 1995: 385; Rowe & Richmond 2004: 3292.

Location and status of types - ZMB 961 (1 syntype), ZMB 962 (1 syntype), ZMB 963 (1 syntype), ZMB 4660 (3 syntypes).

Type locality - Coast of Mozambique (ZMB 961-963); Quirimba Island, Mozambique (ZMB 4660).

Material examined

We examined over 150 individuals of *O. brevipes* from South Africa and Madagascar. On seven of them, one to three smaller individuals were attached in such a way that they had their arms slotted in the bursal slit. We have here tentatively treated them as juvenile *O. brevipes*.

Adults

D.D.=5.6-25.2 mm; D.D./A.L. from 1/3.2 to 1/4.8. Disc colour patterns variable with a combination of light greens, whites, yellows and browns in blotchy star or simply no particular pattern. Disc with small, fine, spherical granules closely packed on both dorsal and ventral side. Oral shields with darker markings, but with no apparent pattern. Dental plate (Plate 1G) between 1.9 and 2.1 times longer than wide, with a wide vertical septum between each oval, slightly elongated tooth foramen, dental papillae region limited to approximately 27% of dental plate length. Genital slits clearly visible, elongated and bordered with slightly more prominent granules. Arms appear banded (darker) on the dorsal side, some specimens with light dots or specks on ventral side of each arm plate along the length of arm. Ventral arm plates nearly as wide as long, bluntly pointed on the proximal side. Dorsal arm plates fan-shaped, much wider than long. Upper-most spines thickest on the proximal part of the arm. Longest arm spine less than or equal to the breadth of the dorsal arm plate. Two tentacle scales.

Juveniles

D.D. = 1.5-4.3 mm; D.D./A.L. from 1/1.8 to 1/2.8. Disc colour brown-grey, both dorsally (Plate 1E) and ventrally (Plate 1F). Dorsal side of disc marked with five radial pairs

of bowed brown lines extending from the margin, passing through radial shields and almost reaching centre of disc (Plate 1E). One specimen has a faint white dot in the centre of its disc. Radial shields oval, exposed, minute in size, hardly visible and similar in colour to disc. Disc circular in outline and moderately convex, covered dorsally and ventrally by imbricated scales of different sizes and shapes. Disc scales hardly visible dorsally but obvious ventrally. Disc granulation absent on ventral and dorsal surfaces. Oral shields and adoral shields uniformly brownish. Oral shields pear-shaped, sometimes with a thickened distal side, hardly longer than broad. Adoral shields triangular, almost touching proximally. Jaws triangular with three to four hyaline-tipped, somewhat pointed oral papillae on each oral plate. Dental plate with one to two teeth and three to four hyaline-tipped dental papillae; lower-most two to three forming a cluster at the apex of the jaw angle (Plate 1F). Dental plate (Plate 2A) 1.6 times longer than wide, with a thin vertical septum between each oval, slightly elongated tooth foramen, dental papillae region limited to approximately 28% of dental plate length. Genital slits unarmed, almost reaching the margin of disc. Dorsal arm plates uniformly brown and fan-shaped, first two to four plates contiguous, thereafter well-separated. Ventral arm plates uniform brownish-grey. First two ventral arm plates slightly broader than long with a straight distal edge; thereafter plates gradually become longer, almost rectangular in shape with the distal edge gradually becoming more concave. Arm spines light brown with dark longitudinal line dorsally (Plate 2B). Arm spines longer than length of arm plates, two on first segment, three on segments two to five, thereafter alternating two and three spines on segments six to nine, and two on further distal segments, hyaline and ragged structure. Distally, arm spines with multifid claw-like hooks (Plate 2C). Single tentacle scale over whole arm length apart from largest juvenile (D.D. = 4.3 mm) with two tentacle scales on first two segments.

Geographical distribution

Tropical Indo-West Pacific region but absent in the Red Sea, the Persian Gulf and north-western parts of the Indian Ocean (Rowe & Richmond 2004). Prior to this study, the only record from southern Africa was Mozambique (Quirimba Archipelago) (Clark & Rowe 1971). Thus the present record extends range to Aliwal Shoal, some 60 km south of Durban, South Africa. Juveniles were found on adults from South Africa, Madagascar and Isles Glorieuses.

Ecology

Ophiocoma brevipes is associated with coral heads or boulders, on fine to coarse sand and at the base of algal plants in the sandy littoral zone (between 0-54 m depth, cf. Lane *et al.* 2000). An overview of known microhabitats of *O. brevipes* is presented in Sloan *et al.* (1979).

On one living adult, the juvenile was observed to partially move into the genital slit of the adult after collection (Plate 1C, D).

Remarks

The complete absence of granulation on the disc and the loose meshwork structure of the dental plate indicate that the specimens attached to the adult *O. brevipes* are most probably juveniles. The colour pattern of these juveniles somewhat resembles a juvenile *Ophiomastix venosa* which is known to attach itself to *Ophiocoma scolopendrina* (Fourgon *et al.* 2007). However, based on the descriptions by Fourgon *et al.* (2007) and Cherbonnier and Guille (1978), it can be ruled out that the nine specimens studied here are juvenile *Ophiomastix venosa*, because (i) arm spines of *O. venosa* are distinctly longer, are glassy and thin; (ii) jaws of *O. venosa* are much more elongated and (iii) ventral arm plates of *O. venosa* taper more proximally.

The proximally extended adoral shields which nearly meet around the oral shield are indicative of *Clarkcoma* Devaney, 1970 and the alternating number of arm spines, with the uppermost spine enlarged (approximately

two segments long) suggests an affinity with Devaney's (1970) Scolopendrina Group. On the other hand, the appressed morphology of the dental plates is indicative of Devaney's (1970) *Brevipes* Group and, therefore, we believe the juveniles are *O. brevipes*. If this identification can be confirmed with complementary studies, such as molecular systematics, this would present a new case of parental care.

The tips of the arms in the juveniles were found to bear hooks that may assist in gripping (see Plate 2C). In addition to the hooks, the spines have a ragged structure that could also assist in clinging to the adult (see Plate 2B). Hooked spines have been also been observed in ophiuroid species with an epizoic lifestyle (Hyman 1955).

