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IRANIAN CORAL REEFS STATUS WITH PARTICULAR REFERENCE TO KISH ISLAND, PERSIAN GULF

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Abstract

In this paper, the coral status of Iranian waters in the Persian Gulf are reviewed and discussed based on the obtained results and information after three years of field surveys in Nay Band Bay, Kish and Farur islands. Altogether, 27 species of corals were identified from the studied areas, belonging to 9 families and 20 genera. Faviidae with 6 genera and 8 species is the most diverse of all families. On the other hand, Poritidae with 2 genera and 4 species is the most abundant corals in all areas. In the last 10 years, *Acropora* has declined from being the most abundant genus in shallow waters of fringing islands, to almost absennt, due to environmental stresses and human impacts. *Anacropora forbesi* is reported for the first time from the area.

Regarding the coral health, the live coral coverage ranges from 9 to 30%, with minimum coverage in Kish Island and maximum in Nay Band Bay.

During this study, no new bleached coral was observed at the surveyed areas, though in the past few years, considerable bleaching events have occurred throughout the area. This may have been the result of high sea surface temperatures reported during the years of 1996 and

1998. A moderate stateYellow-Band Disease was observed for the first time at Farur Island in the year 2000 survey. In the following year , a low incidence of the disease was also observed in Kish Island. Species found to be affected by Yellow Band Disease were *Porites lutea*, *P. compressa*, *Favia pallida*, and *Platygyra daedela*.

In this paper, substrate type and the general pattern of coral distribution and the target associated organisms are also discussed.

Introduction

The Persian Gulf is a semi-enclosed marginal sea surrounded by landmasses and is located in the subtropical northwest of the Indian Ocean. This has imposed a harsh condition on the marine organisms, especially coral reef communities with regard to salinity, temperature and extreme low tides. This is a very shallow sea with an average depth of about 35 meters, and was above sea level 10-15 thousand years ago.

Present climatic conditions force extreme rates of evaporation, which exceed precipitation and fresh water inputs, thus driving the average salinity above 40 ppt. Inflow from the Indian Ocean through the Straight of Hormuz makes up the water balance (Fadlallah et al. 1995). The thermal regime of the shallow gulf is influenced to a great degree by solar radiation and wind. Sea temperature normally ranges 14 to 34° C (Coles and Fadlallah 1991).

A rapid drop in seawater temperature (about 10° C) marks the transition from the warm to cold season between late November and December. The drop in seawater temperature coincides with the onset of the winter Shamal, a strong north-westerly wind carrying cold air during the months of November through April. During the early stages of a Shamal a negative surge is produced at the northern end of the gulf. This surge may exceed 3 m, which is more than the tidal amplitude (Lardner 1993). In later stages, the Shamal produces long period tidal oscillations, thereby effecting extreme low, meteorologically induced tides (CEA 1986; Lardner 1993). Mean sea level reaches a minimum also during the winter months. The coincidence of low astronomical tides and Shamal- forced oscillations produce extreme low tide events. The Shamal weather system is intermittent, normally lasting from 24-72 hours (CEA 1986; Hunter 1986; Williams 1991; Lardner 1993; Reynolds 1993).

Coral bleaching and mortality have been associated with elevated seawater temperature (Glynn 1993) and elevated air temperature (Loya 1976, in Fadlallah et al. 1995) during periods of aerial exposure. Examples of this event have been reported by some authors in different parts of the world, such as the Florida Keys, Fiji and Okinawa (Glynn 1993).

Also, widespread coral mortality at the limits of distribution of coral species in areas such as Florida, Panama, Hawaii, and the Persian Gulf have been related to low temperature stress (Shinn 1966; Glynn and Stewart 1973; Jokiel and Coles 1977; Walker et al. 1982; review in Coles and Fadlallah 1991).
In the Persian Gulf, reef corals experience long periods (months) of high sea temperature (above 30° C) in the summer and low (below 16° C) temperature in the winter (Downing 1985, in Coles and Fadlallah 1991). However, for the southern parts of the Gulf the cause of reef coral mortality has been reported to be lowering of water temperature (below 13° C) over a period of days or weeks (Shinn 1976, in Coles and Fadlallah 1991). While from our experiences and observation, it is clear that the mass mortality of corals occurred in our area

