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Scleractinian coral communities of Hormuz Island in the Persian Gulf

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Abstract

The abundance and health of scleractinian coral communities of Hormuz Island were investigated. For this purpose, we employed 20 m line intercept transects—12 in the intertidal zone and 15 subtidally to evaluate coral cover and community composition. The estimated dead coral coverage was 6.21%±0.81%, while live coral coverage was 16.93%±1.81%, considered as very poor. Totally, 12 genera were recorded, of which *Porites* with 11.9%±1.4% live cover was the dominant, while *Goniopora* had the least cover (0.07%±0.08%). Based on Mann-Whitney U-test, live coral coverage, dead coral coverage, algal coverage, cover of other benthic organisms and abiotic components showed significant univariate differences between zones ($p<0.05$). The Spearman correlation test between the abundance of biotic and abiotic components indicated significant negative correlation of live coral and sand with zoantharian and significant positive correlation of algae and other benthic organisms with rubble. The reef health indices used for the corals indicated that, in general, the environmental conditions were not suitable, which could be attributed to both natural and anthropogenic factors, the most important of which was zoantharian' overgrowth on the scleractinian corals in this region.

Key words: scleractinian corals, zoantharian, reef health indices, Hormuz Island, Persian Gulf

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1 Introduction

Being one of the most biologically diverse and complex ecosystems, coral reefs are known as the second richest ecosystem of the world after tropical rainforests (Reaka-Kudla, 1997; Hidaka, 2016). Although constituting a very small part of oceanic areas, coral reefs are highly productive marine ecosystems upon which millions of animal and plant species are depended on (Birkeland, 1997). Coral reefs are unique living structures providing substantial societal advantages, through food and livelihoods, tourism, treatments for disease and shoreline protection against storms and marine erosion (Burke et al., 2011; Jaleel, 2013). In addition, coral reefs particularly play an important role in supporting tropical coastal populations with providing over US$ 35 million/(km²·a) in products and services (Costanza et al., 2014; Wolff et al., 2015). Other benefits of this highly sensitive ecosystem, including the commercial aspects, have been aptly pointed out in various literatures (Bryant et al., 1998; Ellis, 1999; Center for Applied Biodiversity Science, Conservation International, 2008).

The Persian Gulf is a shallow semi-enclosed marginal sea surrounded by landmasses in the subtropical northwest of the Indian Ocean to which it is connected by limited water exchange via the Strait of Hormuz (Coles and Fadlallah, 1991; Sheppard, 1993). This water body provides a complex and unique tropical marine habitat, particularly scleractinian corals, with comparatively low biodiversity and many endemic species (Price, 1993). Hard coral communities in the Persian Gulf endure a wide range of stressful environmental parameters, such as high salinity (exceeding 45), harsh temperature fluctuations (winter lows less than 12℃ to summer highs above 36℃) and extreme low tides (Coles, 1988). The harsh environmental conditions of this marine ecosystem have also limited the distribution and diversity of scleractinian corals to such an extent that their diversity in the Persian Gulf is four times less than Indian Ocean (Wilkinson, 2008). These extreme conditions are selective for corals adapted to them because they survive in temperatures that would usually cause mortality in other regions (Coles, 2003). Various forms of coral reef communities exist in the Persian Gulf. Nearshore coral communities of the countries at the northern Persian Gulf such as Iraq, Kuwait, northern Saudi Arabia, form patch and fringing reef types (McCain et al., 1984; Coles and Tarr, 1990; Sheppard et al., 1992; Krupp and Müller, 1994). However, coral communities of Iranian waters and seven offshore islands of Saudi Arabia form initial fringing reefs such as coral cays (Sheppard et al., 1992). These types of corals are undoubtedly considered the most extensive and complex coral assemblages in the Persian Gulf, which demonstrate much of the only true coral reefs in this water body (Buchanan et al., 2016). On the contrary, at the countries of southern Persian Gulf such as United Arab Emirates, Bahrain, and Qatar, the nearshore assemblages are overlooked by coral carpets or biostromes (Purkis and Riegl, 2012; Burt et al., 2014), however, fringing and patch types are also occurred (Sheppard et al., 1992, 2010). All the scleractinian corals around the Iranian coastline and islands in the Persian Gulf occur in shallow water (less than 10 m) (Sheppard and Sheppard, 1991). Although several quantitative and qualitative studies on coral communities have been conducted in the southern part of the

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Persian Gulf (Downing, 1985; Sheppard and Sheppard, 1991; Coles and Fadlallah, 1991; Hodgson and Carpenter, 1995; Fadlallah et al., 1995; Vogt, 1995; Riegl, 1999; Bauman et al., 2013; Feary et al., 2013; Burt et al., 2016; Alhazeem, 2017; Fanning et al., 2021), a few information exists on the scleractinian corals in the northern part (Iran), particularly around the Islands (Fatemi and Shokri, 2001; Wilson et al., 2002; Mostafavi et al., 2007; Rezai et al., 2009; Namin and Van Ofwegen, 2009). Although various aspects of scleractinian corals in the northern part of the Persian Gulf have been studied in recent years (Rezai et al., 2010; Namin et al., 2010; Kavousi et al., 2011, 2014; Seyfabadi et al., 2011; Samiei et al., 2016; Bolouki Kourandeh et al., 2018; Oladi and Shokri, 2021), published information is still limited, especially for Iranian hard corals, where many places still remain unknown.

