

Shallow-water sea cucumber inventory in the Sultanate of Oman

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Abstract

The Sultanate of Oman's coastline extends over 3,500 km in three connected bodies of water: the Arabian Gulf (aka Persian Gulf), the Sea of Oman and the Arabian Sea. The aim of this two-year study (from 2007–2009) was to evaluate the diversity and abundance of holothuroids along Oman's coastline. The study was conducted at 11 locations, and in total, 17 species of Aspidochirotida, 2 species of Apoda and 2 species of Dendrochirotida were observed. The most striking result is the large difference in sea cucumber community structure between the Sea of Oman and the Arabian Sea.

Introduction

Although there is a growing number of studies focusing on echinoderms and holothuroids worldwide, the Arabian Sea has not received much attention. There have been a few publications on echinoderms in the region (e.g. Campbell 1988; Price 1982, 1983) but with the exception of recent studies on the fisheries and stock assessment of *Holothuria scabra* (Al-Rashdi et al. 2007a; Al-Rashdi et al. 2007b), there are no (to our knowledge) first hand records of sea cucumbers in the Sultanate of Oman.

The Sultanate of Oman's coastline extends over than 3,500 km in three connected bodies of water: the Arabian Gulf (aka Persian Gulf), the Sea of Oman and the Arabian Sea. The country has always depended on the sea, however human pressure on its natural resources is steadily increasing from fishing, extensive infrastructure development, tourism and industry. Global changes have also taken their toll on marine ecosystems with the passages of the first two recorded tropical cyclones in the Sea of Oman in recent history (Fritz et al. 2010) and an unprecedented and devastating bloom of the toxic dinoflagellate *Cochlodinium polycrikoides* in 2008–2009 (Richlen et al. 2010).

The marine climates in each of the three bodies of water are very distinct. The Arabian Sea coastal ecosystems withstand the full force of a seasonal coastal upwelling during the summer monsoon (June–September) with sea surface temperatures often dropping well below 20°C. The cool upwelled water is accompanied by a steady influx of nutrients that feeds the growth of extensive beds of benthic algae (Barratt 1984) interspersed with rich coral communities. In the Arabian Gulf and the Sea of Oman, sea surface temperatures in the same summer

period often exceed 32°C, whereas in the winter, water temperatures drop to below 22°C. Despite these extremes, coral communities flourish along the hard-substrate shores (Sheppard and Sheppard 1991) and support a rich echinoderm fauna.

There is only one marine protected area (the Daimaniyat Nature Reserve) in the Sea of Oman, and it covers about 20 km² and encompasses a string of nine small islands (Fig. 1). The aim of this study was to evaluate the diversity and abundance of holothuroids in the Sultanate of Oman as a first step toward monitoring and managing this important but fragile resource.

Methods

This study was conducted over two years (from 2007–2009) at 11 locations around the Sultanate of Oman (Fig. 1). At each location, several sites (a minimum of three) were surveyed by scuba from the surface to a maximum depth of 20 m. All holothuroids encountered were identified to the species level on the basis of their gross morphological characteristics, habitat and posture. Species were photographed and some specimens were collected and deposited at Sultan Qaboos University. Species identification followed the description of Clark and Rowe (1971) and more recent reviews of Holothuroidea in the Indian Ocean (Price 1983; Samyn 2003; Samyn et al. 2006).

At each location, at the end of a series of at least three dives in different sites, the abundance of the various species was recorded on a semi-quantitative scale (Braun-Blanquet 1932) from 0 to 5, with 0 = not recorded; 1 = rare (observed once or twice, but not on every dive); 2 = present (observed on nearly every dive at this location); 3 = common (observed several times

