

## Distribution and Abundance of the Corals around Hengam and Farurgan Islands, the Persian Gulf

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### Abstract

The percentage cover and distribution of scleractinian corals were studied at two Iranian islands in the Persian Gulf. Survey techniques involved the use of 20-m line transects placed at 4-9 m depth interval, parallel to the shore. GIS based maps were employed to show the distribution of hard corals. In Farurgan Island, hard coral cover was concentrated in the west and north-west of the island, while in Hengam it was mostly concentrated in the eastern side of the Island. Mean hard coral cover was 25.91% ( $\pm 5.80$ ) and 48.47% ( $\pm 1.36$ ) in Farurgan and Hengam Islands, respectively. There was a significant difference ( $p < 0.01$ ) in hard corals coverage among different reefs in each island. Other benthic life forms showed similar patterns with significant differences ( $p < 0.01$ ) among reefs. It was observed that the predominant hard coral forms were massive (Porites) in Farurgan Island, whilst those in Hengam Island were mainly branching corals (Acropora).

Keywords: *Corals reefs, Abundance, Distribution, Persian Gulf, Spectrometry*

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### 1. Introduction

Coral reefs have a wide range of natural, ecological, economic and cultural values.

The Persian Gulf is endowed with many islands where the marine environment is generally rich in natural resources including fish and corals. All the Islands in the Persian Gulf are of fringing type (Sheppard and Sheppard, 1991).

The Persian Gulf coral communities exist in a harsh environment with respect to salinities, sea temperatures and extreme low tides (Coles, 1988; Sheppard and Sheppard, 1991; Coles and Fadlallah, 1991; Sheppard et al., 1992). Normal winter water

temperatures are amongst the lowest at which coral reefs exist (Downing, 1985). Cold periods may further reduce the temperature below normal (Shinn, 1976) and the lowest temperatures in a coral reef was recorded in the Persian Gulf (Coles and Fadlallah, 1991). These factors have a profound influence on community structure by restricting the number of species in the area and by causing recurrent mortality among the dominant species (Coles and Fadlallah, 1991; Fadlallah et al., 1995).

Coral reefs in the Iranian waters of the Persian Gulf are largely restricted to the Islands. All reefs occur in shallow water, with significant coral development restricted to areas with depths of less than 10 m. Knowledge of Iranian coral communities is based on results of surveys performed earlier by

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Rosen (1971) and Harger (1984), with additional information from Rezai (1995), Shokri et al. (2000), Rezai et al. (2004), Rezai and Savari (2004). While quantitative information exists for coral communities in the southern part of the Persian Gulf (Carpenter et al., 1977; Basson et al., 1977; Burchard, 1979; Sheppard and Sheppard, 1991; Hodgson and Carpenter, 1995; Downing, 1985; Coles and Fadlallah, 1991; Fadlallah et al., 1993; Vogt, 1995), very little information exists on the coral communities of the Iranian waters, particularly around the Islands.

Many factors including natural and anthropogenic activities cause stress to the reef community affecting reef development. The reefs are degraded by those who frequently smash corals for trophies; by fishermen who walk, anchor, and pole boats over reefs; and by those who build piers over reefs. All these destructive activities diminish the value of the reef to fisheries, to conservation of the reef species and to tourism. Therefore, for planning and developing suitable management strategies, it is important to assess the live coral coverage.

The Iranian reefs are also of international scientific interest because they flourish in environmental conditions believed to be too extreme to allow corals to survive with high temperature and salinity variations (Coles and Fadlallah, 1991). Thus, the objectives of the present survey were to estimate coral coverage and to determine their distribution around each selected island.

## 2. Materials and methods

### 2.1 Study area

This study was conducted in Hengam and Farurgan Islands in Hormuzgan Province in the Persian Gulf (Fig 1). Corals are located around fringing reefs of Islands. Hengam Island (26°36' N 55°51' E and 26°41' N, 55°55' E) is located near the entrance of the Strait of Hormuz, South of

Queshm Island and has a small local population engaged mainly in fishing activities. Farurgan (26°15' N 54°29' E and 26°19' N, 54°33' E) is located in the middle of the Persian Gulf, south of Farur Island, having pristine waters with no human population. These islands experience different degrees of natural as well as anthropogenic stresses. (e.g. tourism, fisheries).