Unfortunately, more than 85% of the Persian Gulf's natural coral communities are threatened with the vast destruction of coral reef habitats in the Persian Gulf (Burke et al., 2011). There are 17 islands with coverage of hard corals in the north of the Persian Gulf (Shokri et al., 2005). Hormuz is one of the most important islands in the Persian Gulf with very little knowledge about its hard coral community. The Hormuz Island is a geopolitical and geoeconomical place located in Strait of Hormuz. The Strait of Hormuz is considered as one of the most strategic and economic waterways, especially because oil tankers collecting from several ports in the Persian Gulf must pass through it.

Because of the lack of study, there exists no robust baseline of coral reef health or composition in the region. The only specific work on hard corals in this island is limited to the bioeroders (Jafari et al., 2016). The present study aims (1) to estimate the percent coverage of live and dead scleractinian corals, biotic and abiotic components in the intertidal and subtidal zones of Hormuz Island, and (2) to specify health of the scleractinian corals using the reef health indices.

2 Materials and methods

2.1 *Study area*

The survey was conducted in Hormuz Island (27°04′N, 56°28′E), located in the strategic Strait of Hormuz, northeast of the Persian Gulf, which is one of the important islands of this water body with few patchy hard corals.

2.2 *Field and laboratory surveys*

Field operation and data collection were carried out in the intertidal and subtidal zones of Hormuz Island during 2012. The area was sandy and the stony corals existed in the tidal pools and subtidal zone. Since scleractinian corals in Hormuz Island mainly inhabit the southeastern shoreline (Fig. 1), the work was, therefore, restricted to this site (5 m maximum depth). A 20-m line was used for line intercept transects, and anything observed under the transect was recorded, including live coral (down to genus level), dead coral, rubble, algae, sand, rock and others which included other benthic organisms. The length of each item was recorded in centimeter from zero to the end of the transect, and cover was expressed as percent cover (Rogers et al., 1994). Totally, 12 and 15 transects parallel to the coast were considered in the intertidal and subtidal zone, respectively. The locations of transects were marked by a hand-held GPS (Table 1). The distance between transects was about 50 m in some locations to more than 100 m in other locations. Scleractinian corals and their polyps in the area were photographed with various zoom using a digital camera (Sony Cyber-shot DSC H55, 14.1MPIXEL). Then, photos were compared with the valid identification keys to recognize the genus, according to the morphological features (Sheppard and Sheppard, 1991; Carpenter et al., 1997; Veron, 2000; Claereboudt, 2006). The substrate slope was randomly determined at three locations in the site with an accuracy of 0.01°, using STABILA (LD500) laser rangefinder device. A Horiba-U-10 device was used to record each environmental factor such as salinity, temperature, dissolved oxygen (DO), and pH during fieldwork. A description sheet was used to record the most important destructive factors resulting from physical, biological and other processes based on direct observations throughout the study period.

2.3 *Coral reef health indices*

The semi-qualitative indices provide an easy and effective method to track the overall condition of reef health across the study area. The benthic categories were aggregated into five major groups (LC: live coral; DC: dead coral; Al: algae; Ot: other benthic organisms; Ab: abiotic components) to be engaged in coral reef health indices. The following reef health indices were used to determine the status of scleractinian corals, based on the percent of the organisms found in the transects, stresses and in-