***Ophiocoma cf. dentata* Müller & Troschel, 1842** (Plate 2D, E)

Ophiocoma dentata Müller & Troschel 1842: 99, pl. VII, Figs. 3, 3a; Devaney 1968: 45; Devaney 1970: 13; Clark & Rowe 1971: 86, 119, pl 18, Figs. 2-3; Cherbonnier & Guille 1978: 168, pl. C, Figs. 3, 4; Tortonese 1980: 125, Figs. 11A, B; James 1982: 40, pl. IIC, D; Rowe & Gates 1995: 386; Price & Rowe 1996: 76; Rowe & Richmond 2004: 3292.

Ophiocoma insularia Lyman 1861: 80-81; Macnae & Kalk 1958: 130.

Location and status of types - ZMB 931 (holotype, fixed by monotypy).

Type locality - Unknown according to Müller and Troschel (1842: 99). However, the ZMB has only one specimen of *Ophiocoma dentata* in its collection. The catalogue indicates that this specimen was deposited by Deppe, just as is indicated by Müller and Troschel (1842), and that it comes from 'Celebes?'², currently known as the Islands of Sulawesi (Indonesia).

Material examined

D.D. = 14.3 mm, variegated with brown, white and beige, both dorsally and ventrally with the presence of small dark brown spots. Oral

shields round, as long as wide, with marbled pattern. Dental papillae broad, not extending far into mouth. Dorsal arm plates beige to brown with a whitish-grey patch surrounded by dark brown border on the median distal side, broad and elliptical. Lateral arm plates lighter with several spots. Ventral arm plates light with same spots; sometimes a dark coloured patch is present centrally, square with rounded corners, as wide as long. Arm spines white to beige, broadly and irregularly banded once or twice with light brown. Upper arm spines thick, blunt, somewhat flattened and slightly shorter than the lower ones. Tentacle scales, two.

Ecology

According to Devaney (1970), this species frequents the sub-littoral zone, under boulders or associated with coral and coral debris on a sand or rubble substratum.

Geographical distribution

Ophiocoma dentata has a tropical, Indo-West Pacific distribution (with the exception of the Red Sea and north-western Indian Ocean (Rowe & Gates 1995; Rowe & Richmond 2004). Prior to this study the most southern records originated from Inhaca Island (Mozambique) (Macnae & Kalk 1958; as *O. insularia* Lyman 1862).

Remarks

This specimen, at first examination, bears resemblance to *Ophiocoma brevipes*. Devaney (1970) pointed out three means by which *O. brevipes* can be separated from *O. dentata* (and *O. doederleini*; see hereunder) for specimens of similar size. First, by comparing the arm spine sequence: while *O. brevipes* presents five arm spines on segments four to seven, five to six arm spines up till segment 11, and two to three arm spines thereafter, *O. dentata* has only four (occasionally five) arm spines on segments four to seven, four arm spines up until segment 13 and three arm spines thereafter. Secondly, in *O. brevipes* the longest arm spine rarely exceeds the breadth of the ventral arm plate, while in *O. dentata* (and *O. doederleini*) the longest arm spine greatly exceeds the ventral arm plate. Thirdly,

² Müller & Troschel 1842 give no indication that they had more than one specimen before them, hence ICZN Art 73.2.2 applies.

by comparing the pigmentation: while *O. brevipes* has a uniform white or cream colour on the oral side of arms and the oral plates and shields, the other two species have a more grey, brown or variegated colouration.

However, our specimen differs somewhat from the typical *Ophiocoma dentata* as reported by Devaney (1970). First, the arm spine sequence of our specimen has three arm spines on its four first segments, segments five to fifteen have four arm spines, and thereafter three arm spines, which differs from the arms of *O. dentata* where we never observed five arm spines on segment seven. Second, the colouration of the dorsal arm plates is beige to brown with a whitish-grey patch that is bordered by dark brown on the median distal side, which differs from the description given by Devaney (1970, Fig. 21). Finally, the white to beige arm spines are broadly and irregularly annulated with light brown. Given these three differences, we are reluctant to describe the single specimen as a new species until more material becomes available.

***Ophiocoma doederleini* de Loriol, 1899**

(Plate 2F, G and Plate 3A, B)

Ophiocoma doederleini de Loriol 1899: 30, pl. 3, Fig. 2; Devaney 1968: 69; Devaney 1970: 12-18, Figs. 18, 14, 22, Table 2B, 3; Devaney 1974: 154; Sloan *et al.* 1979: 104, Figs. 8-10; Clark 1980: 534; Humphreys 1981: 10, 24; Clark 1984: 100; Rowe & Gates 1995: 396.

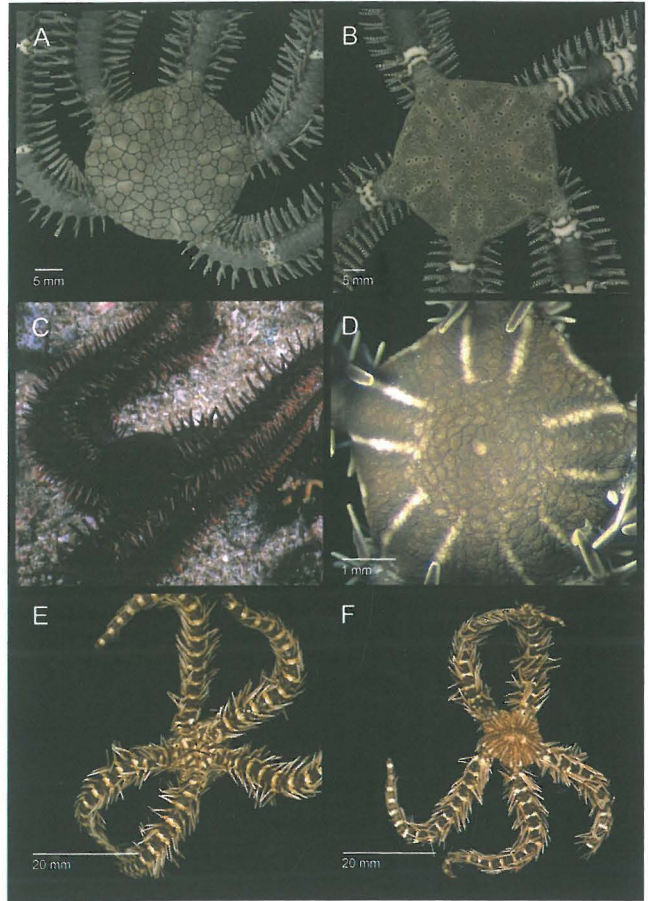


Plate 3. Dorsal views of reticulated (A) and spotted (B) forms of *Ophiocoma doederleini*; dorsal view of *Ophiocoma erinaceus* (C); dorsal view of juvenile *O. erinaceus* (D); ventral (E) and dorsal (F) views of *Ophiocoma pica* (from Mahé, Seychelles).

