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Status of Coral Reef Species at Chabahar Bay, Sistan and Baluchistan, Iran

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Abstract: This study was carried out in the coral growing zone at Chabahar Bay where it located at 25°17′ N and 60° 36′E. It is called horseshoe Bay, because of its semicircle shape. Some destroyer factors have been affected on the health of coral reefs in Chabahar Bay. Port constructions, dredging operations, spearfishing, anchorages and scuba diving activities were distinguished as the most important problems of coral reef in Chabahar Bay. This study was conducted in order to access Semi-Qualitative Indexes of corals in different areas of Chabahar Bay. Five stations were chosen in east and north part of the Bay, where the most construction activities happened. Rectangular Transect and CoralWatch Racket were used to determine the status of the corals. During study, two classes of Hexacoralia and Octocoralia with 15 families were recorded. Twenty one species of hard coral and 10 species of soft coral were recorded. Hexacoralia was recorded the higher number of family with 10 families and 21 species and Octocoralia was recorded the lower with 5 families and 10 species. Hard corals were dominant. The ranges of qualitative indexes showed, of five stations, three of them (stations 2, 4, 5) showed Good Development and two stations (stations 1, 3) showed Fair Development. For the Condition Index, two stations showed Good Condition (stations 1, 5) and two stations showed Fair Condition (stations 2, 3). Only station 4 showed Poor Condition. The ranges of the Succession Index Showed, four stations (stations 1, 2, 3, 4) were in Very poor Succession and one station (stations 5) showed Poor Succession.

Key words: Qualitative indexes, port construction, hard coral, Scuba Diving, Chabahar Bay

INTRODUCTION

Pressure on marine resources such as coral reefs is persistently increasing. Human activities like; spear fishing, fisheries activities, port construction, aquaculture/agriculture wastewater, tourism and recreational activities are the major threatening factors.

Bradbury and Young (1981), without a proper management and dynamic programming the combined effects of these activities may result in the reduction or destruction of these resources. Beenaerts and Berghe (2005), a variety of survey methods have been applied by ecologists to monitor coral reef sessile benthic communities in an effort to develop high quality conservation and management strategies. At below some measuring techniques are expressed; Line transect technique; the theoretical bases and history of application of the Line transect technique which has been employing in many of the same studies were established by Bradbury and Young 1981). Then, Loya and Slobodkin (1971) and Loya (1972) applied this Line Transect technique in studies designed to examine community structure of hermatypic corals in Red Sea.

The method is generally used to estimate the coral density and other type of orgamisms. This is achieved by transecting the research area and measuring the points of intersection of these organisms with the Transect Line. Since the proportion of the transect lying over the (orgamisms), is an unbiased estimator of the fraction of the total area covered by these organisms, irrespective of the shapes, the estimates of areal density may be derived directly (Marshal *et al*., 1984). This technique requires the placement a plastic metric tape measure which has been installing by SCUBA (Self-Contained Underwater Breathing Apparatus) or snorkel divers in the field of study area.

Quadrate technique: Different transect methods are often proffered over quadrates for coral reefs community studies and are widely applied to assess environmental

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impact (Beenaerts and Berghe, 2005). Quadrate method are more laborious to use, are more sensitive to human error concerning estimation and are difficult to place in a highly tree-dimensional structure (Olhorst *et al*., 1988).

CoralWatch chart technique: CoralWatch is an organization built on a research project at the University of Queensland, Brisbane, Australia. They have developed a method of coral health monitoring which uses simple color charts, like paint color matching charts. This is a result of the unusual union between world leading vision and color experts at VTHRC (Vision, Touch and Hearing Research Centre) and world leading coral experts at CMS (Centre for Marine Studies). Current attempts to monitor coral bleaching often involve costly satellite-born technologies, are restricted to locations researcher are working in and often require sampling of live tissue for physiological analysis. Their coral reef monitoring approach using color charts is the first attempt to provide useful data on a relatively large scale with the help of an inexpensive, 'user friendly' and non-invasive device. The color charts can be used by scientists, students, tourists and other interested persons, along with a Line Transect or any other new or modified Transects such as; Line Intercept Transect (Loya, 1972), Linear Point Intercept (Obura, 1995) and McClanahan and Shafir (1990) modified Line Transect. The color charts are based on the actual colors of bleached and healthy corals. Each color square corresponds to a concentration of symbionts contained in the coral tissue. The concentration of symbionts is directly linked to the health of the coral.

