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Oman's coral reefs: A unique ecosystem challenged by natural and man-related stresses and in need of conservation

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ABSTRACT

Oman contains diverse and abundant reef coral communities that extend along a coast that borders three environmentally distinct water bodies, with corals existing under unique and often stressful environmental conditions. In recent years Oman's reefs have undergone considerable change due to recurrent predatory starfish outbreaks, cyclone damage, harmful algal blooms, and other stressors. In this review we summarize current knowledge of the biology and status of corals in Oman, particularly in light of recent stressors and projected future threats, and examine current reef management practices. Oman's coral communities occur in marginal environmental conditions for reefs, and hence are quite vulnerable to anthropogenic effects. We recommend a focus on developing conservation-oriented coral research to guide proactive management and expansion of the number and size of designated protected areas in Oman, particularly those associated with critical coral habitat.

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1. Introduction

The Sultanate of Oman contains over 530 km² of coral reefs spread across one of the longest coastlines in Arabia (2092 km) bordering three biogeographically distinct water bodies: the Arabian/Persian Gulf, the Oman Sea (also called the Gulf of Oman), and the Arabian Sea (Spalding et al., 2001). These reefs support over 100 species of coral and 579 species of reef fish (Claereboudt, 2006; Grandcourt, 2012), as well as one of the largest fisheries economies in the region (US\$ 522 m in 2013; FAO, 2013). Despite their unique biogeographic context and clear importance to biodiversity and economics the coral reefs of Oman are among the least studied in the region, with just 4% of regional reef-related publications focused on reefs in Oman (Burt, 2013; Vaughan and Burt, in this issue). The purpose of this review is to provide a summary of our current understanding of the biology and status of coral communities in Oman, particularly in light of impacts from recent events and projected threats to corals in this area. We then explore current management practices for protecting Oman's coral assets, and provide recommendations on potential changes that would enhance the long-term conservation of this valuable and important ecosystem.

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2. The distribution and diversity of coral reefs in Oman

Knowledge of the corals and reefs of Oman began with surveys by Glynn in the 1980s (Glynn 1993) that originated from concern with the extent of effects from *Acanthaster planci*, Crown of Thorns Starfish (COTS), predation. Glynn's (1993) report identified four principal areas of reef coral occurrence (Fig. 1) in Oman's waters: i) The fjords, bays and coastlines of the Musandam Peninsula that separates the Arabian/Persian Gulf and the Oman Sea; ii) the Muscat Capital Area from Sohar to Ra's Abu Dawood, including the Daymaniyat Islands; iii) the southern shore of Barr Al Hikman and the west coast of Masirah Island; and iv) Dhofar from the Hallaniyat Islands to Mirbat. Much of the rest of the coast of Oman is sandy or otherwise unsuitable for coral settlement or growth (Sheppard and Salm, 1988).

Coral cover in Oman is generally highest around the rocky shores of the Musandam peninsula, and lowest around the Capital Area and Ras Al-Hadd, with an intermediate level of coral cover found in the far south in the Dhofar area (Fig. 2). In contrast, coral species richness has generally been reported as being highest on coral assemblages in the Arabian Sea where, despite the relatively cool environmental conditions associated with monsoonal upwelling, reefs are under strong biological influence from east Africa and the Gulf of Aden (Salm, 1991, 1993; Sheppard, 1987; Sheppard and Salm, 1988). Table 1 lists the number of coral genera and species that have been reported for various major



Fig. 1. Distribution of coral reefs in Oman.

reef areas in Oman over time, showing an increase in taxonomic richness as collection and survey efforts have continued over the past fifty years. The most recent work by [Claereboudt \(2006\)](#) now lists 106 coral species in >50 genera for the Oman Sea alone, including several new species, suggesting that the largest estimate of species richness for the entire country to date (107 species by [Sheppard and Sheppard, 1991](#)) possibly underestimates true species richness of corals across the nation. Much of the historic work on corals has focused on hard corals, but in recent years there have been growth in detailed taxonomic studies of soft corals along Oman's Arabian/Persian Gulf shores in the Musandam ([Samimi-Namin et al., 2009](#); [Samimi-Namin and van Ofwegen, 2012](#)), as well as in the Oman Sea ([Samimi-Namin and van Ofwegen, 2010](#); [Samimi-Namin et al., 2011](#)). Still unpublished work

Table 1
Numbers of genera (in parentheses) and species of corals reported for different regions of the Sultanate of Oman.