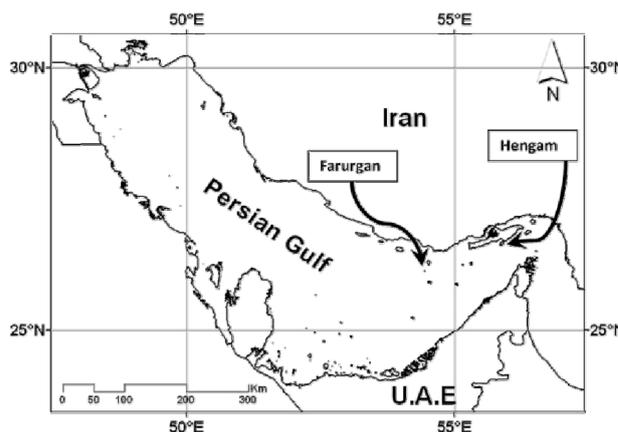


Fig 1. Surveyed Islands in the Persian Gulf.

Surveys were carried out at 28 stations in May 2006 around Farurgan Island (Fig. 2A) and at 43 stations in January and June 2006 around Hengam Island (Fig. 2B), and their positions were recorded by the Global Positioning System (GPS) (Table 1). The reefs were initially surveyed using the Manta Tow techniques as described by Moran and De'ath (1992). Subsequently, line transects were run underwater with SCUBA apparatus. Five line transects of 20 m were set and surveyed thoroughly at each station to the depth interval of 4-9m parallel to the shore. The substrate component beneath the line was recorded with an underwater slate and the projected length of live coral on the tape was measured to the nearest centimeter (Hill and Wilkinson, 2004; English et al., 1997). The data was summarized into six major categories: hard coral (HC), soft coral (SC), dead coral (DC), algae (AL), other fauna (OT), including echinoid *Echinometra* sp. and *Diadema* sp., sea star and sponge, and abiotics (AB). Abiotics included sediments, rocks

and coral rubbles. The percentage cover of all benthic lifeform was calculated Underwater

photography and videography were also employed for more accurate assessment.

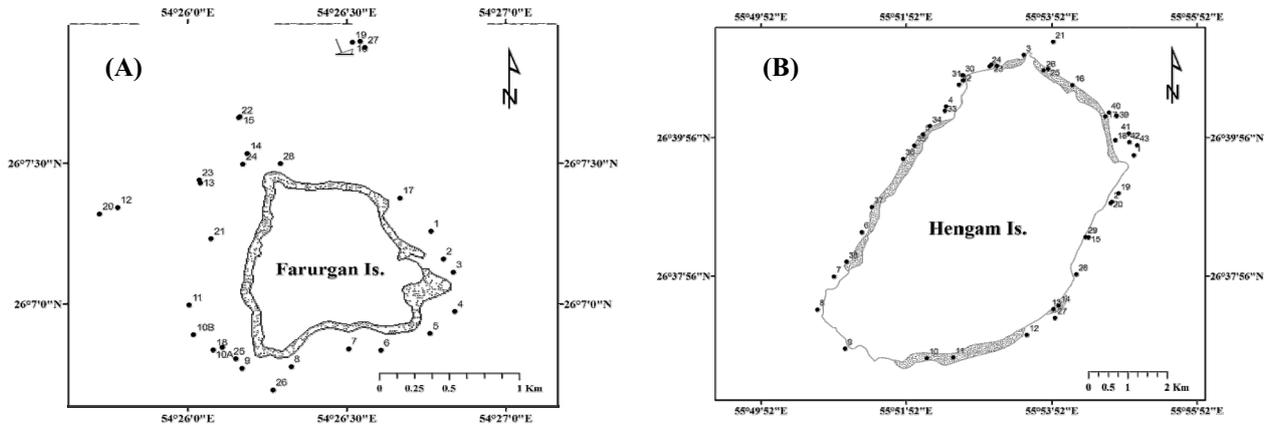


Fig 2. Sampling stations around Farurgan (A) and Hengam (B) Islands.

Table 1. Surveyed reef sites and their geographical positions.