CoralWatch Racket (CWR) and rectangular transect technique: in Biological surveys/estimations, simple methods have always been important. After getting familiar with CoralWatch method, was realized that a new tool for determining; coral bleaching percentage, breaking percentage and percentage of different Lifeforms is needed. Therefore, CoralWatch Racket was designed. It is a very simple, efficient and fantastic tool.

In fact, this tool has been designed in order to obtain the percentage of Hard Coral (HC), Soft Coral (SC), Dead Coral (DC), A Biotic subjects (AB), Algae (AL) and Other fauna (OT) with more accuracy than the other methods, in a study site. The advantages of this technique are including; Easy to use, Easy to read, High maneuverability. Using of other methods such as quadrates shooting may destroy corals during shooting them among the colonies. Also, using plumb bob in Line transect method only can be specified a small point of the bottom in each time shooting. For quadrate method, scuba divers have to dive, frequently. According to scuba principles, divers will be encountered with bottom time limitation. Therefore, several divers are needed for data collection. But CWR will be safe in usage and will be done with minimum scuba divers. In addition, the aim of this study is to determine of semi-qualitative indexes of corals in five different stations in Chabahar Bay.

MATERIALS AND METHODS

The study was carried out over a period of 12 months (October 2008-September 2009). Chabahar Bay was chosen as a study site due to the richness on different coral species. It was located at shore of Oman sea, southeastern of Iran and situated at 25° 17' N and 60° 37' E latitude and longitude of Chabahar, Sistan and Baluchistan province, Iran.

In fact, Chabahar Bay is the only area which is covered by hard corals. And out of the Bay, due to high currents and wave energy, the conditions are not suitable for hard corals and only soft coral species such as Gorgonians can be survived there. Hard corals have been stretched from eastern point of Chabahar Bay to the end of Tis area with 15 km long. In addition, five stations which are determined in Fig. 1 were chosen as study site. Also, Table 1 shows more details of the research stations.

Rectangular Transect was covered 300 m^2 of each station. Benthic lifeforms was recorded by CoralWatch Racket via scuba-diving. Actually, CoralWatch Racket (CWR) is a tennis racket which was changed in usage. A plastic Network, consisting of 100 equal squires was made in the middle part of the racket. A manual counter and underwater thermometer was fixed on the racket's handle. Also, it has been equipped whit CoralWatch color chart. Therefore it'll be able to measure; coral bleaching percentage, coral breaking percentage, percentage of benthic lifeforms and water temperature, rapidly. Actually, it acts as like as other quadrates. What distinguishes CWR from other tools, are including; easy to use during diving, high maneuverability during using, decreasing research time, safe for coral colonies during applying (using of other quadrates, may destroy the coral colonies when it throws on the colonies, randomly. But CWR is safe for them), more accuracy in data recording. In order to apply it, only enough take it against your face and then get it front or back, until 4 points of upper side of a colony become tangent on the CWR's net screen. Then, it must be kept fix for counting of any abnormality, by its counter (Fig. 2).

Kick Cycle (Kicking in Scuba-diving) was used as an underwater measuring unit (Bagherian, 2009) for data recording. In this method, getting up and down of a leg during scuba diving is called Kick Cycle. In order to

Fig. 1: The red points on the map shows the position of research stations at Chabahar Bay (25°17′ N and 60°36′ E), Sistan and Baluchistan, Iran