(northern part of the Gulf) was due to the high sea temperature observed in Kish Island during 1996 and 1998, and not from the temperature lowering.
The distribution of corals in the northern parts of the Persian Gulf (Iranian waters) is as follows:

The islands of the northern Persian Gulf have two geological origins during the Tertiary Period. The islands northwest of Kish Island, and Qeshm Island (the largest in the Persian Gulf) are the continuation of sedimentary layer outcrops from the Zagros Mountain Range on the mainland (Fig. 1). The others have been uplifted by a salt dome intrusion from the sea bottom (a unique tectonic feature of the Bandar Abbas area). The Eastern Islands which are situated in the Straight of Hormuz are greatly influenced by the less saline and nutrient-rich oceanic waters from Indian Ocean, while the Inner Islands tolerate a more saline and less fertile condition prevailed in nearly entire region. Coral reefs around these islands are of two types: a) patchy corals exist in suitable shallow waters and protected areas along the shoreline, such as Bandar Taheri Port and Khalij-e-Nay Band Bay in Bushehr Province, and b) fringing reefs which are found around all of the islands.

Methods

This article contains the results of field surveys of reefs in the northern Persian Gulf, from Kharko Island in the northwest to Hormuz Island in the Strait of Hormuz. The distribution of reefs was determined through field observations and surveys. Determination of the seaward extent of reefs was done using the violet-blue band of satellite images (Land Sat TM 1992). Surveys were conducted at three areas, Nay Band Bay, Kish and Farur islands, using SCUBA. At these sites, data was collected on coral species diversity and distribution, and on the health status of the coral reefs.
Coral species identification was carried out using available references specially Veron (2000), and through communication for further checking. All the species were photographed showing the whole specimen and also the corallite structures. The health status of reefs was determined using the Manta Tow Technique (UNEP 1993) and Transect survey (Reef Check 1998). Other observations such as, bleaching and diseases of coral species were also recorded to give information on anthropogenic and natural environmental stresses.

Results
Reef and Island Descriptions

Of the sites surveyed for this study, the main areas of patch corals were found at Nay Band Bay and also off the rocky shores of Taheri Port area, adjacent to the mainland, both in Bushehr Province. These are constituted of a few species scattered here and there and are not very dense. These areas could be regarded as “coral community”, where the hard-bottom community is dominated by scleractinian corals, but coral growth has not been sufficient to build a calcium carbonate framework. Reef zonation at Nay Band Bay includes 4 distinctive zones parallel to the shoreline, including sand, coral rubble, compact live and dead coral and an offshore sandy belt. Similar coral communities have been reported by Burchard (1979) for the western Persian Gulf, on the Saudi Arabian.

Fringing coral reefs surround all the islands, with a width of about 1 to 2 km, and extending from 1 meter below the mean low tide mark to a depth of 15-20 meters. The shallow zone down to 5 meters is mostly covered by Acroporidae species, whereas the dominant species in

deeper depths are mainly Poritidae and Faviidae. This is occurs at nearly all islands, except for Qeshm and Hormuz Islands, where reefs exist only on the southern part of the islands.

Coral Biodiversity

According to the present study, a total of 27 species belonging to 9 families and 20 genera were found from studied areas including, Nay Band Bay, Kish and Farur islands (Table1). The most abundant family is Faviidae with 6 genera and 8 species and is followed by Acroporidae with 5 and Poritidae with 4 species (Fig. 2). The data indicates that coral species diversity is highest at Kish Island with 21 species while it is 16 and 5 for Farur Island and Nay Band Bay respectively. Most of the species have already been reported from the area, but a new species *Anacropora forbesi* is reported for the first time for the Persian Gulf.
The most prominent species in terms of cover and frequency were *Porites lutea* and *P. compressa* in Nay Band Bay and Kish Island, whereas in Farur Island it was *P. compressa* which was the most abundant in upper part of the slope and *Acropora clathrata* at the deeper depths.

Coral Health Status

Coral status: Coral health status was determined using two methods, Manta Tows and Line Transects. Manta Tow was used at three sites while Line Transects were done only at Kish and Nay Band (Tables 2, 3 & 4). Live coral coverage ranges from 9 to 30%, with the least coverage in Kish Island and the most in Nay Band Bay. On most islands, coral extends from a depth of 3 down to a maximum 15 meters, with the typical zonation pattern shown in Figure 3.