Island (name)	Date (Day, month, year)	Reef (name)	Geographic Position (Lat., Long.)			
Farurgan	7.02.07	Mahijoo	26o	6.830'	54o	26.080'
	7.02.07	Mokhtari	26o	7.226'	54o	26.073'
	7.02.07	Mohtarami	26o	6.799'	54o	26.151'
	7.02.07	Masoud	26o	7.906'	54o	26.557'
	7.02.07	Rameshi	26o	7.493'	54o	26.291'
Hengam	6.01.07	Hamzeh	26o	39.673'	55o	55.990'
	6.01.07	Yaghoub	26o	38.997'	55o	54.690'
	6.01.07	Cheragh	26o	38.485'	55o	54.368'
	9.01.07	Meisam	26o	37.951'	55o	54.197'
	9.01.07	Kaveh	26o	38.490'	55o	54.325'
	10.01.07	Pooya	26o	40.828'	55o	52.634'
	10.01.07	Haji Mohamad	26o	39.986'	55o	54.920'
10.01.07	Manuchehr	26o	39.817'	55o	55.037'	

### 3. Statistical Analysis

Statistical analysis of data on the coral coverage among stations was carried out using one-way ANOVA. Data on coral percentage was normalized using  $\sqrt{\text{arcsine}}$  transformation (Zar, 1984; Cassie, 1963). One-way ANOVA was performed to test the variations of the ratios of live to dead corals among stations for which data were transformed using  $\log_{10} [x+1]$  (Zar, 1984; Cassie, 1963). Geographic distribution of hard corals around each island was shown using Arc GIS (Ver. 9.2).

### 4. Results

#### 4.1 Farurgan Island

Fishing lines, fish traps and moored boats were found to cause damage to the reefs around the island. A total of five sites were surveyed. Mean coral coverage was 25.91% ( $\pm 5.80$ ) with Mohtarami Reef showing the highest coral coverage (40.50%  $\pm 1.50$ ) and Mosoud Reef showing the lowest coral coverage (11.40%  $\pm 2.00$ ) (Fig. 3). Only Mokhtari and

Mohtarami reef sites showed >35% hard corals (Fig.4). Algal cover ranged from 13.57% to 36.60% around the island.

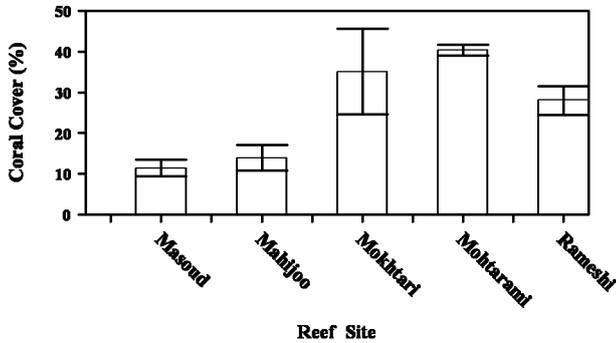


Fig 3. Mean estimates of hard coral cover at study sites in Farugan Island. Vertical bars indicate standard errors.

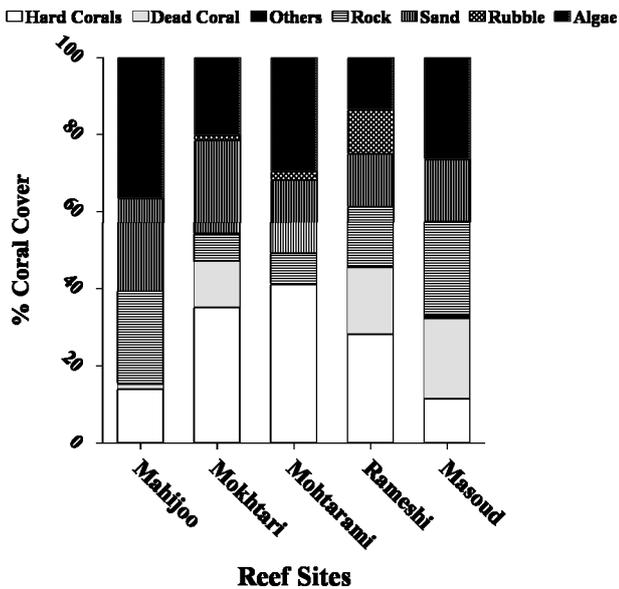


Fig 4. Mean estimates of different life forms at reef sites around Farugan Island.

