Species Diversity and Distribution of Scleractinian Coral at Daao Bay, Shenzhen

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Abstract: Species diversity and distribution status of the scleractinian were surveyed by Line Intercept Transect method at Daao Bay in the east Shenzhen in 2017. Through the image survey data and sample analysis to filed survey, this survey got 13 kinds of scleractinian coral, which the main dominant species is Platygyra yaeyamaensis. Statistical analysis showed that Daao Bay scleractinian coral coverage rate was 9.12 %, the Shannon-wiener diversity index, Simpson's diversity index and Margarlef species richness index were 2.251 nit, 1.754 and 0.856, respectively. The scleractinian coral coverage rate declined seriously compared to 2007. The coral communities were experiencing degradation. Fortunately, there was 0 bleaching or dead scleractinian coral coverage found in this vessel. This area was disturbed highly by human activities, which may alter the natural disturbance regimes of coral reefs by transforming pulse events into persistent disturbance or even chronic stress, by introducing new disturbance, or by suppressing or removing disturbance. It should strengthen monitor coral reef and its ecosystem in this area for better protecting increasingly recession coral reef resources.

1 INTRODUCTION

Coral reefs, mangroves and sea grass beds are important three typical marine ecosystems, with high biodiversity and primary productivity (Muruganantham et al., 2017; Halik and Verweij, 2017; De et al.2018), providing rich food and habitats for marine life (Roelfsema et al., 2018; Eyal et al., 2015). It also provides mankind with a great deal of material products and extremely high aesthetic value (Moberg and Folke 1999). But the community structure, composition and ecosystem functioning of coral reefs have been extensive changed by the human's disturbances (Ferrigno et al., 2016). Coral is sensitive to environmental changes (Holden and Ledrew 2002). When it suffers external environmental pressure beyond physical tolerance, it will release the symbiotic zooxanthellae, resulting in coral bleaching (Glynn 1993). Facing the human-dominated world, ecologists are now reconsidering the role of disturbance for coral reef ecosystem. Human activities alter the natural disturbance regimes of coral reefs by transforming pulse events into persistent disturbance or even chronic stress, by introducing new disturbance, or by suppressing or removing disturbance. Which has caused widespread concern around the world (Nyström et al., 2000 . The coral reef monitoring network has been established worldwide to monitor the health status of coral reef ecosystems which would contribute to prevent the degradation of valuable coral reef resources (Tun and Wilkinson 2004). Understanding the species distribution and diversity of corals is an important part of coral conservation, Mebrahtu investigated variation in scleractinian coral Richness and community diversity in the Western Indian Ocean on different spatial scales to understand how diversity is organized is essential to inference about appropriate scales for natural resource research and management (Ateweberhan and Mcclanahan 2016). Hector considered sampling scale and lack of attention to taxa other than scleractinian corals have limited the capacity to protect coral reefs and coral communities

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(Guevara and Breedy 2004). Alessandro Cau using a combination of multivariate statistical analyses reveal that environmental and bathymetric factors were important drivers of the observed patterns of coral biodiversity (Cau et al., 2017). Oktiyas Muzaky Luthfi use Line Intercept Transect to assess the condition and distribution of stony corals at Karang Pakiman Reef, Bawean Islands (Luthfi and Anugrah 2017). Samantha Howlett data on live coral cover, coral genus, diversity, and coral colony structure type to compared to give an indication of reef quality between habitats (Howlett et al., 2016).

Daao Bay was a good habitat for scleractinian corals before. As the economy developed rapidly in recent years, many real estate and tourism projects had been developed in the near shore. The distribution and health status of coral resources is facing disturbance, this study using Line Intercept Transect to study the diversity, distribution and abundance of Scleractinian coral in Daao Bay. Which could assess the health condition of coral reef as a basic ecosystems for reference conservation.

2 MATERIALS AND METHODS

2.1 Research Area

The research was conducted along the Daao Bay, Shenzhen in November 2017. Which located at the Daao Bay Coast (114°28′02.10″E, 22°33′06.21″N ~114°27 ' 58.52 "E, 22°33 ' 10.59" N) (Fig. 1). The scleractinian coral species distribution, health and sediment conditions were evaluated in this coral reef area. The survey water bottom sea temperature was 22.5℃, transparency was 2.5 m and salinity was 32.2‰. With handheld GPS Positioning System (78s, Garmin, American) determines the exact position in this investigation. Investigate sea water depth was range of 3-10 meters.