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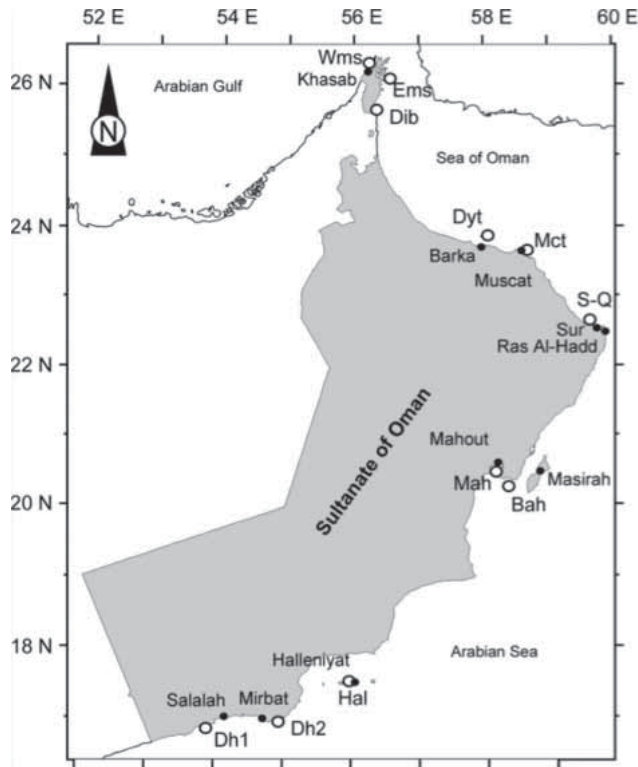


Figure 1. The 11 sea cucumber sampling locations around the Sultanate of Oman. Black, filled circles are cities and towns, and unfilled circles are sampling sites: Dh1 = Dhofar Rakhyut, Dh2 = Dhofar Mirbat, Hal = Halleniyat, Mah = Mahout, Bah = Masirah-Bar Al-Hikman, S-Q = Sur-Qalhat, Mct = Muscat, Dyt = Damanyat, Dib = Dibab, Ems = East Musandam, Wms = West Musandam.

during each dive at that location); 4 = abundant (observed many times during each dive) and 5 = dominant (one of the species encountered in significant numbers during any given dive). Distribution patterns were analyzed by clustering analysis and non-metric multidimensional scaling (MDS) on Bray-Curtis similarity matrix using Primer (Clarke and Gorley 2006).

Results

In total, 17 species of Aspidochirotida, 2 species of Apoda and 2 species of Dendrochirotida were observed during the survey (Table 1). Additional species of Dendrochirotida were observed in the south of Oman but were neither collected nor identified and will require additional fieldwork.

Although eight species were found in all or nearly all locations, many others were only found in four locations or fewer. *Holothuria scabra* (Fig. 2E), for instance, was restricted to two locations on the Arabian Sea near the Island of Masirah, and *Holothuria arenacava* was only found in a few sandy embayments near Muscat (two sites at one location) (Fig. 2A). The overall number of species decreased from the Arabian Sea (19 species) to the Sea of Oman (13 species) to the Arabian Gulf (8 species). Several species were recorded for the first time during the survey: *Holothuria arenacava* (Fig. 2A), *H. nobilis* (Fig. 2C), a common yet unidentified species of *Holothuria* (Fig. 2B), *H. cinerescens*, and a mottled pink *Actinopyga* (Fig. 2D), these last three were from Dhofar (southern Oman). *Holothuria hilla* and *Holothuria impatiens* (Fig. 2F) were also observed.