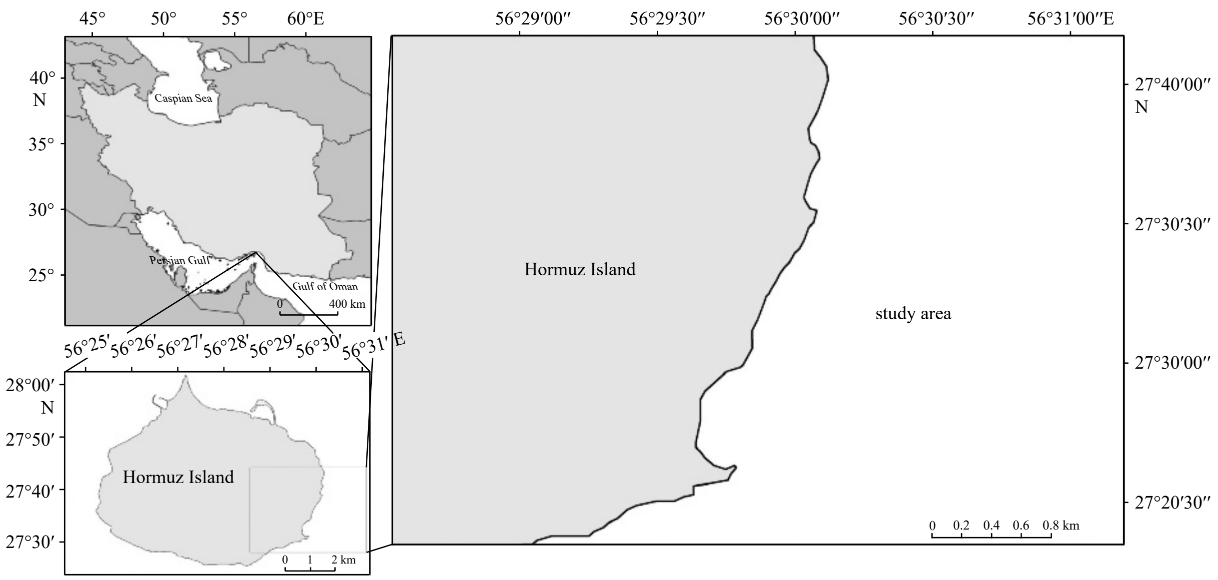

Fig. 1. Map showing the position of Hormuz Island and study area.

Table 1. Location and depth of the transects at the study site

Transect	Latitude	Longitude	Depth/m	Zone
Transect 1	27°03′00.14″N	56°30′03.27″E	<1	intertidal
Transect 2	27°03′01.64″N	56°30′03.75″E	<1	intertidal
Transect 3	27°03′04.69″N	56°30′05.43″E	<1	intertidal
Transect 4	27°03′07.92″N	56°30′04.91″E	<1	intertidal
Transect 5	27°03′12.81″N	56°30′04.57″E	<1	intertidal
Transect 6	27°03′18.41″N	56°30′04.09″E	<1	intertidal
Transect 7	27°03′21.22″N	56°30′06.29″E	<1	intertidal
Transect 8	27°03′20.92″N	56°30′09.13″E	<1	intertidal
Transect 9	27°03′25.83″N	56°30′08.20″E	<1	intertidal
Transect 10	27°03′29.18″N	56°30′08.66″E	<1	intertidal
Transect 11	27°03′32.80″N	56°30′08.88″E	<1	intertidal
Transect 12	27°03′37.95″N	56°30′10.02″E	<1	intertidal
Transect 13	27°02′48.10″N	56°30′10.31″E	<5	subtidal
Transect 14	27°02′46.61″N	56°30′17.90″E	<5	subtidal
Transect 15	27°03′01.06″N	56°30′20.29″E	<5	subtidal
Transect 16	27°03′08.30″N	56°30′14.95″E	<5	subtidal
Transect 17	27°03′05.95″N	56°30′24.82″E	<5	subtidal
Transect 18	27°03′10.06″N	56°30′15.87″E	<5	subtidal
Transect 19	27°03′08.12″N	56°30′24.95″E	<5	subtidal
Transect 20	27°03′11.25″N	56°30′15.32″E	<5	subtidal
Transect 21	27°03′08.14″N	56°30′23.92″E	<5	subtidal
Transect 22	27°03′16.90″N	56°30′16.81″E	<5	subtidal
Transect 23	27°03′22.30″N	56°30′16.95″E	<5	subtidal
Transect 24	27°03′20.76″N	56°30′29.61″E	<5	subtidal
Transect 25	27°03′23.96″N	56°30′32.36″E	<5	subtidal
Transect 26	27°03′27.90″N	56°30′16.33″E	<5	subtidal
Transect 27	27°03′35.69″N	56°30′26.78″E	<5	subtidal

fluence of biotic and abiotic components in those conditions: mortality index (Gomez et al., 1994), development index, condition index, and succession (by algae) index (Manthachitra, 1994), using the equations below.

Mortality index (MI): Mortality index calculated as ratio of dead coral cover to total coverage of both live coral and dead coral (Gomez et al., 1994). Mortality index values near zero show no significant changes for live coral, while the value of 1 indicates that there is a change of live to dead coral. Totally, if mortality index is more than 0.33, considered to be high and the coral reef is categorized as sick (Sadhukhan and Raghunathan, 2011).

$$\mathrm{MI}=\frac{\%\,\mathrm{DC}}{\%\,\mathrm{LC}+\mathrm{DC}}. \tag{1}$$

Development index (DI): This index shows the development and natural condition of scleractinian coral communities and is described with live coral, dead coral, algae, other benthic organisms, and abiotic components such as rubble, sand and rock.

$$\mathrm{DI}=\log_{10}\left(\frac{\mathrm{LC}+\mathrm{DC}+\mathrm{Al}+\mathrm{Ot}}{\mathrm{Ab}}\right). \tag{2}$$

Condition index (CI): This index shows the condition of scleractinian corals and the levels of tension in them.

$$\mathrm{CI}=\log_{10}\left(\frac{\mathrm{LC}}{\mathrm{DC}+\mathrm{Al}+\mathrm{Ot}}\right). \tag{3}$$

Succession index (SI): This index shows the succession of two other groups of benthos in a coral reef, including algae (SI_1) and other benthic organisms (SI_2) besides the scleractinian corals (including dead ones).

$$\mathrm{SI}_1=\log_{10}\left(\frac{\mathrm{Al}}{\mathrm{DC}+\mathrm{Ot}}\right), \tag{4}$$

$$\mathrm{SI}_2=\log_{10}\left(\frac{\mathrm{Ot}}{\mathrm{DC}+\mathrm{Al}}\right). \tag{5}$$

As it has been shown in Table 2, indices should be changed from quantitative amount to qualitative information (five category) in order to manage sources (Idris et al., 2006).