Ophiocoma dentata Lütken 1859: 165 (non Müller & Troschel 1842); Clark 1921: 121.

Location and status of types - MHNG INVE 71892 (Holotype).

Type locality - Mauritius.

Material examined

The specimens collected represent the two known colour forms (Devaney 1970; Sloan *et al.* 1979).

Whole specimens greyish-brown dorsally and ventrally (Plate 2F, G). Disc greyish-brown with fine black reticulating lines, white-ringed black spots, or speckled with light spots. Spots, speckles and lines do not outline the shape of radial shields, thus radial shields are not conspicuous (Plate 3A, B). Oral shields large, round to oval in shape, white on edges

and often with large irregular grey blotches. Dental papillae broad but, lower-most shorter than others. Ventral side of arms brown with spotted white bands or with dark bands, with narrower bands in between which continue down the arm. Arm spines taper, annulated white and/or grey. Combination of two and three tentacle scales on arms.

Ecology

All specimens were present under large boulders over gravel. Rowe and Gates (1995) record it as a benthic, inshore, littoral species. An overview of known microhabitats of *Ophiocoma doederleini* is presented in Sloan *et al.* (1979).

Geographical distribution

Indian Ocean and west central Pacific Ocean (Rowe & Gates 1995). Our specimens represent a new record for southern Africa.

Remarks

Devaney (1970: 15-16, Table 2b) provides an accurate means to separate *Ophiocoma dentata* from *O. doederleini*: annulation of the arm spines is easily used in the field and is absent in *O. dentata* but present in *O. doederleini*.

Ophiocoma erinaceus Müller & Troschel, 1842 (Plate 3C, D)

Ophiocoma erinaceus Müller & Troschel 1842: 98; Devaney 1968: 173 (synonymy³); Devaney 1970: 33, figs 45-47; Kalka 1958: 207, 216, 237; Clark 1967: 47; Clark & Rowe 1971: 86, 119, pl. 17, figs 5, 6; Clark & Courtman-Stock 1976: 122, 173; Cherbonnier & Guille 1978: 169, pl. X, Figs. 5, 6; Sloan *et al.* 1979: 106, Figs. 11, 12; Clark 1980: 535, 548; Tortonesi 1980: 124; Humphreys 1981: 10, 24; James 1982: 38, pl ID; Price 1982: 8; Clark 1984: 100; Rowe & Gates 1995: 387; Price & Rowe 1996: 77; Rowe & Richmond

2004: 3292; O'Hara *et al.* 2004: 537-541; Benavides-Serrato & O'Hara 2008: 51; Reza Fatemi *et al.* 2010: 44, Fig. 2.

Ophiocoma similanensis Bussarawit & Rowe 1985: 1, Figs. 1, 2; Price and Rowe 1996: 77.

Location and status of types – ZMB 921 (Syntype 1); ZMB 922 (Syntype 2); ZMB 923 (Syntype 3), specimen lost; ZMB 924 (Syntype 4), specimen lost.

Type locality - Red Sea and Indian Ocean.

Material examined

D.D. = 2.8-21.5 mm. Specimens characteristically black, dark brown or dark red dorsally and lighter ventrally. Some of the specimens under study were juveniles as evident from pigmentation of the dorsal disc (pairs of cream lines starting at the margin, passing through the radial shields and almost reaching the centre of the disc; Plate 3D), the arm spines (edge lighter) and the armament of the disc (disc dorsally and ventrally devoid of granules) (see also Cherbonnier & Guille 1978: 171; Bussarawit & Rowe 1985, as *Ophiocoma similanensis*). Oral shields pear-shaped, distally broadest. Dorsal arm plates uniform black, fan-shaped, distally convex, overlapping as tiles on a roof, more than twice as wide as long. Ventral arm plates uniform brown, from regular hexagons proximally to pentagons distally. Two equal-sized tentacle scales over the complete arm. Three to four arm spines, with uppermost one always largest. Three specimens had longitudinal stripes on arms spines similar to the juveniles of this species. Tube feet of the live specimens were reddish. Arm spines on most specimens flattened close to disc.

Ecology

Benthic, inshore (Rowe & Gates 1995) from 0-27 m depth (Lane *et al.* 2000). They are associated with coral (Clark & Courtman-Stock 1976; Humphreys 1981; Bussarawit & Rowe 1985; Stöhr *et al.* 2008) and are often found on gravel under boulders. Juveniles were found on an encrusting turret sponge (*Haliclona* sp.) or under dead coral boulders.

³ Cherbonnier & Guille (1978) removed *O. schoenleinii* Müller & Troschel, 1842 - characterized by the presence of just one tentacle scale, not two as in *O. erinaceus* - from Devaney's synonymy. We follow Cherbonnier & Guille (1978).

An overview of known microhabitats of *Ophiocoma erinaceus* is presented by Sloan *et al.* (1979).

Geographical distribution

Tropical to subtropical Indo-Pacific region.

Remarks

Even though *O. erinaceus* is one of the most abundant and conspicuous brittle stars in littoral tropical seas, its taxonomy has only recently been elaborated. O'Hara *et al.* (2004) used molecular, morphological and day/night colour change data to show that *O. erinaceus* is a species complex of three species: *O. erinaceus*, *O. schoenleinii* Müller & Troschel, 1842 and a third undescribed species. The latter was formally described and named *O. cynthiae* by Benavides-Serrato and O'Hara in 2008. Species in the complex can be distinguished from one another by: (i) colouration of tube feet (red in live or white in preserved *O. erinaceus*; grey in life and preserved *O. cynthiae* and *O. schoenleinii*), (ii) number of tentacle scales (one in *O. schoenleinii*; two in *O. erinaceus* and *O. cynthiae*); (iii) granulation of the ventral side of the disc (largely absent in *O. cynthiae*, as a wedge near the margin in *O. schoenleinii* and extending almost to the oral shields in *O. erinaceus*); and (iv) the size and morphology of the dental plates. Price and Rowe (1996) recognised that their *O. similanensis* Bussarawit & Rowe, 1985 is but a juvenile *O. erinaceus* and described growth changes for specimens ranging from a D.D. of 3.6-22.2 mm. The juveniles in this study match the description of *O. similanensis* very well.