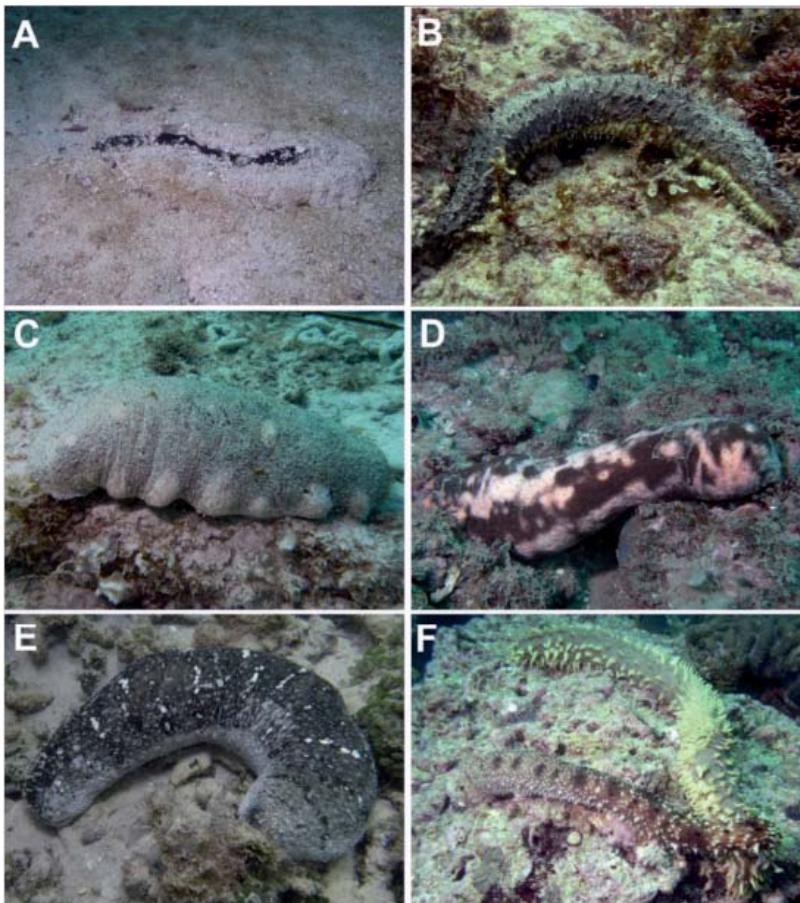


Figure 2.

Some of the holothuroids observed in the shallow waters of Oman.

- A: *Holothuria arenacava*, specimen nearly completely buried;
 B: unidentified species of *Holothuria*;
 C: *Holothuria nobilis*;
 D: unidentified species of *Actinopyga*.
 E: *Holothuria scabra*;
 F: *Holothuria hilla* (larger specimen) and *Holothuria impatiens*.

Table 1. Shallow-water Holothuroidea fauna in the NE Indian Ocean from Price (1982,1983) and relative abundances of species of holothuroids observed during the survey in the shallow waters of the Sultanate of Oman.

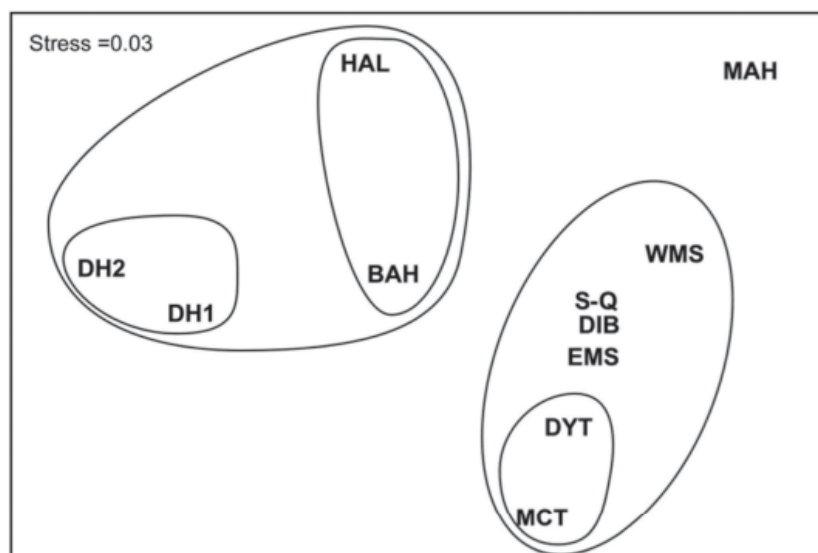
	Arab. Gulf ^a	Arab. Sea ^a	Arabian Sea ^b					Sea of Oman ^b					
			Dh1	Dh2	Hal	Mah	Bah	S-Q	Mct	Dyt	Dib	EMs	WMs
Holothuroidea													
<i>Stichopus variegatus</i>	+	+	3	3	3	2	3	3	4	4	3	3	3
<i>Labidodemas semperianum</i>	+												
<i>Holothuria atra</i>	+	+	3	3	3	4	3	3	3	3	3	3	3
<i>Holothuria edulis</i>	+	+	3	1	2	2	2	3	4	3	3	3	3
<i>Holothuria rigida</i>	+												
<i>Holothuria leucospilota</i>	+	+	3	4	4	3	3	3	4	3	3	3	3
<i>Holothuria arenicola</i>	+	+	0	0	1	1	0	0	0	1	0	0	0
<i>Holothuria hilla</i>	+	+	1	1	1	1	1	2	3	2	2	2	2
<i>Holothuria impatiens</i>	+	+	2	2	0	0	1	0	2	1	0	1	1
<i>Holothuria scabra</i>		+	0	0	0	3	1	0	0	0	0	0	0
<i>Holothuria arenacava</i>			0	0	0	0	0	0	1	0	0	0	0
<i>Holothuria pardalis</i>	+												
<i>Holothuria nobilis</i>		+	1	1	0	0	0	0	0	0	0	0	0
<i>Holothuria difficilis</i>		+	2	2	0	0	1	1	1	1	1	1	0
<i>Holothuria cinerescens</i>		+	1	1	1	0	0	0	0	0	0	0	0
<i>Holothuria pervicax</i>		+	2	1	1	0	1	1	1	1	1	1	1
<i>Actinopyga milliaris</i>		+	2	2	1	0	0	0	0	0	0	0	0
<i>Actinopyga mauritiana</i>		+	2	2	1	2	3	2	3	4	3	3	2
<i>Actinopyga sp.</i>			0	1	0	0	0	0	0	0	0	0	0
<i>Holothuria sp.</i>			4	4	2	0	2	0	0	0	0	0	0
<i>Thyone dura</i>	+	+	2	3	1	0	2	0	0	0	0	0	0
<i>Oshimimella ehrenbergi</i>	+	+	1	2	0	0	0	0	1	1	0	0	0
<i>Euapta goddefroyi</i>		+	0	0	0	1	1	1	2	2	1	1	0
<i>Leptosynapta chela</i>	+												