2.4 *Statistical analysis*

Prior to analysis, data were tested for normality ($p\geqslant 0.05$) by using Shapiro-Wilk test. The Mann-Whitney U-test (SPSS version 23) was applied to evaluate the significant differences of the mean abundance of biotic and abiotic components between zones. The relationship between the percent coverage of biotic and abiotic components was carried out using Spearman correlation test in SPSS version 23. SigmaPlot software (version 12.3) was used during this research for statistical calculation and drawing the diagrams.

3 Results

3.1 *Live coral, biotic and abiotic components cover*

In total, 12 genera of hard corals were recorded in Hormuz Island, of which *Porites* constituted the highest live coverage (11.9%±1.4%), while *Goniopora* had the least coverage (0.07%±0.08%) (Fig. 2). *Porites* was the dominant genus at intertidal (10.44%±1.47%) and subtidal (13.07%±1.27%) zones of Hormuz Island, while *Goniopora* only was observed at subtidal zone (0.12%±0.1%) (Fig. 3). The mean live coral coverage of Hormuz Island was 16.93%±1.81% of all substrata (Fig. 4), which was in a very poor state (Table 2). The mean live coral coverage extents at the intertidal and subtidal zones were 14.29%±1.51% and 19.04%±1.79%, respectively (Fig. 5). The percent coverage of the substrate components was measured according to the total average of the transects, which revealed that zoantharian (Fig. 6) had the highest coverage in the coral zones, followed by sand, dead coral, algae, coral rubble, rock and other benthic organisms (Fig. 7).

Based on Mann-Whitney U-test, live coral coverage, dead coral coverage, algal coverage, cover of other benthic organisms and abiotic components showed significant univariate differences between zones ($p<0.05$). The Spearman correlation test between the abundance of biotic and abiotic components revealed negatively significant correlation of live coral and sand with zoantharian. However, a significant positive correlation of algae and other benthic organisms was observed with rubble (Table 3).

Table 2. Semi-qualitative scale for assessment of qualitative indices in two corresponding forms: percentage and index scale form (Idris et al. 2006)

Quality	Percentage/%	Index scale
Very poor	<20	<−0.602
Poor	20.00–40.00	−0.602 to −0.176
Fair	40.01–60.00	−0.176 to 0.176
Good	60.01–80.00	0.176–0.602
Very good	>80.00	>0.602

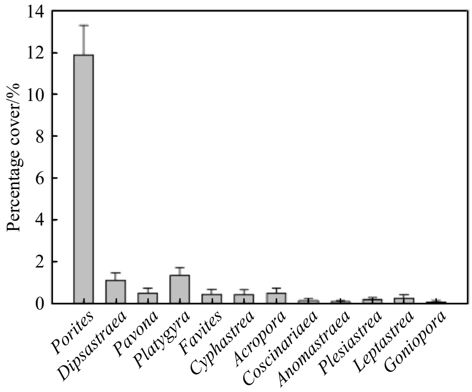

Fig. 2. Coral genera coverage at Hormuz Island.

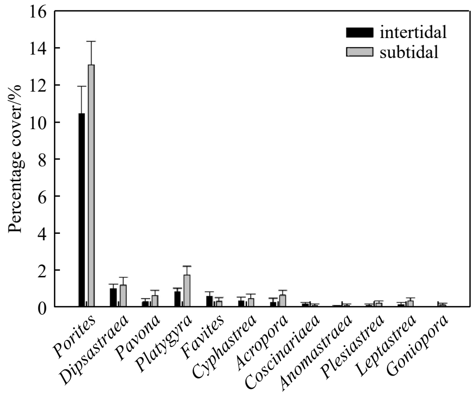

Fig. 3. Coral genera coverage at the intertidal and subtidal zones of Hormuz Island.

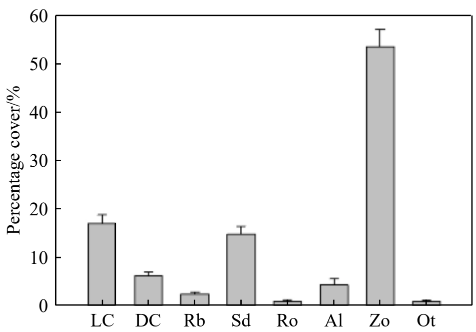

Fig. 4. Percentages of biotic and abiotic components at Hormuz Island (LC: live coral; DC: dead coral; Rb: rubble; Sd: sand; Ro: rock; Al: algae; Zo: zoantharian; Ot: others).