Ophiocoma pica Müller & Troschel, 1842 (Plate 3E, F)

Ophiocoma pica Müller & Troschel 1842: 101; Clark 1921: 127, pl. 13, Fig. 8; Clark 1938: 333; Balinsky 1957: 25-26; Devaney 1968: 131; Macnae & Kalk 1958: 130; Devaney 1970: 19, Figs. 23 & 24, 20, Figs. 27, 25; Clark & Rowe 1971: 86-87, 118; Clark & Courtman-Stock 1976: 173; Cherbonnier & Guille 1978: 172, pl. XI, Figs. 5, 6; Sloan *et*

al. 1979: 106; Clark 1980: 535, 548; Tortonese 1980: 124; Price 1982: 8; Clark 1984: 100; James 1982: 36-38, pl IC; Rowe & Gates 1995: 387; Price & Rowe 1996: 77.

Location and status of types - Unknown; placed in MNHN according to Müller and Troschel (1842: 101) and according to the MNHN catalogue but not in MNHN according to Dr N. Améziane (pers. comm.).

Type locality - Unknown according to Müller and Troschel (1842). The senior subjective synonym (Lyman 1865) *Ophiocoma lineolata* Desjardins in Müller and Troschel 1842 stems from Mauritius.

Material examined

D.D. = 5.3 mm (D.D./A.L = 1/4). Disc covered dorsally with spherical granules extending onto distal parts of ventral interradial. Colour, pale yellow (after preservation in alcohol). Oral shields mainly oval; adoral shields triangular, not contiguous proximally; oral papillae three to four, dental papillae six to ten; teeth one or two, slightly elongated and blunt. Genital papillae present, cone-shaped. Dorsal arm plates fan-shaped, convex on distal side and concave on proximal side, hardly changing shape distally. Ventral arm plates straight to slightly convex on distal side, concave proximally, plates becoming slightly longer distally. Arm spines five proximally and four distally, slender, second spine longest, about two times segment length, lower arm spines same length as segment or slightly longer. Tentacle scales two, inner one slightly smaller proximally.

Ecology

Benthic, inshore (Rowe & Gates 1995), 0-24 m (Lane *et al.* 2000). Usually associated with coral (Clark 1952; Devaney 1968, 1970; Clark & Courtman-Stock 1976; Price & Rowe 1996) but also found under rock or dead coral rubble (Devaney 1970). An overview of known microhabitats of *Ophiocoma pica* is presented by Sloan *et al.* (1979).

Geographical distribution

Widely distributed throughout Indo-Pacific region (Clark 1921; Clark & Rowe 1971).

Remarks

Given the material from South Africa was in a poor state, we chose to illustrate (Plate 3E, F) a specimen from Mahé (Seychelles). The record discussed here presents a range extension from Richards Bay to Qolora (Eastern Cape Province).

Colour in life dark brown or black with radiating golden lines on disc and, often, transverse bands annulating the arms.

Ophiocoma pusilla (Brock, 1888) (Plate 4A, B)

Ophiomastix pusilla Brock 1888: 499; Devaney 1970: 25 (records before 1970).

Ophiocoma latilanxa Murakami 1943a: 194-196; Murakami 1943b: 218; Devaney 1970: 25-27.

Ophiocoma pusilla (Brock, 1888); Clark 1921: 131; Devaney 1970: 25, Figs. 26, 29; Clark & Rowe 1971: 86-87, 118; Clark & Courtman-Stock 1976: 122, 174, Fig. 190; Cherbonnier & Guille 1978: 173-174, pl. XI, Figs. 3,4; Sloan *et al.* 1979: 106; Clark 1980: 535, 544; Tortonese 1980: 127; Humphreys 1981: 10, 24; Price 1982: 8; Clark 1984: 100; Rowe & Gates 1995: 388; Price & Rowe 1996: 77.

Location and status of types - ZMB 5429 (Lectotype); ZMB 4777 (Paralectotype).

Type locality - Ambon, Indonesia.

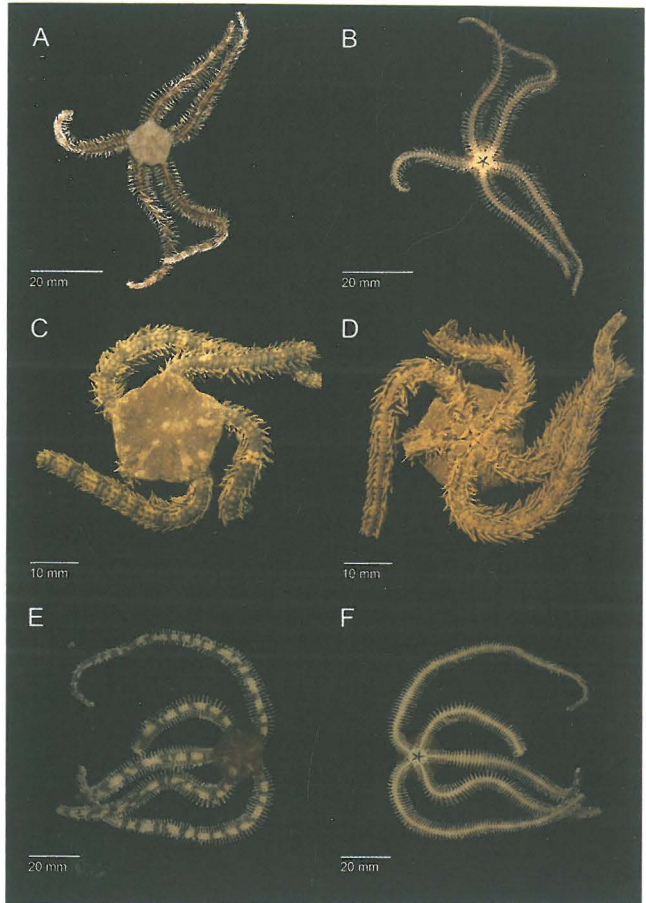


Plate 4. Dorsal (A) and ventral (B) views of *Ophiocoma pusilla*; dorsal (C) and ventral (D) views of *Ophiocoma scolopendrina* (Neotype: MNHN EcOh 11043); dorsal (E) and ventral (F) views of *Ophiocoma valenciae*.