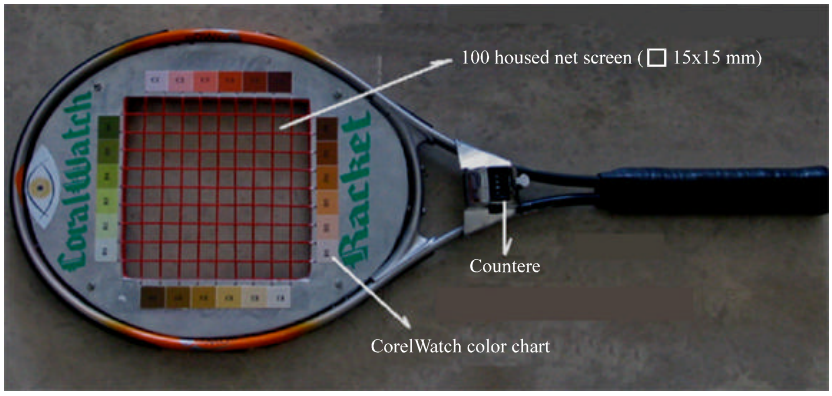

Fig. 2: CoralWatch Racket, as a new tool in order to measuring benthic lifeforms

Table 1: More details of the research stations in Chabahar Bay, Sistan and Baluchistan

St. No.	St. name	Lat. and Lon.	Comments
1	Beheshti	25° 17′ 37″ N 60° 36′ 35 E	Protected area by Beheshti and new breakwater no current and water circulation
2	Daryanavardi	25° 18′ 33″N 60° 37′ 11″ E	Protected area by Haft-e- tir and Kalantari's breakwater, proportional current and circulation
3	Lipar	25°19′ 23″ N 60° 36′ 55″ E	Protected area only by Kalantari's breakwater proportional current and circulation
4	Tis	25°21′ 25″ N 60° 35′ 16″ E	Unprotected area, low waves and currents, fishing area
5	Big Sea	25°17′ 29″ N 60° 35′ 39″ E	Unprotected area, high waves and currents, located out of the Bay

determine of sea bottom structures in the research stations, the bottom was monitored every 10 Kick Cycle by CoralWatch Racket.

In order to prevent the decrease in size and foul format of Rectangular Transect, it was installed parallel to currents (Base on previous experiment). It was a flexible plastic rope which was stretched on the sea bed. A wrest compass was applied in order to find specified points inside transect. For proper implementation of this method, divers should swim from specified path by a compass and check the require points for data collection. But the most important issue is to swim based on rotation angles (+90° during turning right and -90° during turning left) which is shown in Fig. 3, as well.

In this study, six categories of coral lifeform were studied. As mentioned in above, Rectangular Transect and CoralWatch Racket were applied in order to evaluate of the percentage of all benthic lifeform. The six reviewed categories of Lifeforms were included; Hard Coral (HC), Soft Coral (SC), Dead Coral (DC), Algae (AL), Abiotic (AB) and Other fauna (OT). Of these were used to formulate three qualitative indices on the community structure of sampling stations as follows (Idris *et al*., 2006).

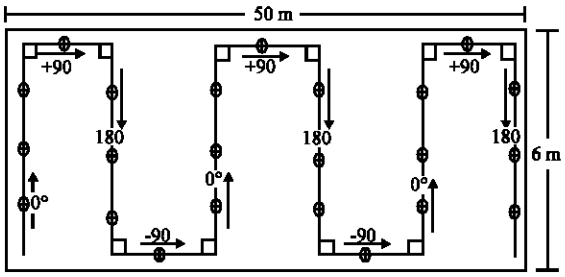

Fig. 3: Rectangular Transect. The marks in above (⊕) show the survey points

Condition Index (CI): It is indicating the degree of coral reef assemblage and degree of stress on each particular reef. The Condition Index is given as:

$$CI = \log_{10}\left[\frac{LC}{DC+AL+OT}\right] \quad (1)$$

In this formulate, LC is the percentage of live corals, DC is the percentage of Dead Corals, AL is the percentage of Algae and OT is the percentage of Other Faunas.

Development Index (DI): This index is use to indicate the degree of coral reef assemblage development. It provides the natural background of the reef. It computes as follows:

$$DI = \log_{10}\left[\frac{LC+DC+AL+OT}{AB}\right] \quad (2)$$

AB is the percentage area which is covered by Abiotic (inorganic matters). The other abbreviations are definition as like as above formula.