The thrice measured slope of the seabed in study site showed an average slope of 3.2°. The tidal range was about 3.5 m. The fluctuation of environmental factors was very low during the study period. Water temperatures ranged from 27℃ in April to 32℃ in August whereas salinity was about 36 to 37 during the study period. In addition, pH was about 8.2 and DO ranged from 6 mg/L to 7 mg/L.

3.2 *Determination of the coral reef health indices*

Reef health indices were measured for the scleractinian corals of the study area. The average MI of 0.268 indicates healthy reef with significant change of live coral coverage in different zones. In terms of the reef health indices, we observed that the

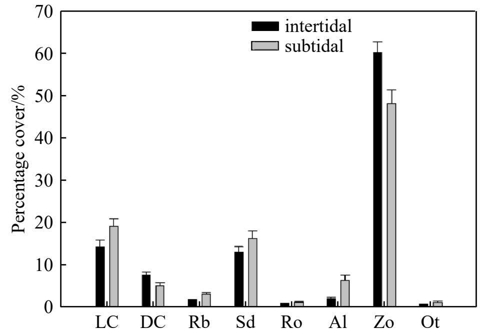

Fig. 5. Percentages of biotic and abiotic components at the intertidal and subtidal zones of Hormuz Island (LC: live coral; DC: dead coral; Rb: rubble; Sd: sand; Ro: rock; Al: algae; Zo: zoantharian; Ot: others).

reefs were highly developed, but with high mortality and a high proportion of zoantharian. The average DI was within Manthachitra's "very good" category at 0.653, inside the Hormuz Island, indicating that these reefs were well developed, with the spaces in the reefs being inhabited or were habitable by benthic organisms, in contrast to poorly developed reefs which were mostly sand or silt. The average CI was within Manthachitra's "very poor" category at –0.583, inside the Hormuz Island, implying that the reefs were very poorly coral-dominated. On the other hand, the average SI_1 was also within Manthachitra's "very poor" category, at –1.141 inside the Hormuz Island, suggesting low algal cover and that algae are likely not to succeed corals in dominance among other benthic organisms. Lastly, the average SI_2 was also within Manthachitra's "very good" category, at 0.710 inside the Hormuz Island, suggesting substantial zoantharian cover and that zoantharians are definitely to succeed corals in dominance among other benthic organisms. Hard coral mortality index for intertidal and subtidal zones was calculated to be 0.346 and 0.211, respectively. High mortality value of intertidal zone indicate healthy coral reefs, while low mortality at subtidal zone classified as sick coral reefs condition (MI>0.33). DI for intertidal and subtidal zones were estimated to be 0.738 and 0.592, respectively, which was very good index for development of coral reef communities. However, the estimated CI of –0.691 and –0.502 for intertidal and subtidal zones showed very poor condition for the hard corals coverage. The result of algal succession (SI_1) for intertidal (–1.535) and subtidal zones (–0.936) revealed that this index was not an appropriate factor as it had insignificant influence on corals of the area. The estimated succession index for the benthic organisms other than algae in intertidal (0.801) and subtidal zones (0.635) were very good. Detailed information is shown in Figs 8 and 9.

The most important destructive factors observed by researchers or mentioned by island's inhabitants throughout the study period are demonstrated in Table 4. Since long-term monitoring data were not available, no quantity and quality of these factors were measured.

4 Discussion

During one month of fieldwork, totally 12 genera of scleractinian corals were recorded from 12 and 15 transects in the intertidal and subtidal zones of Hormuz Island. Most of the coral genera in Hormuz Island are similar to those that occur in other parts of the Persian Gulf. Some genera, viz. *Goniopora, Anomastraea*, *Plesiastrea*, *Leptastrea* and *Coscinariaea*—for some reasons such as adverse environmental conditions were rare in the