Material examined

D.D. = 3.3-7.7 mm. Disc of one specimen slightly speckled while another specimen had banded arms from halfway down the arms to the tips. Dorsal disc with uniformly distributed granules concealing radial shields. Ventral disc with same type of granules, leaving bare only a narrow V-shaped interbrachial area. Oral shields oval, nearly twice as long as wide. Adoral shields triangular, not touching proximally. Four to five oral papillae per jaw. Dental papillae in two to three rows. Dorsal arm plates proximally fan-shaped, wider than long, with convex distal side touching the next plate only for about a third of its width; distally plates longer than wide and less contiguous. Ventral arm plates fan-shaped, broader than long, though distally becoming longer than broad. Four to five arm spines, hollow, glassy and about 2.5 times the segment length. Second uppermost arm spines at a third of arm length

with pustular distal expansions, while other arm spines taper (cf. also Clark & Rowe 1971). Tentacle scales, two.

Ecology

Benthic, inshore (Rowe & Gates 1995), 0–20 m depth according to Lane *et al.* (2000), our deepest specimen was found at 32 m depth. Known to occur in sand channels, under rubble and associated with coral (Clark & Courtman-Stock 1976; Humphreys 1981; Price & Rowe 1996). An overview of known microhabitats of *Ophiocoma pusilla* is presented by Sloan *et al.* (1979).

Geographical distribution

Ophiocoma pusilla has a tropical Indo-West Central Pacific Ocean distribution (Rowe & Gates 1995), including the Red Sea (Clark 1967, as *Ophiomastix pusilla*, Price 1982). In southern Africa, this species was reported from Mozambique (Clark & Courtman-Stock 1976).

Remarks

After examination of the size, shape and sequence of the arm spines, the nature of the dental plates and oral shields and the number of dental papillae, Devaney (1970) concluded that *Ophiocoma latilanxa* Murakami, 1943, is a junior synonym of *O. pusilla*. In 1989, Soliman ignored this when he identified *O. latilanxa*⁴ from the Red Sea. In 1991, a new species, *Ophiocoma aegyptiaca* Soliman, 1991, was described from the same area and Soliman (1991) continued to treat *O. latilanxa* as a valid species and noted that his new species bears close resemblance to *O. schoenleinii* and *O. latilanxa* (= *O. pusilla*). Although we have not seen the type material, we suspect that *O. aegyptiaca* and *O. latilanxa* (= *O. pusilla*) will prove to be synonyms. According to Soliman (1991), the differences between *O. aegyptiaca* and *O. latilanxa* consist mainly of: (i) the colour pattern of the disc and the plates (our specimens of *O. pusilla* show that the colouration is very

variable (disc uniform brown to reticulate to spotted with dark blotches; spines uniformly coloured to spotted)); (ii) the shape of the oral shields (although Soliman (1991) states that the oral shields of *O. aegyptiaca* are trapezoidal he drew them oval (Fig. 3A, p. 82 & p. 85), similar to the ones of *O. pusilla*); (iii) the number of arm spines (maximum five in *O. aegyptiaca*, except Soliman (1991) does not give the sequence of the arm spines; our *O. pusilla* specimens mostly have arm spine sequences: 3-3-4-4-4(or 5)-5-4-5). On the other hand the form and size of the dorsal arm plates are very similar for *O. aegyptiaca* and *O. pusilla* (compare Devaney 1970: Fig. 29 p. 21 with Soliman 1991: Fig. 4 p. 83).

Ophiocoma scolopendrina (Lamarck, 1816)
(Plate 4C, D)

Ophiura scolopendrina Lamarck, 1816: 544.

Ophiocoma scolopendrina (Lamarck, 1816): Kalk 1958: 205; Macnae and Kalk 1958: 130; Devaney 1968: 203; Devaney 1970: 33-35; Clark & Rowe 1971: 86, 119, pl. 17, Figs. 3, 4; Clark & Courtman-Stock 1976: 122, 174; Sloan *et al.* 1979: 106, Fig. 13; Clark 1980: 535; Tortonese 1980: 124; Price 1982: 8; James 1982: 36-39, pl. IIA; Rowe & Gates 1995: 388; Reza Fatemi *et al.* 2010: 45, Fig. 3.

Location and status of types – Unknown for *O. scolopendrina*, not in the MNHN (Dr M. Eleaume, pers. comm.). According to Devaney (1968), type specimens are present in the Dorpat Museum as the junior subjective synonym *O. variabilis* Grube, 1857 (from 'Waohu Island' – Oahu Island?) and in the Museum of Comparative Zoology as the junior subjective synonym *O. molaris* Lyman, 1861 (from 'Kingsmill Islands' = Gilbert Islands, Kiribati).

Type locality – Recorded by Lamarck (1816) as Mauritius ('Ile de France'). The ZMB holds two syntypes of a junior synonym, *O. alternans* von Martens, 1870, from Java.

⁴ Soliman 1989 misspelled *Ophiocoma latilanxa* as *O. latilanxa*.

Material examined

Given that current synonymy might lead to some confusion in its distribution, we felt it appropriate to establish a neotype from the original type locality, Mauritius.

Type material

Neotype *Ophiocoma scolopendrina* (Lamarck, 1816), here designated: MNHN EcOh 11043 (specimen with D.D. = 23.8 mm), Mauritius, coll. M. Carié, 1913.

Disc uniformly brown both dorsally and ventrally, although where granules have been worn off, lighter patches visible. Dorsal arm plates blotched with brown on beige, giving arms a variegated to banded pattern. Oral and adoral shields with similar blotching. Arm spines uniform in colour (light brown ventrally and somewhat darker dorsally), although on rare occasions some banding can be observed on uppermost spines. Disc pentagonal with interradiar margins straight to slightly indented. Dorsal disc densely covered with spherical granules, covering the whole surface including the radial shields which cannot be distinguished. Ventral disc with same, densely distributed granules, but less dense closer to genital slit which is bordered by a fringe of elongated genital papillae. Oral shields oval, shorter (2.5 mm) than wide (3.0 mm). Adoral shields restricted to the lateral edge of the oral shield, triangular but with other margin curved, not touching proximally. Five oral papillae on each oral plate, inner ones are more pointed than outer, wider ones; buccal tentacle scale very low and wide. Four to nine dental papillae, placed in a cluster below wide truncated teeth. Dorsal arm plates fan-shaped, wider than long with distal margin straight in first segments, becoming more convex in distal segments, plates contiguous throughout the arm. First two ventral arm plates distinctly smaller than rest, with distal margin indented, lateral margins convex and proximal margin straight, about as long as wide. Subsequent ventral arm plates significantly larger, wider than long, with convex distal margin and concave proximal margin which is only slightly overlain by preceding plate, laterally

plates recurved around tentacle pore. Arm spines three to five (three on segment three, four to five on segment eight), uppermost ones thick, short, but longer than dorsal arm plates; lower arm spines more slender, always longer than dorsal arm plates, except for first two segments. Arm spines uniform in colour (light brown ventrally and somewhat darker dorsally), although on rare occasion some banding can be observed on uppermost spines. Two oval, tentacle scales, inner one a fraction longer, over the complete arm length.