Numbers are semi-quantitative abundances (0–5; Braun-Blanquet 1932). Dh1 = Dhofar Rakhyut, Dh2 = Dhofar Mirbat, Hal = Halleniyat, Mah = Mahout; Bah = Masirah-Bar Al-Hikman; S-Q = Sur-Qalhat; Mct = Muscat; Dyt = Damanyat; Dib = Dibab; Ems = east Musandam; Wms = west Musandam.

^a Arabian Gulf and Arabian Sea from Price (1982,1983).

^b This survey.

Figure 3. Non-metric multidimensional scaling plot (MDS) of the 11 sites with regards to the sea cucumber community structure. The Bray-Curtis similarity index was used on the semi-quantitative abundance data to calculate inter-site similarities. The low stress value (0.03) indicates a good two-dimensional representation of the multidimensional data. See legend of figure one for the names of sampling sites.



From a community standpoint, both the non-metric multidimensional scaling analysis and the cluster analysis, identified a major split in the structure of sea cucumber communities between the Arabian Sea and the Sea of Oman. This first subdivision is mainly due to six species that were restricted to the Arabian Sea coast of the Sultanate: *Holothuria scabra*, *H. nobilis*, *Actinopyga miliaris*, *Actinopyga* sp. (unidentified species), *H. cinerescens* and an unidentified species of *Holothuria* sp. Secondary subdivisions of communities distinguish the northern part of the Arabian Sea coast from its most southern part (Dhofar). In the Sea of Oman, sea cucumber communities from the central part of the Gulf (Muscat) are separated from those in the northern and southern regions (Fig. 3). The holothuroid community found near Mahout Island appeared to be relatively distinct from both that of the Arabian Sea and the Sea of Oman.

Discussion

The holothuroid fauna of Oman is a somewhat impoverished subset of the tropical Indian Ocean fauna (Rowe and Richmond 2004; Samyn 2003). Most genera (and subgenera) of Aspidochirotida are represented with the exception of *Bohadrschia* and *Thelenota*. There were also some unusual observations such as “burrowing” *Holothuria arenacava* (Samyn et al. 2001), which was previously only known from coral communities in East Africa. The burrowing habits of this species in sediment, and its superficial resemblance with the abundant *H. leucospilota*, makes it considerably more difficult to observe in the field and probably strongly underestimated in the records elsewhere in the western Indian Ocean. In terms of exploitation, only

H. scabra and, to a lesser extent, *H. atra* (but in the same area and as substitute for *H. scabra*) are reportedly exploited within the country (Al-Rashdi et al. 2007a). *H. scabra* has, unfortunately, nearly disappeared from its very limited range after only a few years of uncontrolled exploitation (Al-Rashdi and Claereboudt 2010), thereby emphasizing the need for stricter management of the sea cucumber fishery.