Reference	Location	Hermatypic	Ahermatypic	Total
Sheppard (1987)	Oman Sea	(31) 52	(1) 1	(32) 52
	South Oman	(28) 49	(0) 0	(31) 49
	All Oman	(32) 67	(1) 1	(33) 68
Sheppard and Salm (1988)	Musandam	(31) 51	(8) 10	(39) 61
	Capital area	(34) 61	(6) 7	(40) 68
	Dhofar	(31) 52	(2) 3	(33) 55
	All Oman	(38) 77	(10) 14	(47) 91
Salm (1991)	Musandam	(36)	(5)	(41)
	Muscat	(39)	(3)	(42)
	Gulf Masirah	(26)	(1)	(27)
	Dhofar	(43)	(5)	(48)
	All Oman	(43)	(8)	(51)
Sheppard and Sheppard (1991)	Oman Sea	(34) 70	(6) 8	(40) 78
	Dhofar & Aden	(39) 83	(4) 4	(43) 87
	All Oman & Aden	(42) 96	(10) 11	(52) 107
Claereboudt (2006)	Oman Sea	(35) 104	(2) 2	(37) 106

suggests that there may be higher richness of octocorals than hard corals, and that their diversity is likely higher in the southern Arabian Sea than in the areas further north, in contrast to patterns observed in hard corals ([K. Samimi-Namin, pers. obs.](#)).

3. Environmental constraints on Oman reefs

The northern Indian Ocean undergoes a biannual reversal of wind direction, with a southwest monsoon occurring in June through September and a reversal to the northeast monsoon in November to March ([Brock and McClain, 1992](#)). These winds are the driving force of traditional maritime sailing and trade for the region and also the dominant factor influencing the nearshore environment of Yemen and Oman. Vigorous southwest monsoon-driven circulation normally peaks in July and August as the Southwest Monsoon Current and dissipates in October.

The Southwest Monsoon is the major climatic factor affecting the near-shore environment and areas of coral growth in Oman during the summer months, from June to August ([Brock and McClain, 1992](#); [Sheppard et al., 1992](#)). These strong seasonal winds drive northeast parallel to the coast of southern Oman in the Arabian Sea, with associated Ekman transport creating strong upwelling along the coastal margins, bringing cold, nutrient-rich water to the surface ([Fig. 3](#)). This upwelled water directly affects shallow coastal areas along Oman's Arabian Sea coast, and has indirect impacts on corals and reef areas further north in the Oman Sea through gyres and eddy systems that sweep into the

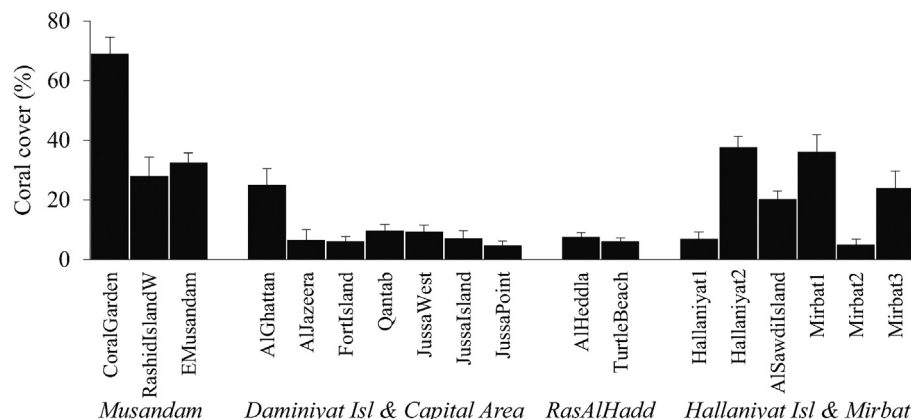


Fig. 2. Mean coral cover (\pm SE) observed in major reef areas throughout Oman in 2008. Adapted from [Burt et al. \(2011b\)](#).

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