There was a highly significant difference ( $p < 0.001$ ) in coral coverage and in the ratios of live to dead corals among the stations. The ratios ranged from 0.67 ( $\pm 0.26$ ) in Masoud to 2.75 ( $\pm 0.69$ ) in Mohtarami reefs. Massive corals *Porites* was the dominant group of coral followed by *Faviids*, while *Acropora* was less prominent (Fig.5). Geographic distribution of hard corals showed higher coral coverage around the western part of the Island (Fig.6).

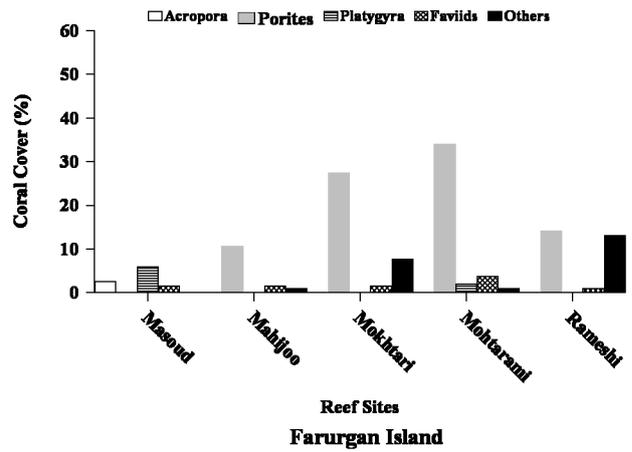


Fig 5. Percentage cover of major coral genera around Farugan Island.

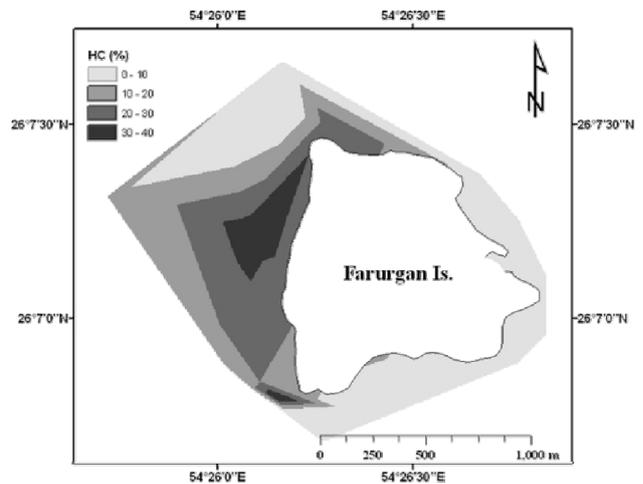


Fig 6. Distribution of hard corals around Farugan Island.

#### 4.2 Hengam Island

Due to the rapid expansion of tourism in Queshm Island, many boats transfer tourists to the reefs around Hengam Island for diving and fishing activities. Heavy damage to corals mostly due to theft by non natives as well as local people was observed. The moored boats also caused heavy damage to the reefs. Mean coral coverage was 48.47% ( $\pm 1.36$ ) around the Island with Yaghouf Reef showing the highest coral coverage (65.46% $\pm 2.12$ ) and Kaveh Reef showing the lowest coral coverage (22.73% $\pm 1.88$ ) (Fig. 7).

There was a highly significant difference ( $p < 0.001$ ) in coral coverage among stations. Furthermore, a highly significant difference

( $p < 0.001$ ) was found in the ratios of live to dead corals among the stations. These ratios were  $> 0.3$  indicating abiotic coverage. These ratios ranged from  $0.31 (\pm 0.17)$  in Kaveh to  $2.66 (\pm 1.09)$  in Yaghoub reefs. In contrast to Farurgan Island, there was no algal coverage in any of the transects surveyed in Hengam Island (Fig. 8).

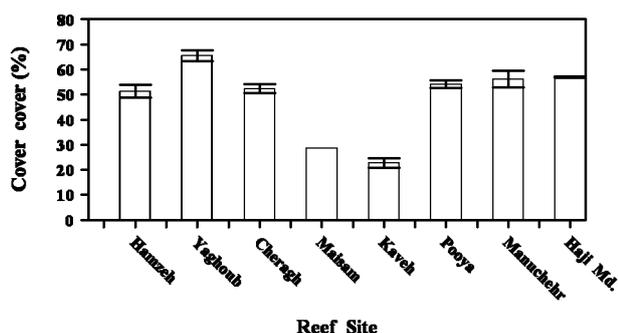


Fig 7. Mean estimates of hard coral cover at study sites in Hengam Island. (Vertical bars indicate standard errors).