On Kish Island, the highest live hard coral coverage is found on the eastern and southeast margin. The highest dead coral cover is found on the northern part where the main shipping and harbor activities, and a desalination plant, are found. Five years ago, corals were abundant with no sign of dead coral. At that time, *Acropora* species were dominant in shallow areas, while it is now *Porites.*

On Farur Island, live corals are mostly found on the eastern and northeastern part dominating by *Acropora*, while old dead corals are mostly found on the western side. On other parts of the island, *Porites* is dominant.

In Nay Band Bay, the highest living hard coral cover was found in the northern portion of the bay, whereas the southern portion facing the open Gulf was dominated by coarse sandy flats. Old dead corals are more abundant in the middle portion of the bay to the east. Out of bay to the west along the shoreline of the mainland, some small patches of corals occur which extend for tens of kilometers. Recent activities of oil and gas installation constructions have severely damaged these patches so as they are mostly dead now. In the bay itself the extent of corals is from 2 down to 10 meters.

Coral Bleaching: Over the last few years, the Persian Gulf has experienced two major coral bleaching events, one in the summer of 1996 and another more severe case in the summer of 1998, which led to near-complete mortality of the reefs in Saudi Arabia, Bahrain, Qatar, and UAE (Wilkinson 1998). An average of around 50% mortality was also experienced in Kuwait and lower mortality was recorded in Oman (Wilkinson 1998).

Bleaching observations on the Iranian side has also been documented through field observation at Kish, Farur and Hendourabi islands by Rezaei Marnani (1996) and Sadat Sadeghi (1997). At Kish Island the results of a survey in 1999 showed that approximately 15% of massive (*Favia sp*.) and sub-massive coral (*Porites sp.*) colonies showed bleaching in which typically 70% of each colony exhibited surface bleaching. This might have been the result of high sea surface temperature, which was reported during the years of 1996 and 1998. In 2000 and 2001 however, bleaching was absent or at very low incidence.

Yellow-Band Disease: The first incidence of this disease from the northern Persian Gulf was observed around Farur Island in 2000, at a moderate level. In 2001, low incidence was observed in Kish Island. Species found to be affected by Yellow Band Disease were *Porites compressa*, *Favia pallida*, and *Platygyra daedela*. This disease has been previously reported from the Southern Persian Gulf (Korrubel and Riegl 1997) and Gulf of Oman (Coles 1994).

Target organisms: With the help of belt transect survey, the occurrence of selected target organisms was determined, the results of which are presented in Table 4. While the data cannot be analyzed statistically, the number of target organisms at Kish Island is very low. This may be correlated with the low coral cover there. On the other hand, the population of target organisms at Nay Band Bay, is higher than at Kish Island, potentially related to the higher abundance of live corals at Nay Band Bay (about 30 %compared to 10% at Kish Island, Table 2).

Discussion

This paper tries to present a general view about the type, species richness, distribution and the health of different coral reef types in Iran, covering the northern part of the Persian Gulf. In spite of a few old and new studies by different local and expatriate researchers (e.g. Rezaei Marnani 1996; Harger 1982), no comprehensive study has been carried out in this regard so far, which, regarding the recent environmental stresses and anthropogenic impacts on the marine environment in general and coral reefs in particular, is urgently needed. The work presented here is only a start in this direction.

Coral Fauna and Zoogeography

The coral fauna identified in this study, numbering 27 Scleractinian species, occurs in two reef types, patches along the mainland and fringing reefs surrounding islands. The number of species reported here are from three site surveys and therefore it is likely that this number would increase if more work is done. Among these species, a new species was recorded before for the entire Gulf, *Anacropora forbesi*. In an earlier study, Rezaei Marnani (1996) reported 29 Scleractinian species and 6 Alcyonarians from 12 islands in the area though unfortunately did not provide the identification of these specimens to the species level.

Comparing the diversity of these islands, Kish Island with at least 21 species identified so far bears the highest diversity in northern part of the Gulf. This study has been carried out after at least two major bleaching events in the area and therefore it is possible that some species, especially *Acropora* are missing or have not been recovered by diving. Coral species richness in the Gulf appears to be subject to temporal fluctuations caused by mass mortality of certain sets of species. Riegl (1999) has reported that 6 species of *Acropora* disappeared from the live fauna after the 1996 mass mortality in UAE waters.