The most striking result of this survey is the large difference in sea cucumber community structure between the Sea of Oman and the Arabian Sea (Fig. 4). This difference is not surprising given the strong seasonal effect of the monsoon on coastal habitats in the Arabian Sea (Barratt 1984).

Similar observations were made of other groups of marine organisms. Scleractinian corals, for instance, are also impoverished from the Arabian Sea to the Sea of Oman and the Arabian Gulf (Sheppard 1998), and macroalgae have a very similar distribution split across the geographic limits between the Arabian Sea and the Sea of Oman at Ras-Al-Hadd (Schils and Wilson 2006). Two of the sea cucumbers photographed and collected during the survey did not correspond to known shallow-water western Indian Ocean species (Figs 2B and 2D). These may correspond to new species (taxonomic and genetic studies are underway). Although very small in size (only 600 km of coastline), and only superficially surveyed, southern Oman is rich in endemic species such as sea stars (e.g. *Ferdina sadhensis* and *Patriella paradoxa*), the clownfish *Amphiprion omanensis* (Randall 1995), the abalone *Haliotis mariae* (Bosch et al. 1995), the parrotfish *Scarus zhofer* (Randall 1995) and the coral *Porites decasepta* (Claereboudt 2006).

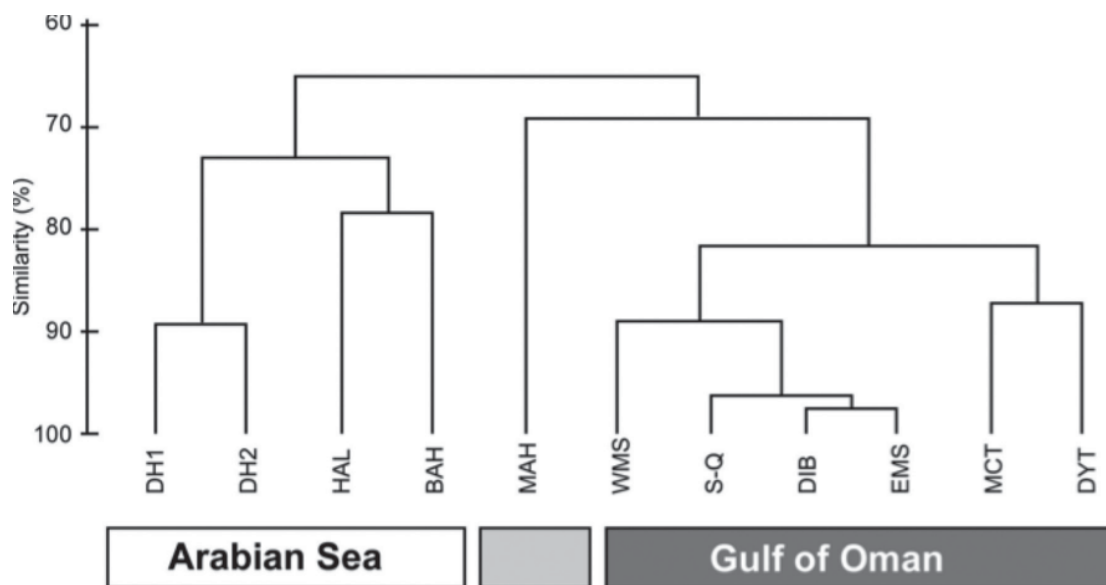


Figure 4. Cluster analysis dendrogram of sea cucumber communities along the coast of Oman. Similarity was measured using the Bray-Curtis index.

While endemic, these species are nearly all relatively common in their limited area of distribution.

The outlier community at Mahout Island (Fig. 1; Mah) is most likely the reflection of a change in fauna due to extensive shallow seagrass beds found near the island and the more limited coral reef development in the area. It is the only place where *Holothuria scabra* has been found in the whole survey and also the only population of sea cucumber in Oman supporting an artisanal fishery. Although, other species of high value (*H. nobilis*) or intermediate commercial value (*Stichopus variegatus*) were recorded, there appeared to be no exploitation of these species. *H. nobilis* is so rare that it could not support any exploitation, while *S. variegatus* on the other hand is relatively common in both the Sea of Oman and the Arabian Sea and could support a fishery but only under a very strict management plan.

Acknowledgements

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