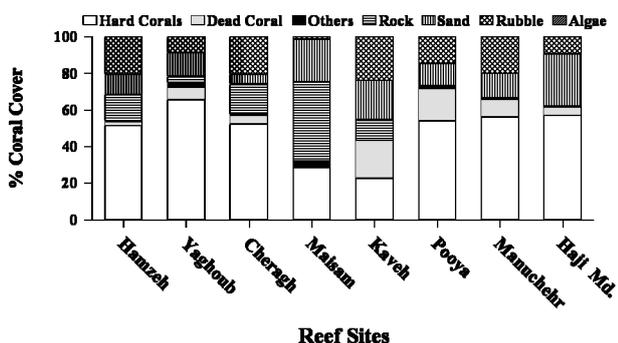


Fig 8. Mean estimates of different life forms at reef sites around Hengam Island.

Although this study did not intend to identify corals to the species level, species richness was considerably higher than those found in smaller Farugan Island. Branching corals *Acropora* was the dominant group of corals followed by *Porites* and *Platygyra* (Fig. 9). Coral development extended up to 12 m in depth, after which hard coral and coral species diversity decreased considerably or ceased to grow. Geographic distribution of hard corals showed higher coral coverage in the east and north-eastern parts of the island (Fig. 10).

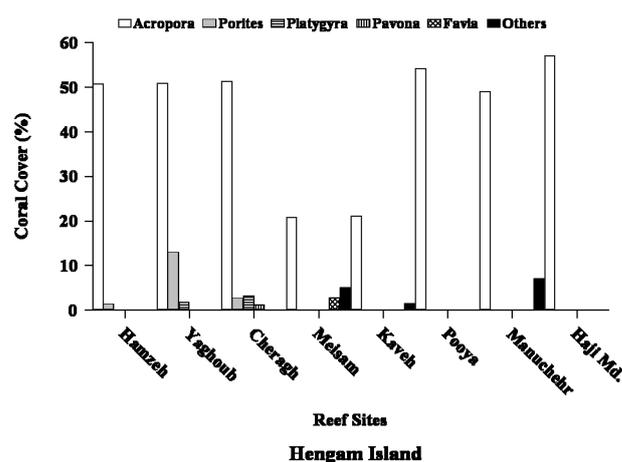


Fig 9. Percentage cover of major coral genera around Hengam Island.

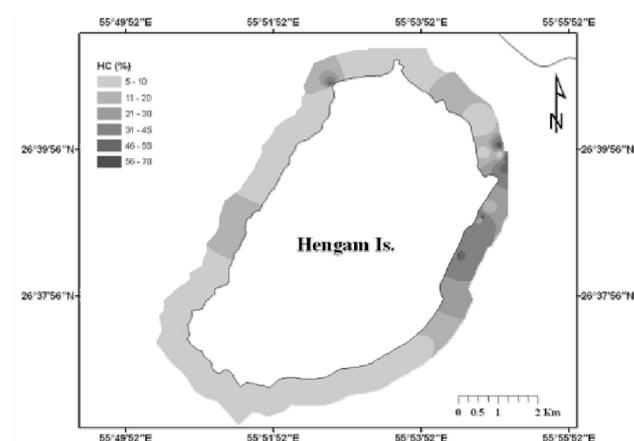


Fig 10. Distribution of hard corals around Hengam Island.

## 5. Discussion

Coral reefs found in the Iranian waters of the Persian Gulf are mainly located around the offshore islands. Described as harsh environment not optimum for luxuriant growth of corals (Sheppard et al., 1992), the islands in the northern part of the Persian Gulf harbor a rich community of scleractinians as well as reef associated organisms. Compared to Hengam Island, Acroporid corals were poorly represented (2.5%) in Farurgan. Reefs with high coral coverage were composed of mono species corals with low species diversity (Aronson and Precht, 1995). The dominant corals of Farurgan Island were the massive non-acroporids such as

Porites spp. This may be an adaptative feature of high stress levels to the environment.