Succession Index (SI): The succession index is used to indicate the level of succession occurring on the reef. In the other hand, this index shows the sequential of benthic communities growing on dead corals. It is computing as follows:

$$SI = \log_{10}\left[\frac{OT}{DC+AL}\right] \quad (3)$$

The log-transformed index scale was used in this study (Idris *et al*., 2006) where, the range ±∞. The index value usually ranges from -3 to +3. The ratio is 1:999 and 999:1, respectively in all six major Lifeforms (Table 2).

Table 2: Semi-qualitative scale for an assessment of index two corresponding forms, percentage and index scale form

Quality	Percentage	Index scale
Very poor	<20	<-0.602
Poor	20.01 to 40.00	-0.602 to -0.0176
Fair	40.01 to 60.00	-0.176 to 0.0176
Good	60.0 to 80.00	0.176 to 0.602
Very good	>80.01	>0.602

RESULTS AND DISCUSSION

Two classes of Hexacoralia and Octocoralia with 15 families, 21 species of hard coral and 10 species of soft coral were recorded. Hexacoralia was recorded the higher number of family with 10 families and 21 species and Octocoralia recorded the lower with 5 families and 10 species. Most of the species founded at study site were belonged to hard coral.

The percentage areas of six benthic life forms and three qualitative indexes are displayed in Table 3, according to the results; the percentage areas covered by corals were varied in Chabahar Bay. Most of the species were related to hard corals. Twenty eight percent of research stations covered by hard corals, averagely. The highest and the lowest of them were recorded in station 5 and 4, respectively. Also 4.1 and 19.9% of research stations covered by soft and dead coral, respectively. The 47.8% of research stations covered by abiotic, algae and other fauna, averagely. Dominant species were recorded in the research stations as follows:

Branching corals (Acroporidae, Pocilloporidae) in station one, Boulder corals (Faviidae) in stations two and three, Plate corals in stations four and five were recorded. The least sea currents and waves were observed in station one. Therefore, this is quite natural that this region becomes suitable for growth of branching corals. Boulder corals were dominant in stations one and two. And plate corals were as dominant species in station 4 and five. Because, there are sever currents and wave energy in these stations and usually, plate corals show more resistance again current and waves.

The relationship between three indexes was displayed in Fig. 4a-c. The results showed, three stations (2, 4, 5) with good Development Index (DI) but showed different degree of Condition Index (CI) and two stations (1, 3) with fair development, showed good and fair condition, respectively.

Manthachitra (1994) found out, the areas with very poor or poor condition usually are the areas with very good development. The areas with good condition are usually the areas with fair development. At a same study which had been carried out in Malaysia, it seems, due to different degree of human manipulations, different

Table 3: Percentage cover of six major benthic life form on coral reef areas at Chabahar Bay

Stations	HC	SC	DC	AB	AL	OT	DI	CI	SI
1	37	4	11.9	5	40	2.1	0.17	0.34	-0.92
2	26	3	23.5	4	42	1.5	0.4	0.00	-1.00
3	22	3	14	12	46	3	0.07	-0.06	-0.88
4	16	3	41	3	33	4	0.3	-0.43	-1.00
5	39	7.5	9.25	5	33.5	5.75	0.29	0.34	-0.40

HC: Hard coral, SC: Soft coral, DC: Dead coral, AB: Abiotic, AL: Algae, OT: Other, DI: Development index, CI: Condition index, SI: Succession index

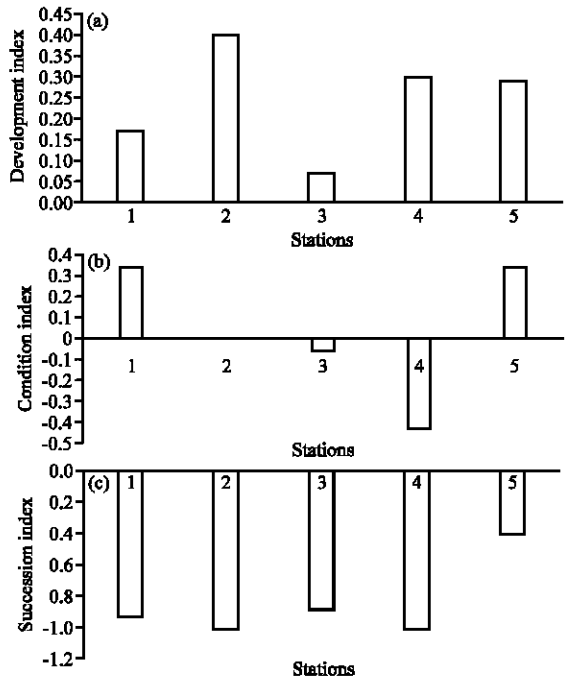

Fig. 4: (a) Development index, (b) condition index and (c) succession index for every study area at Chabahar Bay