Non-type material

To avoid damage to the neotype, we used another specimen to describe the dental plate which is between 1.9 times longer than wide, with a very wide vertical septum between each oval, elongated tooth foramen; dental papillae region limited to approximately 20% of dental plate length.

Remarks

As noted by Devaney (1968) and others, *O. scolopendrina* is often confused with *O. macropalca* (Clark, 1915), a Hawaiian endemic, and *O. erinaceus* Müller & Troschel, 1842. We did not have *O. macropalca* specimens at our disposal so will refrain from commenting on Devaney's (1970) means of distinguishing it from *O. erinaceus* and *O. scolopendrina*. On the other hand, our limited comparative study of the dental plates of *O. erinaceus*, and *O. scolopendrina* shows that dental plate morphology can be used to recognize both species with certainty.

The senior primary homonym, *Ophiocoma scolopendrina* Agassiz, 1836 (as for instance mentioned by Müller & Troschel 1842), is to be considered a nomen nudum.

Ecology

Benthic, inshore, littoral (Rowe & Gates 1995), 0-13 m depth (Lane *et al.* 2000). An overview of known microhabitats of *Ophiocoma scolopendrina* is presented by Sloan *et al.* (1979).

Geographical distribution

Tropical, Indo-Pacific region (Rowe & Gates 1995), including the Red Sea.

Ophiocoma valenciae Müller & Troschel, 1842 (Plate 4E, F)

Ophiocoma valenciae Müller & Troschel 1842: 102; Devaney 1968: 126; Eyre & Stephenson 1938: 38, 43; Kalk 1958: 200, 207, 237; Macnae & Kalk 1958: 130; Clark 1967: 44-45; Macnae & Kalk 1969: 101, 106, 130; Clark & Rowe 1971: 86, 119, pl. 18 Fig. 1; Sloan *et al.* 1979: 109, Fig. 14; Clark 1980: 535, 548; Tortonese 1980: 125; Humphreys 1981: 10, 24-25; Price 1982: 8.

Location and status of types - ZMB 4625 (Syntype 1); ZMB 955 (Syntype 2).

Type locality - Aden.

Material examined

D.D. = 7.7-20.3 mm. Disc colour brownish, arms tawny with darker bands; one specimen lacking darker bands on arms. Disc covered dorsally and ventrally with moderately fine granules, which become elongated towards margin of disc. Radial shields defined by lighter colour on some specimens, but could be an artefact due to preservation. Dorsal arm plates broad, oval with up to six arm spines proximally. Uppermost arm spines shorter than middle spines, as long as arm width. Tentacle scale, one.

Ecology

Associated with coral (Day 1969) and sponges (Humphreys 1981). Found within rocky crevices, cobbles, rubble and various algal beds (Humphreys 1981). An overview of known microhabitats of *O. valenciae* is presented by Sloan *et al.* (1979).

Geographical distribution

Tropical Indian Ocean, including Red Sea and possibly the Persian Gulf (Clark and Rowe 1971; Tortonese 1980).

DISCUSSION

A total of 70 *Ophiocoma* specimens belonging to eight species were collected during the five expeditions to KwaZulu-Natal. *O. brevipes* was the most common (n=24) followed by *O. pusilla* (n=14) and *O. valenciae* (n=14). Only a single individual of *O. dentata* was collected in South Africa. Although previously recorded in the Eastern Cape, no *O. pica* or *O. scolopendrina* were collected by us. *O. brevipes*, *O. doederleini*, *O. pusilla* and *O. dentata* are new records for South Africa. Even though Martynov (2010) warned that dental plates are to be used with caution as a taxonomic character, the dental plates permitted us to assign the juveniles in our study to the *Brevipes* Group, as suggested by Devaney (1970).

According to Hendler (1975), only 55 species of ophiuroids have been reported as viviparous, which is less than 3% of all known species. If the juveniles we found attached to adult *O. brevipes* individuals are indeed also *O. brevipes* individuals, this report is the first account of brooding behaviour and parental care in *O. brevipes*. However, based on the examined material, we conclude that free-living juveniles of *O. brevipes* must be very rare, which is in contrast to other ophiocomid species such as *O. erinaceus* which have been found as free-living (Price & Rowe 1996). Reproductive experiments with *O. brevipes* populations from various locations will probably provide an insight into the ontology and the reproductive strategy of *O. brevipes*.