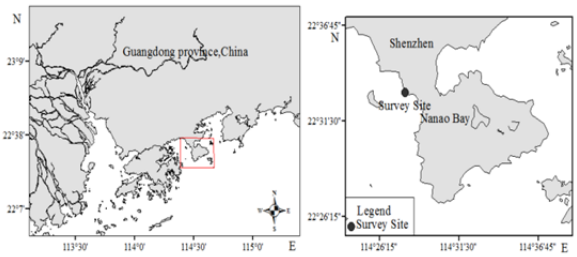

Figure 1: Scleractinian coral survey stations

2.2 Survey Methods

In this area, the survey and sampling of coral reefs are an international commonly used Line Intercept Transect (Luthfi and Anugrah 2017, Amin, 2017, Facon et al., 2016). Fifty meter long transect were laid in this zonation and parallels to the shoreline, date and samples were got by SCUBA diver. There were three transect laid totally, and the distances between each transect between 10 m. Diver swarm along the sampling belt constant speed and recorded a video perpendicularly to the seabed surface underwater. The scleractinian species on each section are photographed, to assist in the identification of coral species, the more difficult to identify the coral, to collect its skeleton from living coral colonies and fixed in the alcohol for further classification and identification in the laboratory. Place square blocks of 0.5 m × 0.5 m equidistantly on the spline (50 sample frames per sample strip, 1 m interval); Take vertical photographs of each sample to further interpret the coral community information. The video data is interpreted by computer, and each sampling band was divided evenly into 50 mark points. Measuring the points of interest below the sample frame. The species and number of scleractinian, rock, rubble, sand, sea urchin and other were recorded, and the coverage, distribution characteristics and health status of the reef coral reefs are investigated by statistical analysis. Each point was counted for the number of points where the substrate was scleractinian coral and the type of the corresponding coral. The ratio of the coral cover point to the total number of points in each sample was calculated, i.e. the coverage rate of scleractinian corals; the occurrence of each coral was counted. The scleractinian coral frequency is the number of times this category appears in all sample frames. Furthermore, the ratio of dead coral and living coral cover was calculated with categories (1) Healthy, if percent living to dead coral > 2:1, (2). Fair/moderate, if between 2:1 and 1:2, (3) Unhealthy, if live to dead coral < 1:2) (Reza and Sancayaningsih 2015).

In this study, we refer to the morphological classification of scleractinian species according to the “Chinese Animal Records” volume 23 by Zhou Renlin (Zhou R 2011) and “Corals of The World” volume 1.2 and 3 by Veron (Veron 2000).

2.3 Data Analysis

Data was compiled and collated using MS. Excel and SPSS 17.0. Analysis the diversity, distribution characteristics and health status of the scleractinian coral by Shannon-wiener index, Simpson's diversity index, Margarlef species richness index, and Pielou index. We surveyed the normal coral, dead and blanching coral cover degree to assess the scleractinian corals healthy condition at the same time. The dominant scleractinian coral species in this area was sorted by the important values of scleractinian corals (importance value, *IV*). The formulas were as follows:

$$H=-\sum_{i=1}^{S} p_i \log_2 p_i \quad (1)$$

$$D=1-\sum_{i=1}^{S} p_i^2 \quad (2)$$

$$M=(S-1)/\log_2 N \quad (3)$$

$$J=H/\log_2 S \quad (4)$$

$$RA=\text{The individuals of this scleractinian species / The individuals of all scleractinian species} \quad (5)$$

$$RF=\text{Frequency of this scleractinian species /Total frequency of all scleractinian species} \quad (6)$$

$$RC=\text{The coverage area of this species of scleractinian /Total coverage area of all species of scleractinian} \quad (7)$$

$$IV=RA+RF+RC \quad (8)$$

Where H is the scleractinian coral Shannon-wiener Diversity index; p_i is the proportion of individuals belonging to species i in all individuals (i.e., the ratio of species i coverage to total live scleractinian coral coverage); D is the scleractinian coral Simpson's diversity index; M is the scleractinian coral Margarlef species richness index; N is the total scleractinian coral individual number (i.e., total live scleractinian coral coverage); J is the scleractinian coral Pielou index; S is total coral species number; RA is the relative individuals number of scleractinian coral; RF is relative frequency of scleractinian corals; RC for relative coverage rate; IV The is an important value for scleractinian corals.