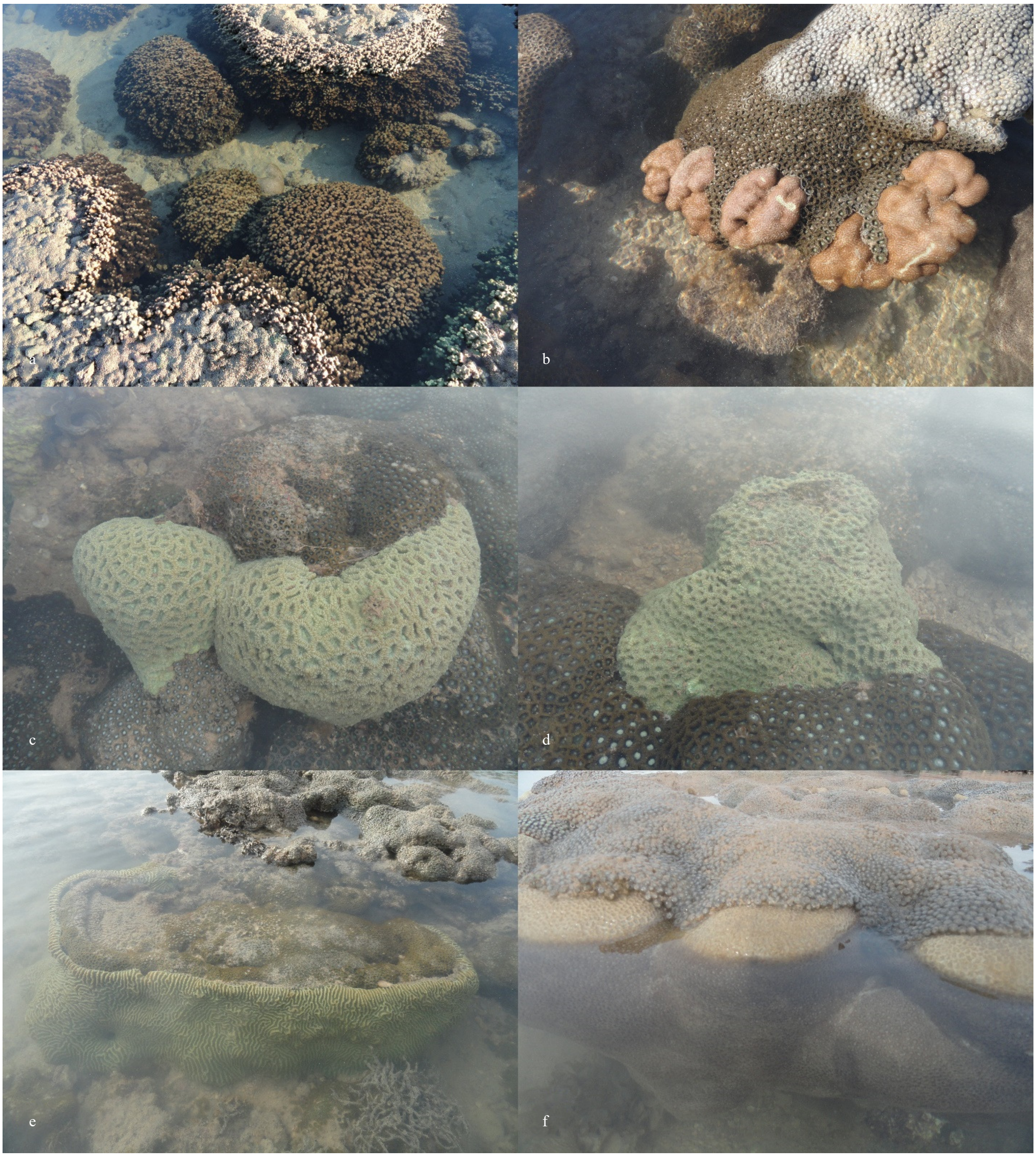

Fig. 6. Overgrowth of zoantharian on some hard corals genera: *Porites* (a, b); *Dipsastraea* (c); *Favites* (d); *Platygyra* (e); *Anomastraea* (f).

area and only a few colonies—were found which can all be considered indications of the harsh conditions for hard corals. Few years ago, 16 genera of scleractinian corals were reported from the waters of Kish Island, 11 genera from Farur Island, 4 genera from the Nay-Band Bay (Fatemi and Shokri, 2001), 10 genera from Qeshm Island (Kavousi et al., 2011), 16 genera from Larak Island (Mohammadizadeh et al., 2013) and 26 species from Abu-Musa and Sirri Islands (Salimi et al., 2018). In addition, in the southern part of the Persian Gulf, 25 genera of scleractinian corals from the waters of Kuwait (Carpenter et al., 1997), 16 genera from the United Arab Emirates (Sheppard, 1988), and 8 genera from Qatar (Emara et al., 1985) have been reported. The Persian Gulf scleractinian coral fauna with about 10% of the total Indo-Pacific species is a subset of this general biogeographic region fauna (Coles, 2003). Harsh and limiting environmental conditions like wide range of the temperature fluctuations, high salinity, extreme sedimentation and oil pollution put the hard corals of the Persian Gulf in a bad situation (Coles, 2003). Besides the bad situation, some other factors such as limited rocky shoreline, lack of hard substrate for larval settlement, and other antropological or environmental factors limit the stony corals in this island. Hard corals are mostly found in the southeast and west of the island, the main reason of which is the appropriate conditions in these areas, including the existence of tidal pools that prevents exposure of scleractinian corals to the air during the low tide. The dominant genus in Hormuz Island was *Porites*

Fig. 7. Biotic and abiotic components at the study area.