The species composition of Persian Gulf corals is typically Indo-Pacific, with most species occurring in a wide geographical area (Riegl 1999). A few exceptions to this are *Acropora arabensis* and *Anacropora forbesi* (newly found in this study) which are limited-distribution species. The closest faunal proximity to other coral areas of the Indo-Pacific is to the Red Sea (Sheppard and Sheppard 1991, in Riegl 1999) due to the shared paleoceanographic history of restriction during the last sea- level low stand and simultaneous flooding during the Holocene transgression. While this has led to the marked development of local endemism in the Red Sea, it is less pronounced in the Persian Gulf. The coral species of Iran and those of the Gulf in general, are similar to those at the geographical periphery of reefs. The very common *Acropora clathrata* and *Porites lutea*, for example, are also dominant species on the southernmost reefs of the western Indian Ocean in South Africa (Riegl et al. 1995; Riegl 1996, in Riegl 1999).

The Iranian coral fauna is mostly made up by scleractinia and there are only a few species of alcyonacean soft corals or reef building hydrozoa, which are common on other high- latitude reefs in the Red Sea and the Indian Ocean. According to the Riegl (1999), soft corals are not present in Dubai Waters.

The Iranian coast has a lower coral species richness than the southern part of the Gulf, where 34 coral species are reported in Kuwait (Carpenter et al. 1997), 50 (Basson et al. 1977) and 55 (Burchard 1979) species in Saudi Arabia, 34 species in UAE (Riegl 1999) and 53 species in Oman (Coles 1996). While a more complete survey in Iran would result in more species, environmental conditions prevailing in central waters of the Gulf, such as stronger waves and currents, low-nutrient waters and especially pollution in recent three decades (e.g. Downing and Roberts 1993), may cause lower diversity. Riegl (1999) points out that species-specific tolerances to low or high temperature are highly likely to be a deciding factor in community differentiation all over the Gulf. Furthermore, he emphasizes that substratum, most notably the thickness and grain size of sand or mud overlying the limestone, are important factors shaping community composition due to sediment stress during stormy conditions caused by the Shamal wind. Sediment resistant corals like faviids and poritids have an advantage in areas of high re-suspension and resettlement, while acroporids, with a low tolerance to sediment, only dominate in areas with little resident sand and therefore lower re-suspension.

Coral Health

The health status of corals is now a major concern following mass coral mortality following coral bleaching phenomena throughout the world, including the Persian Gulf. The results of present study show that a mass coral mortality occurred at nearly all islands, especially Kish Island, where more data and information exists through the local divers and the direct observation of the authors.

Widespread coral mortality has been reported for the southern parts of the Gulf (e.g. Tarut Bay, Fadlallah et al. 1995) and attributed to extreme low sea level stands and combined with low sea temperature. The cause of bleaching and subsequent death of shallow corals may have resulted from the impact of wind-chill, desiccation, irradiance, or contact with surface pollutants (e.g., oil sheens).

Based on our current knowledge and observation, we believe that mass mortality of coral species in the northern part of the Persian Gulf has been caused by seawater temperature elevation during the summer time, especially those of 1996 and 1998. In 1996 a massive bleaching event occurred at Kish Island after an unusually high sea temperature excursion which was followed by a strong storm lasting for many hours. Basson et al. (1977) state that

air temperature and solar irradiance are so extreme in the Gulf that coral would stand little chance of surviving very short periods of exposure.

On the other hand, recovery through coral growth has already started at Kish Island mainly for *Acropora* species, which were damaged and destroyed during bleaching. The fast growth of these corals (at least 10 cm. per year) suggests that it is likely that the *Acropora* population would be established in a few years time if there is not any similar bleaching incident in the future. However, we believe that the human impact on the marine environment in the area, especially large oil spills in the last years and also the continuation of oil pollutants from shipping activity in the area, have narrowed the tolerance limits of these stressed coral species, therefore enhancing their mortality.

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Table 1. Reef-building coral species found in the studied areas.