In this study, we classified the scleractinian corals frequency into A to E 5 grades. Which the scleractinian coral frequency between 1% and 20% is zoned A level; Which the scleractinian coral frequency between 20% and 40% is zoned B level; Which the scleractinian coral frequency between 40% and 60% is zoned C level; Which the scleractinian coral frequency between 60% and 80% is zoned D level; Which the scleractinian coral frequency between 80% and 100% is zoned E level.

3 RESULTS AND DISCUSSIONS

3.1 Daao Bay Reef Coral Species Composition

A total of 4 families, 8 genera, 13 species scleractinian coral were recorded in this vessel, based on coral morphology identification. The Important Values (*IV*) sort results (table 1) indicates that the main advantages of Daao Bay scleractinian coral was *Platygyra yaeyamaensis* (*IV* =0.725), next is *porites lobate* (*IV* =0.453). We divided scleractinian coral into leaf-like corals, dendritic corals and clumps coral according to the form. The statistical results showed that there were 9 species leaf-like coral, 2 species dendritic coral, 2 species clumps coral in this area. The clumps coral take the highest proportion, which is similar to the Daya Bay nearly. Researches shows that clumps coral can adapt the low temperature, suspended sediments, environmental pollution etc. marine environment changes better. As the latitude rises, the lower water temperature, coral skeleton is also closer to the clumps species (Riegl and Purkis 2009).

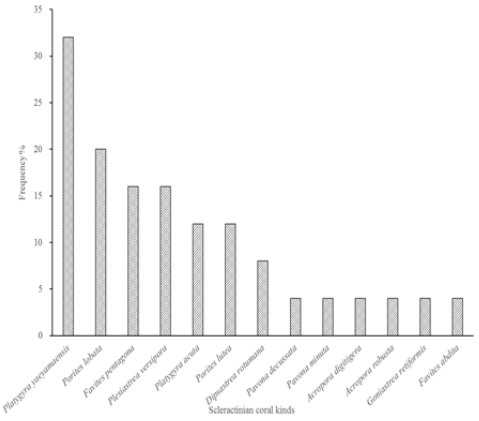

Figure 2: Frequency distribution of Scleractinian corals at Daao Bay

Table 1: Sorted importance value of scleractinian corals at Daao Bay

Rank	Species	P_i	*RF*	*RA*	*RC*	*IV*
1	*Platygyra yaeyamaensis*	0.320	0.229	0.234	0.262	0.725
2	*Porites lobata*	0.200	0.143	0.106	0.203	0.453
3	*Favites pentagona*	0.160	0.114	0.149	0.059	0.322
4	*Plesiastrea versipora*	0.160	0.114	0.128	0.026	0.268
5	*Platygyra acuta*	0.120	0.086	0.106	0.043	0.235
6	*Porites lutea*	0.120	0.086	0.085	0.059	0.230
7	*Dipsastrea rotumana*	0.080	0.057	0.043	0.072	0.172
8	*Pavona decussata*	0.040	0.029	0.021	0.105	0.155
9	*Pavona minuta*	0.040	0.029	0.043	0.043	0.114
10	*Acropora digitigera*	0.040	0.029	0.021	0.059	0.109
11	*Acropora robusta*	0.040	0.029	0.021	0.056	0.106
12	*Goniastrea retiformis*	0.040	0.029	0.021	0.010	0.060
13	*Favites abdita*	0.040	0.029	0.021	0.003	0.053

3.2 Daao Bay Reef Coral Frequency Distribution

The scleractinian coral distribution frequency diagram (Figure 2) shows that 84.62% scleractinian coral appears low frequency at Daao Bay sea area, belongs to the A level; There were 15.38 % scleractinian coral species in B level; There is no scleractinian coral species in C,D,E level. The five frequency-level relationships was A>B>C=D=E. The A level is far higher than the other levels. The level C, D and E were 0 in this result. It indicate that most of the species in this area is low frequency distributing, even if the *Platygyra yaeyamaensis*, which is frequency is only 32%. The 84.62% species is fragmentary distribution around. The light, transparency and other environment condition determine the distribution characteristic. This area was carrying out a reef restoration work. Reef restoration is a novel ecological discipline that has been receiving increasing attention over the past two decades, though many of its theoretical and practical aspects have yet to be elucidated (Rinkevich B 2015). It might be change the frequency distribution and structure of community directly; the frequency distribution would provide a simple parameter to get the structure of community in the future. Recreation of suitable condition for native communties' development could alleviate ecological barriers to reef regeneration (Horoszowski-Fridman and Rinkevich 2017). The sparse planting model could be more suitable in this area in the restoration works compare to the intensive planting.