On the other hand, acroporids are less tolerant to suspended sediments than poritids and faviids are and prefer substrates with less sand and lower suspended sediments (Riegl, 1999). Up to 2002, almost all of the acroporids were destroyed in shallow water areas of the Persian Gulf (Riegl, 1999; Sheppard and Loughland, 2002). These included corals which were previously resistant to warm waters (Kinsman, 1964). The branching corals Acropora, which had higher abundance and diversity were destroyed.

The most important environmental factors affecting the distribution and abundance of coral reefs are the interaction of biological and physical factors such as light and marine currents (Done, 1983). The shallow slope of southwestern part of Farurgan Island may have contributed to higher amount of wave actions whereby algal growth competes with corals for space. Algal coverage at Farurgan reefs is apparently dependent upon the presence of uncolonized space within the reefs. The increase in algal cover which is made up of primary algal colonizers, did not indicate the availability of dead coral surfaces.

In contrast, the relatively deeper waters around Hengam Island not only protected the corals from long exposure periods, but also exposed them less to stressful environmental factors such as bleaching episodes. Although algal groups were poorly represented, the acroporids were well represented. Moreover, exposure periods during summer and winter might cause some less resistant coral species to disappear and/or to be replaced by more resistant species such as Porites and Faviids.

Hard coral cover is one of the most important components of coral reefs (Dahl and Salvat, 1998) and the percentage of hard coral cover is an indicative of a healthy reef (Brown, 1988). Reese (1981) chose as his criterion of a healthy reef, one, in which corals were flourishing (high coral

cover). Although mean coral coverage in Hengam Island was almost double (48.48%) that of Farurgan (25.91%), it did not mean that the latter is less healthy. Considering the size of Hengam as compared to Farurgan Island (almost 50 times greater), it is not surprising that the coral coverage in the former Island was higher. This was due to the higher availability of suitable substrate for the settlement and growth of corals. Hard corals were recorded from the west and northwestern parts of the Farurgan Island where hard substrate was occurred.

As mentioned above, the higher species diversity and abundance around Hengam Island were due to acroporiid and poritid corals. Areas with higher coral coverage had lower diversity and were composed of mono species corals (Aronson and Precht, 1995). In some parts of the world, the reef structure is composed only of a single genus or species. For example, Porites was the dominant coral in Farurgan Island, whereas Acropora was dominant in Hengam Island. In other parts of the Persian Gulf, single species of Porites compressa is a dominant community in Bahrain (Sheppard and Sheppard, 1991) and in Saudi Arabia (Vogt, 1996). There are similarities between community structure of Hengam Island and other parts of the Persian Gulf. For example, the dominant community structure of acroporids in Kuwait (Downing, 1985) and Acropora clathrata in Kharg Island (Shin, 1976).

The depth specific line transect method used in this study gave a fair representation of the sessile lifeforms on the reef. It did not, however, fully describe the distribution of free living lifeforms (a large proportion of which inhabit coral reefs), especially if their distribution was patchy. Examples of such organisms would be the echinoderms, crustaceans and molluscs which inhabit crevices and cavities. Lim's (1987) study on the distribution of the echinoderms fauna of Singapore reefs revealed a patchy but wide

distribution of the sea urchin *Diadema*.

Due to the importance of corals for fisheries and tourism industry, government authorities should change their attitudes with respect to corals and consider them as valuable national natural resources. The establishment of marine protected areas in Hormuzgan Province governed by central government institution, local government and non-government organizations could be identified as one of the options to ensure proper utilization and conservation of natural resources. Some or all of the islands in Hormuzgan Province should be designated as marine parks so that their biodiversity could be maintained and well protected.

There is an urgent need to adopt a number of legal measures to conserve coral reefs. These include foremost enforcement of a ban on collection of corals and industrial development including land-filling and integration of public and private sectors in reef conservation.

The coral reefs of the Islands in Hormuzgan Province are critical habitats of cultural, socioeconomic and scientific values. However, their development is constrained by a variety of oceanographic factors: including extreme temperatures and salinity, high level of suspended sediments, limited surface areas of substratum suitable for the settlement of recruits and the scouring action of mobile sediments. An interesting study that should be carried out in association with hard corals is the ecology and roles of associated organisms.

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