geographical conditions and difference in corals species between Chabahar Bay and Sarawak Island, results have been shown a little differences.

At bellow, the relationship between indexes in each station is explained, separately.

Station one (Faire Development, Good Condition); this station is surrounded by two new breakwaters and coral reefs are encountered with limitation in growth space. On the other hand, because of public protests, constructions were stopped, temporarily. Then, stress conditions were reduced. Because of this event, good conditions were created for coral reefs in this station.

Station Two (Good Development, Faire Condition); this station is located at end of the Kalantari's jetty, where the most sedimentation will be formed. This station has also been limited by two breakwaters. But, there is an acceptable distance between these two breakwaters yet. So, due to enough area and low current and water circulation, Corals showed Good Development and because of sedimentation corals showed Faire Condition.

Station Three (Faire Development, Fair Condition); this station is located inside of the Kalantari's jetty. In this station, corals are encountered with different kinds of stress such as; limitation in growth space, fishing and trade vessels traffics, sediments accumulation and other stress factors. Therefore, these factors can be the reasons for faire development and faire condition, in this station.

Station Four (Good Development, Poor condition); it is located little far from port construction and there is not any limitation for growth space and development. But it has been placed in the center of fishermen and scuba divers activities. So, in this station, coral reefs are placed under the severe stress and poor conditions.

Station Five (Good Development, Good Condition); this station is located out of the bay, where the port construction did not have any affected on coral reefs development or condition. This area has also a little affected by waves and Sea currents. These issues are created some limitations in diversity of coral species. So, only kind of resistance species such as plate and boulder corals can survive in these conditions.

According to old fishermen observations, most parts of the Bay covered by coral in 20 years ago. Iranian geology organization reviewed sediments compositions in Chabahar bay, recently. The results showed that there are high concentrations of calcium carbonate in east and northern parts of Chabahar Bay (present study site).

On the other hand, port and coastal construction has been started in 1999. According to the existence of high concentration of calcium carbonate and past observations of fishermen regarding good condition and development of coral reefs, it seems that human manipulations (anthropogenic factors) are determined as the major problems for coral reefs in Chabahar Bay.

CONCLUSIONS

According to local reports and fishermen observations can be realized that corals had a very good condition and development in less than 10 years past. Also, port constructions have been started 10 years ago by Iranian Shipping Organization in Chabahar bay. During that, different types of breakwater were made. Seemingly, the breakwaters created disturbance in the natural path of water circulation to the bay. The following cases were recognized as the main factors in the appearance of coral problems in Chabahar Bay;

- Disturbance in water circulation to the bay
- Increase of sediments accumulation

- Increase of relative temperature due to reduction of water circulation
- Increase of fishing activities, scuba diving and different vessel traffic

According to the results, Chabahar Bay covered with different type of corals. Hard coral species was dominant in all research stations. The percent of dead corals was almost two times more than live corals. The major percent of study areas is covered by algae, abiotic and other fauna. Actually, Study on coral reefs at Chabahar bay showed that they are in danger, due to anthropogenic factors. The Results of qualitative indexes were showed, two areas with fair development showed good and faire condition, respectively and three areas with good development showed fair, poor and good condition, respectively. The succession index shows the level and degree of reef recovery. In the other hands, the numeric value of this index indicates the percent of the reef recovery.

The lower the numeric value of succession index comparing with other indexes indicates the higher percent of the reef recovery.

Due to human manipulations, coral species in Chabahar bay are in danger. Also, layoff the port constructions are unavoidable. Therefore, coral relocation project under the supervision of professionals and experienced scientists is the only way to save them.

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