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REFERENCES

- Agassiz L (1836) *Prodrome d'une monographie des radiaires ou Echinodermes*. Mémoires de la Société des Sciences Naturelles de Neuchâtel 1: 168-199
- Balinsky JB (1957) The Ophiuroidea of Inhaca Island. *Annals of the Natal Museum* 14: 1-33
- Balinsky JB (1969) The Echinoderms. In: Macnae W & Kalk M (eds) *Natural History of Inhaca Island: Mozambique*. Witwatersrand University Press, Johannesburg, pp 97-156
- Bell FJ (1905) Echinoderma found off the coast of South Africa 3. Ophiuroidea. *Marine Investigations of South Africa* 3: 255-260
- Bell FJ (1909) Report on the Echinoderma (other than Holothurians) collected by Mr J. Stanley Gardiner in the Western Parts of the Indian Ocean. *Transactions of the Linnean Society of London: Zoology* 13: 17-22
- Benavides-Serrato M, O'Hara T (2008) A new species in the *Ophiocoma erinaceus* complex from the south-west Pacific Ocean (Echinodermata: Ophiuroidea: Ophiocomidae). *Memoirs of Museum Victoria* 65: 51-56
- Brock J (1888) Die Ophiuridenfauna des indischen Archipels. *Zeitschrift für Wissenschaftliche Zoologie* 47: 465-539
- Bussarawit S, Rowe FWE (1985) A new species in the Ophiocomid genus *Ophiocoma* (Echinodermata: Ophiuroidea) from the west coast of Thailand, Andaman Sea. *Research Bulletin Phuket Marine Biological Centre, Research Bulletin* 35: 1-6
- Cherbonnier G, Guille A (1978) *Faune de Madagascar* 48. Echinodermes: Ophiurides. *Museum National de' Histoire Naturelle*, 272 pp
- Clark AH (1952) Echinoderms from the Marshall Islands. *Proceedings of the United States National Museum* 102(3302): 265-303
- Clark AM (1967) Echinoderms from the Red Sea. Part 2. (Crinoids, Ophiuroids, Echinoids and more Asteroids). *Bulletin of the Sea Fisheries Research Station Israel* 41: 26-58
- Clark AM (1974) Notes on some echinoderms from South Africa. *Bulletin of the British Museum of Natural History (Zoology)* 26: 421-487
- Clark AM (1977) The South African Museum's Meiring Naude cruises. 4. Echinoderms. *Annals of the South African Museum* 76: 13-147
- Clark AM (1980) Some Ophiuroidea from the Seychelles Islands and Inhaca, Mozambique. *Revue de Zoologie Africaine* 94: 533-558
- Clark AM (1984) Echinodermata of the Seychelles. In D. R. Stoddart (ed) *Biogeography and ecology of the Seychelles Islands*. Dr W Junk Publishers, The Hague, pp 83-102
- Clark AM, Rowe FWE (1971) *Monograph of shallow-water Indo-West Pacific Echinoderms*. Publication no. 690. British Museum of Natural History, London, 238 pp
- Clark AM, Courtman-Stock J (1976) *The Echinoderms of Southern Africa*. British Museum (Natural History), London, 277 pp
- Clark HL (1908) Some Japanese and East Indian echinoderms. *Bulletin of the Museum of Comparative Zoology* 11(11): 279-311
- Clark HL (1911) North Pacific Ophiurans in the collection of the United States National Museum. *Bulletin of the United States National Museum* 75, 336 pp

- Clark HL (1915) Catalogue of recent Ophiurans, based on the collection of the Museum of Comparative Zoology. *Memoirs of the Museum of Comparative Zoology at Harvard College* 25: 164-376
- Clark HL (1921) The echinoderm fauna of Torres Strait. *Publications of the Carnegie Institute Washington* 10: 1-233
- Clark HL (1923) The Echinoderm fauna of South Africa. *Annals of the South African Museum* 13: 221-435
- Clark HL (1938) Echinoderms from Australia, an account of collections made in 1929 and 1932. *Memoirs of the Museum of Comparative Zoology at Harvard College* 55: 727
- Day JH (1969) A guide to marine life on South African shores. Cape Town, Balkema, 300 pp
- de Loriol P (1893) Catalogue raisonne des Echinodermes recueillis par M. V. de Robillard a l'Ile Maurice. III. Ophiurides et Astrophytides. *Memoires de la Societe de Physique et d'Historie Naturelle de Geneve* 32: 1-64
- de Loriol P (1899) Notes pour servir a l'etude des echinodermes. VII. *Memoires de la Societe de Physique et d'Historie Naturelle de Geneve* 33(2, 1): 1-34
- Devaney DM (1968) The systematics and post-larval growth changes in Ophiocomid brittle stars. PhD thesis. University of Hawaii, 272 pp
- Devaney DM (1970) Studies on Ophiocomid brittle stars. I. A new Genus (Clarkcoma) of Ophiocominae with a re-evaluation of the Genus *Ophiocoma*. *Smithsonian Contributions to Zoology* 51: 1-41
- Devaney DM (1974) Shallow-water asterozoans of southeastern Polynesia. 2. Ophiuroidea. *Micronesica* 10: 105-204
- Devaney DM (1978) A review of the genus *Ophiomastix* (Ophiuroidea: Ophiocomidae). *Micronesica* 14: 273-359
- Eyre J, Stephenson TA (1938) The South African intertidal zone and its relation to ocean currents. V. A subtropical Indian Ocean shore. *Annals of the Natal Museum* 9: 21-46
- Fourgon D, Jangoux M, Eeckhaut I (2007) Biology of a 'babysitting' symbiosis in brittle stars: analysis of the interactions between *Ophiomastix venosa* and *Ophiocoma scolopendrina*. *Invertebrate Biology* 126: 385-395
- Grube AE (1857) Diagnosen einiger neuen Echinodermen. *Archiv Für Naturgeschichte* 23: 340-344
- Hendler G (1975) Adaptational significance of the patterns of ophiuroid development. *American Zoologist* 15: 691-715
- Hendler G (1984) Brittlestar colour-change and phototaxis (Echinodermata: Ophiuroidea: Ophiocomidae). *Marine Ecology* 5: 379-401
- Hyman LH (1955) The invertebrates: Echinodermata, The Coelomate Bilateria. New York, McGraw-Hill Book Company, 763 pp
- James DB (1982) Studies on Indian echinoderms-10. *Ophiocoma anaglyptica* (Ophiuroidea: Ophiocomidae), a new record from the Indian Ocean with notes on other species of *Ophiocoma* from Indian seas. *Journal of the Marine Biological Association of India* 24: 36-41
- Kalk M (1958) The fauna of the intertidal rocks at Inhaca Island, Delagoa Bay. *Annals of the Natal Museum* 14: 189-242
- Koehler R (1922) Ophiurians of the Philippine seas and adjacent waters. *Bulletin of the United States National Museum* 100: 1-480
- Lamarck, de JBPA (1816) *Historie Naturelle des Animaux sans Vertebres*. Verdiere, Paris 2: 522-568