Family	Genius	Species	Area		
			Kish Island	Farur Island	Nay Band Bay
Poritidae	*Porites*	*lutea*	+	+	+
		compressa	+	+	+
		harrisoni	+	+	--
	Goniopora	*lobata*	--	+	--
Acroporidae	*Acropora*	*clathrata*	--	+	--
		downingi	+	+	--
		arabensis	--	+	--
	Anacropora	*forbesi*?*	--	+	--
	Montipora	*aequituberculata?*	--	+	--
Pocilloporidae	*Stylophora*	*pistillata*	+	--	--
Siderastreidae	*Siderastrea*	*savignyana*	+	--	--
	Anomastraea	*irregularis*	--	+	--
	Psammocora	*contigua*	+	+	--
	Coscinaraea	*columna*	+	--	--
Agariciidae	*Pavona*	*decussata*	+	+	--
Pectinidae	*Echinophyllia*	*aspera*	+	--	--
Mussidae	*Acanthastrea*	*echinata*	+	--	--
Faviidae	*Favia*	*pallida*	+	+	+
		speciosa	+	--	--
	Favites	*chinensis*	+	+	--
		pentagona	+	+	--
	Platygyra	*daedalea*	+	+	+
	Leptastrea	*transversa*	+	--	--
	Cyphastrea	*microphthalma*	+	--	--
	Plesiastrea	*versipora*	+	--	+
Dendrophyllidae	*Turbinaria*	*reniformis*	+	--	--
		peltata	+	--	--
Total 9	20	27	21	16	5

* The first report from the area

Ref. Fatemi & Shokri 2001, present study

Table 2. Percent cover of corals in the studied areas, Mean ± SD.

Area	Coral		
	Live	Recently killed	Rubble
Kish Island	9.76 ± 14.1	0.94 ± 3.23	8 ± 13.52
Farur Island	20.53 ± 13.9	1.31± 2.81	6.84 ± 9.31
Nay Band Bay	29.23 ± 28.3	0	5.38 ± 5.19

Table 3. Changes in relative abundance of hard coral, recently killed coral, and coral rubble along permanent Reef Check transects over a three-year period. N= 4 ×20m transects at each of two depths (2-6 m and 6-12 m); Mean ± SD of percent cover by each substrate type.

Zone depth	Substrate	Year/ Area		
		1999	2001	2000
		Kish Island	Kish Island	Nay Band Bay
Shallow (2-6 m)	Hard coral	0	8.5% ± 1.3%	10.5% ± 3.3%
	Recently killed coral	0	0	1.5% ± 2.4%
	Coral rubble	19.3% ± 4%	7% ± 3.2%	7.25% ± 2.5%
Intermediate (6-12 m)	Hard coral	0	5.3% ± 1.3%	11.3% ± 7.1%
	Recently killed coral	0	0	0.75% ± 0.9%
	Coral rubble	11.5% ± 4.4%	13.75% ± 8.5%	0.25% ± 0.5%

Table 4. Total numbers of selected target organisms observed along Reef Check permanent transects during three years of surveys in the studied areas. N= 4 transects at each of two depths: 2-6 m and 6-12 m.

Target organisms	Year/ Area		
	1999	2001	2000
	Kish Island	Kish Island	Nay Band Bay
Vertebrates			
Butterflyfish	28	8	33
Snapper	1	0	70
Parrotfish	7	3	5
Angelfish	0	0	21
Surgeonfish	0	0	3
Rubberlip	0	0	10
Grouper>30 cm	0	0	3
Moray eel	0	2	0
Picasso Triggerfish	0	2	0
Invertebrates			
Sea urchin	66	227	259
Sea cucumber	0	4	1
Cowery shell	0	0	2