Table 3. Spearman coefficient of correlations between biotic and abiotic components (LC: live coral; DC: dead coral; Rb: rubble; Sd: sand; Ro: rock; Al: algae; Zo: zoantharian; Ot: others)

Biotic and abiotic components	LC	DC	Zo	Al	Ot	Rb	Sd	Ro
LC	1							
DC	−0.093	1						
Zo	−0.726**	−0.054	1					
Al	0.203	−0.194	−0.548**	1				
Ot	0.230	−0.130	−0.186	0.251	1			
Rb	0.242	−0.101	−0.253	0.428*	0.529**	1		
Sd	0.093	−0.317	−0.492**	0.289	−0.047	−0.070	1	
Ro	−0.339	0.056	0.063	−0.011	0.052	0.094	0.157	1

Note: ** Correlation is significant at the 0.01 level; * correlation is significant at the 0.05 level.

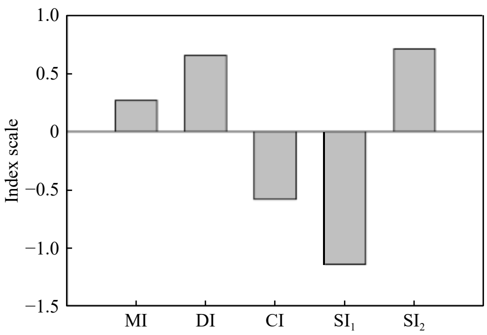

Fig. 8. Reef health indices used for hard corals at Hormuz Island.

with a total live coverage of 11.9%±1.4%, which was the maximum coverage among the 12 genera observed in this area. It seems that various species of *Porites* are able to withstand the sedimentation, salinity and temperature fluctuations of the Persian Gulf (Riegl and Purkis, 2012; Burt et al., 2014; Salimi et al., 2017). Prevalence of this genus had already been reported both around the Farurgan Island (Rezai et al., 2010) and Qeshm Island (Kavousi et al., 2011).

Based on the results, the live coral coverage in Hormuz Island was in a relatively poor situation (16.93%±1.81%) due to various reasons (Sheppard, 2006). The low abundance and diversity of corals in this region may be impacted by the inability of

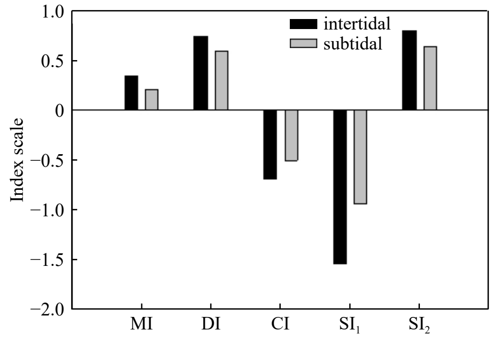

Fig. 9. Reef health indices used for hard corals at the intertidal and subtidal zones of Hormuz Island.

Table 4. Destructive factors at Hormuz Island and their presence (+) or absence (–) at the study area

Destructive factor	Intertidal zone	Subtidal zone
Sedimentation	+	+
Trawling	–	+
Military maneuvers	–	–
Lost net and fishing gear	+	+
Breakwaters	–	–
Boats	–	+
Diving and snorkeling	+	+
Oil pollution	+	+
Urban run-off	+	+
Littering	+	+
Extremely low tide	+	+
Warm weather	+	+
Red tide	–	–
Coral diseases	+	+
Coral reef fishes	+	+
Sea urchins (*Echinometra mathaei*)	+	+
Algal overgrowth	–	–
Zoantharian overgrowth	+	+
Other factors	+	+

many corals to recover from severe bleaching and other ongoing stressors during the last few decades. This might be due to the high temperature during the extreme low tides in some locations and shallowness of the coral substrates (<5 m), as greater live coral coverage had been recorded in deeper waters (Rezai et al., 2010; Kavousi et al., 2011). The lower live coral coverage at some locations could also be due to the overgrowth of macroalgae (Coles, 2003). The macroalgae coverage (1.98%±0.35% at the intertidal zone and 6.28%±1.35% at subtidal zone) could influence the scleractinian corals by means of reducing the available energy for corals' growth and fecundity (Tanner, 1995; Jompa and McCook, 2003), disturbance of larval settlement (Mumby et al., 2005) and destroy the scleractinian corals (Lirman, 2001). Macroalgae were in general not common (0.7% to 15.5%) during transects. The most common macroalga was *Iyengaria stellata*- a species of widely distributed brown algae in warm waters. Some coral colonies at both of zones were completely covered by zoantharian. The overgrowth of zoantharian (60.14%±2.54% at the intertidal zone and 48.09%±3.21% at subtidal zone) could also play a negative role on corals. This study indicated that the zoantharian coverage was far higher than the scleractinian coral coverage, which could probably be due to the higher tolerability of zoantharians to harsh environmental conditions. This phenomenon could be attributed chiefly to the existence of more coral calcium carbonate, rocky and steady substrates that provided suitable habitats for the settlement of its larvae and, hence, a higher abundance of zoantharians in that area, which is in correspondence with the other findings (Reimer, 2007; Irei et al., 2011; Pouryousef et al., 2020). Besides, it has been supposed that such extensive colonization of zoantharians occur in reef-building corals with copious rubble and dead corals (Karlson, 1983; Cruz et al., 2016). The dominance of zoantharians from intertidal and subtidal zones of shallow waters in the Atlantic and the Pacific have been previously reported (Karlson, 1983; Yang et al., 2013; Cruz et al., 2015).