- Lane DJW, Marsh LM, VandenSpiegel D, Rowe FWE (2000) Echinoderm fauna of the South China Sea: An inventory and analysis of distribution patterns. The Raffles Bulletin of Zoology 8(supplement): 459-493
- Ljungman A (1867) Om nagra nya arter af Ophiurider. Öfversigt af Kongliga Vetenskaps-Akademiens Förhandlingar, pp 163-166
- Lütken C (1859) Bidrag til Kundskab om de ved Kysterne af Mellem og Syd-Amerika levende Arter af Söstjerner. Videnskabelige Meddelelser, pp 25-96
- Lyman T (1861) Descriptions of new Ophiuridae, belonging to the Smithsonian Institution and to the Museum of Comparative Zoology at Cambridge. Proceedings of the Boston Society of Natural History 7: 193-203
- Lyman T (1862) Descriptions of new Ophiuridae. Proceedings of the Boston Society of Natural History 8: 75-86
- Lyman T (1865) Ophiuridae and Astrophytidae. Illustrated Catalogue of the Museum of Comparative Zoology, Harvard University 1: 1-200
- Macnae W, Kalk M (1958) A natural history of Inhaca Island, Mozambique. Witwatersrand University Press, Johannesburg, 163 pp
- Macnae W, Kalk M (1969) A natural history of Inhaca Island, Mozambique (Second edition). Witwatersrand University Press, Johannesburg, 395 pp
- Marktanner-Turneretscher G (1887) Beschreibung neuer Ophiuriden und Bemerkungen zu Bekannten. Annalen des Naturhistorischen Museums in Wien 2: 291-316
- Martynov, A (2010) Reassessment of the classification of the Ophiuroidea (Echinodermata), based on morphological characters. I. General character evaluation and delineation of the families Ophiomyxidae and Ophiacanthidae. Zootaxa 2697: 1-154
- Matsumoto H (1915) A new classification of the Ophiuroidea: with descriptions of new genera and species. Proceedings of the Academy of Natural Sciences of Philadelphia 67: 43-92
- Mortensen T (1925) On some echinoderms from South Africa. Annals and Magazine of Natural History 9: 146-154
- Mortensen T (1933) Echinoderms of South Africa (Asteroidea and Ophiuroidea). Papers from Dr. Th. Mortensen's Pacific Expedition 1914-16. Videnskabelige Meddelelser fra Dansk Naturhistorisk Forening, 93: 215-490
- Müller J, Troschel FH (1840) Über die Gattungen der Ophiuren. Wiegmanns Archiv für Naturgeschichte 6: 318-326
- Müller J, Troschel FH (1842) System der Asteriden. Braunschweig, 134 pp
- Murakami S (1943a) Report on the Ophiurans of Palao Caroline Islands. Journal of the Department of Agriculture, Kyusyu Imperial University 7: 159-203
- Murakami S (1943b) Report on the Ophiurans of Yaeyama, Ryukyu. Journal of the Department of Agriculture, Kyusyu Imperial University 7: 205-222
- O'Hara TD, Byre M, Cisternas P (2004) The *Ophiocoma erinaceus* complex: another case of cryptic speciation in echinoderms: pp 537-542 In: Heinzeller T, Nebelsick JH (eds) Echinoderms Munchen: Proceedings of the 11th International Echinoderm Conference, Munich, Germany, 6-10 October 2003, A.A. Balkema, Netherlands.
- Peters WCH (1851) Übersicht der von ihm an der Kuste von Mossambique eingesammelten Ophiuren, unter denen sich zwei neue Gattungen befinden. Berichte der Königlichen Preussischen Akademie der Wissenschaften zu Berlin 1851: 463-466

- Price ARG, Rowe FWE (1996) Indian Ocean echinoderms collected during the Sinbad Voyage (1980-1981): 3 Ophiuroidea and Echinoidea. *Bulletin of the Natural History Museum of London (Zoology)* 62: 71-82
- Price ARG (1982) Echinoderms of Saudi Arabia. Comparison between echinoderm faunas of Arabian Gulf Sea, SE Arabia, Red Sea, Gulfs of Aqaba and Suez. *Fauna Saudi Arabia* 4: 3-21
- Reza Fatemi SM, Jamili S, Valinassab T, Kuranlu N (2010) Diversity of Ophiuroidea from Lengeh Portand Qeshm Island in the Persian Gulf. *Journal of Fisheries and Aquatic Science* 5: 42-48
- Rowe FWE, Gates J (1995) Echinodermata. In: Wells A (ed.) *Zoological Catalogue of Australia* 33, Melbourne: CSIRO Australia viii, 510 pp
- Rowe FWE, Pawson DL (1977) A catalogue of echinoderm type-specimens in the Australian Museum, Sydney. *Records of the Australian Museum* 30: 337-364
- Rowe FWE, Richmond MD (2004) A preliminary account of the shallow water echinoderms of Rodrigues, Mauritius, Western Indian Ocean. *Journal of Natural History* 38: 3273-3314
- Samyn Y, Thandar AS (2003). Towards an understanding of the shallow-water echinoderm biodiversity of KwaZulu-Natal, Republic of South Africa. *Echinoderm Research* 2001: 41-47
- Sloan NA, Clark AM, Taylor JD (1979). The echinoderms of Aldabra and their habitats. *Bulletin of the British Museum (Natural History)*, *Zoology* 37: 81-128
- Soliman FE (1989) Studies on the Egyptian Echinodermata. *Ophiocoma latilanxa* (Ophiuroidea: Ophiocomidae). A new record from the Red Sea. *Bulletin of the Faculty of Science of Assiut University* 18: 97-105
- Soliman FE (1991) Studies on Egyptian Echinodermata: *Ophiocoma aegyptiaca* sp. nov. (Ophiuroidea: Ophiocomidae) from the Red Sea. *Galaxea* 10: 79-88
- Stöhr S (2005) Who's who among baby brittle stars (Echinodermata: Ophiuroidea): post metamorphic development of some North Atlantic forms. *Zoological Journal of the Linnean Society* 143: 543-576
- Stöhr, S, Conand C, Boissin E (2008) Brittle stars (Echinodermata: Ophiuroidea) from La Reunion and the systematic position of *Ophiocanops* Koehler 1922. *Zoological Journal of the Linnean Society* 153: 545-560
- Sumida PYG, Tyler PA, Gage JD, Nørrevang A (1998) Postlarval development in shallow and deep-sea ophiuroids (Echinodermata: Ophiuroidea) of the NE Atlantic Ocean. *Zoological Journal of the Linnean Society* 124: 267-300
- Tortonese E (1980) Researches on the coast of Somalia. Littoral Echinodermata, *Monitore Zoologico Italiano N. S. Supplemento* 13, 5: 99-139.
- von Martens E (1870) Die Ophiuriden des indischen Oceans. *Archiv für Naturgeschichte* 36: 244-262.