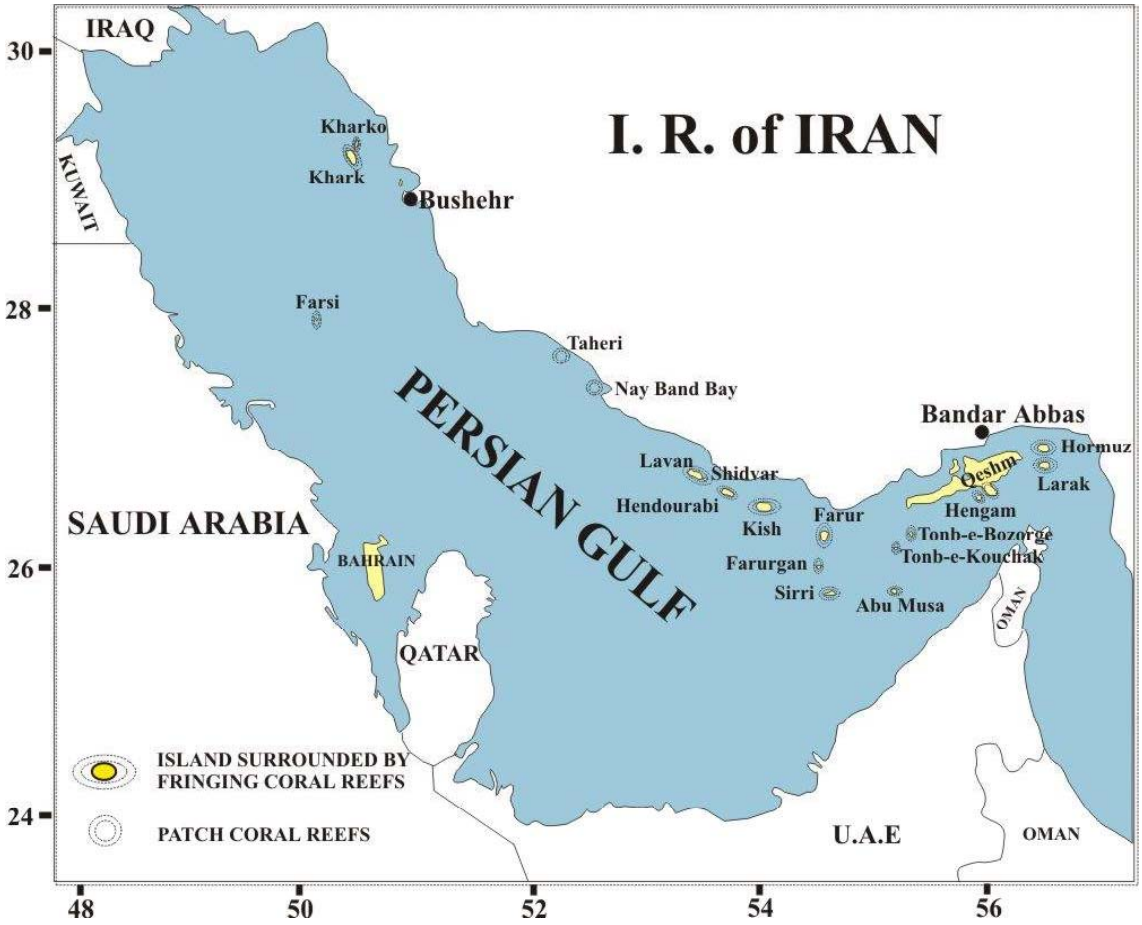

Fig. 1. Coral reef distribution in the northern Persian Gulf, Iranian waters.

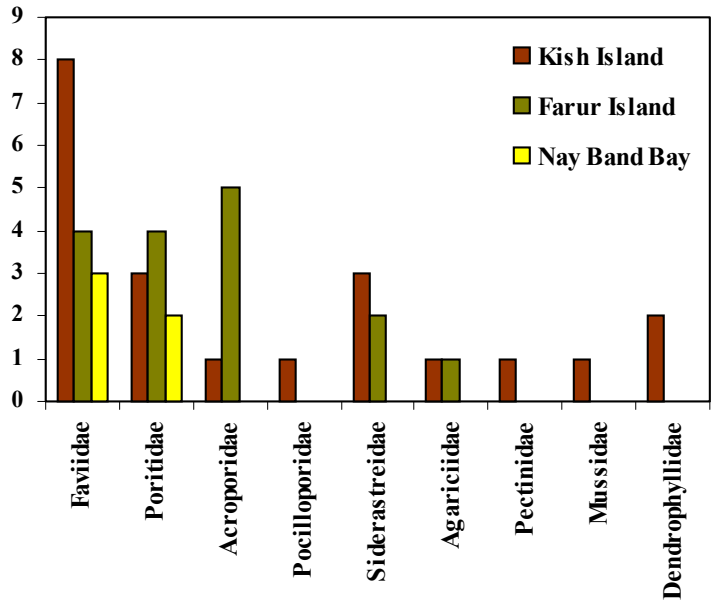

Fig. 2. Coral species frequency according to the family.