The percent coverage of live coral and dead coral showed a significant difference between intertidal and subtidal zones (p<0.05). The subtidal zone contained location with the higher live coral coverage and genera diversity in which *Porites* genus were dominant, while they were lower percentage cover in intertidal zone (Fig. 2). Corals in near shore are extremely influenced by higher concentration of ongoing stressors which exposed by run-off and development of anthropogenic activities (Smith et al., 2008). Comparison of biotic and abiotic components between different zones revealed the coral abundance were only correlated with the zoantharian abundance and not with the other measured factors.

Coral density and diversity in the Persian Gulf have been reported to be low due to various harsh anthropogenic and natural circumstances, such as the sedimentation, oil pollution, wide temperature fluctuations and high salinities (Coles, 2003; Turner et al., 2000). As for Hormuz Island, the limited hard bed and high anthropogenic impacts have restricted coral settlement only to certain small locations. Sand on the substrate is the source of stress in stormy conditions (Riegl, 1999; Rezai et al., 2004). Compared to other coral families, members of Poritidae and Favidae are more resistant to suspended sediment and that may be the reason for the higher abundance of *Porites* and other genera in these families. Mooring cause serious harm to coral communities in some area (Glynn, 1994; Tratalos and Austin, 2001). Acroporiids, which are prevailing in shallow waters and have fragile structure can be easily hurt by divers (Riegl and Velimirov, 1991). In the present study, it was found that the *Acropora* and other hard coral genera were damaged by diving activities, which was in correspondence with other researches (Rezai et al., 2010; Kavousi et al., 2011; Mohammadizadeh et al., 2013). Growth of algae and other sessile benthic organisms cause partial coral tissue death (Smith et al., 2008). Moreover, overfishing has diminished reef fish communities throughout the study site which can cause severe physical damage of coral reef ecosystems (McClanahan et al., 1996; Hodgson, 1999). This study demonstrate that coral communities of Hormuz Island have been damaged by anthropogenic impacts such as sedimentation, municipal run-off, tourism, diving activities, boat anchors, trap fishing and other human activities.

Scleractinian corals which exist in the tidal zone of the southeastern part of the island are scattered as separate colonies that spread with patchy patterns of various sizes in various tidal pools that provide suitable places for hard coral colonies to grow. Live coverage of scleractinian corals is the most important supporting part of the coral reef ecosystems (Endean, 1976) and its percentage is, therefore, used as its health index (Brown, 1988). In this research, the study site had the highest coral coverage, so we could consider it as healthy place. Reef health indices were measured for the hard corals of this area. DI for Hormuz Island, intertidal and subtidal zones were estimated to be 0.653, 0.738 and 0.592, respectively, which was very good index for coral development. However, the estimated CI of –0.583, –0.691 and –0.502 for Hormuz Island, intertidal and subtidal zones, respectively, showed very poor condition for the hard corals of the area, considering the fact that level of stress for scleractinian corals was extreme in this area. According to Manthachitra (1994), the areas with very good development usually are the areas with very poor or poor condition which is in correspondence with our findings. The succession (by algae) index (SI_1), as an inappropriate factor, revealed that algae had no significant influence on corals. However, the index of 0.710, 0.801 and 0.635 for the succession of other benthic organisms (SI_2) indicated a very good succession condition for such benthos as zoantharian that their overgrowth cover constituted more than 90% of all of the benthos in the area. This revealed how bad the condition for the scleractinian corals was there as the zoantharian coverage on their surface prevented the light reaching to corals that resulted to severe damage and, ultimately, their death. This is a serious peril for scleractinian corals of the Hormuz Island. According to study conducted by Idris et al. (2006), the different stations exhibited good to fair condition. In another study conducted by Panga et al. (2021), using coral reef health indices was not found consistent differences between coral reef communities. The not-so-good condition for the hard corals in other areas adjacent to the Iranian islands had also been denoted by some researchers in the northern Persian Gulf (Namin et al., 2010; Kavousi et al., 2011, 2013, 2014; Tavakoli-Kolour et al., 2015).

5 Conclusions

Definitely, there are more coral genera in the Persian Gulf, especially in the Iranian waters and around islands where the hard corals in several places exist, but very little information available about them. Overall, scleractinian corals of Hormuz Island are in an unfavorable situation that is because of various natural and human factors. The present study revealed that the zoantharian coverage was much more than that of the hard coral coverage in the area waters, which could probably be attributed to the higher tolerability of zoantharians to intensive sunshine, air exposure and more competitive for space against scleractinian corals. Wide presence and overgrowth of zoantharians was probably the main factor that prevent the light access by hard corals, which should be considered a threatening and serious danger for the hard corals of Hormuz Island. Finally, researches in the future should be concentrated on topics which can make an obvious image of the importance of zoantharians to the health of scleractinian corals.

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