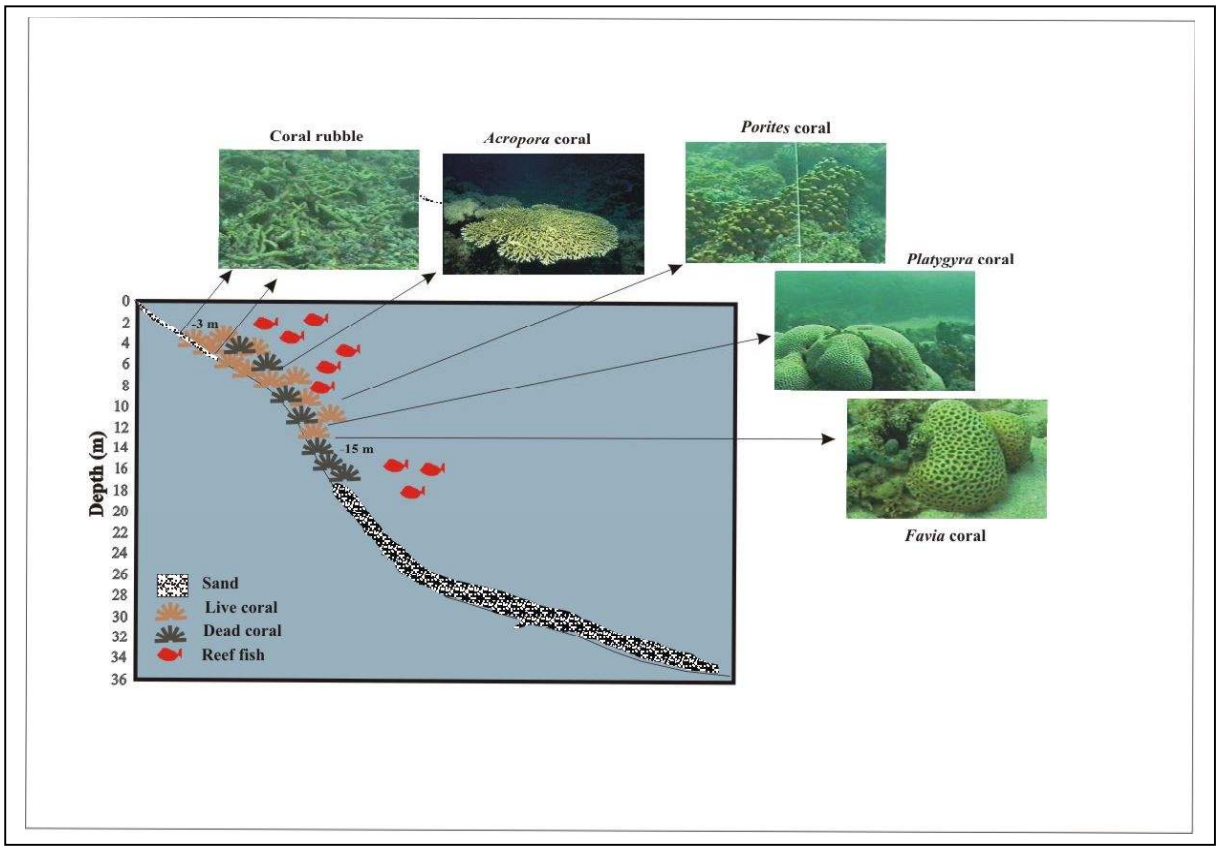

Fig. 3. Typical slope zonation of fringing reefs of the Iranian islands.

Kish (Persian: Ú©ÛŒØ´â€Ž (KÄ«sh) listen) is a 91.5-square-kilometre (35.3 sq mi) resort island in Bandar Lengeh County, HormozgÄn Province off the southern coast of Iran in the Persian Gulf . Owing to its free trade zone status, the island is touted as a consumer's paradise, with numerous malls, shopping centres, tourist attractions, and resort hotels. It has an estimated population of almost 40,000 residents and about 1 million visitors annually. Conservation Value of Coral Reefs around Kish Island, Iran. Marine Resource Economics, Vol. 28, Issue. 4, p. 331.Â Fatemi, S.M.R. and Shokri, M.R. (2001) Iranian coral reefs status with particular reference to Kish Island, Persian Gulf. International Coral Reef Initiative Indian Ocean Regional Workshop, Maputo, Mozambique, 26â€“28 November 2001. Harger, J.R.E. (1984) Rapid survey techniques to determine distribution and structure of coral communities. In Comparing Coral Reef Survey Methods. UNEPâ€“UNESCO Workshop: Thailand, p. 8391. Harrington, F.A. (1976) Iran: surveys of the southern Iranian coastline with recommendations for additional marine reserves.