3.3 Reef Coral Diversity

This survey area scleractinian Coral Shannon-wiener diversity index, Simpson's diversity index and Margarlef species richness index were 2.251 nit, 1.754 and 0.856, respectively. The Daao Bay coral Shannon-wiener diversity index was higher than the Daya bay (Shannon-wiener diversity index=1.754 nit). The scleractinian Coral Pielou index was 0.608 at Daao bay, higher than the Daya bay 0.305. This survey had been recorded in total of 30 scleractinian coral species, which is similar to that of coral reefs in neighboring Daya bay waters (15 species), and more than the Dongshan sea area in Fujian province (5 species).

3.4 Bottom Coverage

The percent cover at a given station consists of the mean of its three transects reef coral coverage of the 2017 in the survey area is 9.12%, and the year of Daao Bay Reef Coral coverage average 34.4% in 2007 (Jia C et al., 2008). The coral reef coverage in Daao Bay has seriously declined recent 10 years. As to this survey the highest coverage in this sea area was rock (79.32%), and the sand, rubble, sea urchins, other organisms were 6.38 %, 3.40 %, 1.78 %, 0.16 %, respectively. The scleractinian coral was mainly distributed in the rock bottom and a small amount of rock and gravel mixed bottom. Coral bleaching considered an important index for ecosystem health evaluating (Glynn 1993; Awak et al., 2016). The survey results showed there were 0 deaths or bleaching corals were found in the survey area. The ratio of living coral to dead coral cover percent > 2:1, which indicating that the coral reefs in

the region are in good health condition recently. The distribution of coral reef coverage shows that the coverage of coral reefs in the Daao Bay was heterogeneous, and the coverage interlaced high-low. Sea urchins are important grazers and influence Reef development in the eastern tropical Pacific (Cabanillasterán et al., 2016). Researches show that, sea urchins preferential resource appeared to be benthic algal and turf, But if those were not available, it feeds on other organisms, such as the corals *Pavona clavus*, *Pocillopora spp*. and *Porites lobate* (Reaka-Kudla et al., 1996). The sea urchin coverage rate in this area was 1.78%. Because of the complex dynamic balance of grazing animals between sea urchins with coral reef (Mcclanahan and Shafir 1990, Nash et al., 2016). The further tracking is needed to study the relationship between sea urchins and coral reefs to better understand the health of coral reef ecosystems in the region.

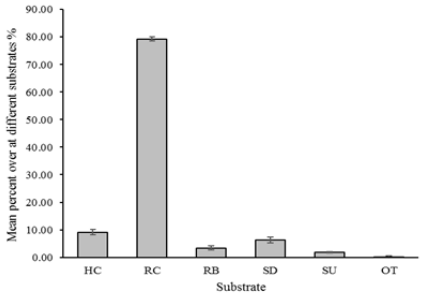

Figure 3. Coverage rates of different survey sample substrates. (Note: a. HC: Hard Coral, RC: Rock, RB: Rubble, SD: sand, SU: Sea urchin, OT: other. Error bars correspond to standard deviation value.)

4 CONCLUSION

The present survey results showed that the average coverage of the scleractinian coral was 9.12% in the Daao Bay, and the Shannon-wiener diversity index was 2.25 nit, which declined seriously compared to 2007. Because of the incomplete sampling and the drawback by morphological identification, there might be some cryptic species that have not been identified; the next stage will use molecular biological means to classify the species diversity of the coral (Wang et al., 2018;Daniel and Sergej, 2017; Xin et al., 2017). Each zonation has its own pattern in term of coverage and composition of corals life form this pattern of coral distribution and abundance with depth suggests this each coral species could have an optimal depth (Hoogenboom et al., 2009). For reasons such as transparency, light et al., the vertical distribution of reef coral in this area was not obvious (Yeung et al., 2014), and its main distribution is in the depth of 3-10 m. The dominant species of reef coral communities in this area was mainly clumps of coral, followed by leaf-like corals. Coral reef ecosystem is a marine ecosystem with high productivity and diverse biodiversity, but also a low resistance, very fragile ecosystem, as a consequence of increasing human pressure, coastal Ecosystems are facing a wide range of threats, such as resource exploitation and habitat modification (Rossi S 2013). Although there was no recent death or blanching scleractinian coral have been found in the survey area, but the coverage and diversity of species were lower than historical data. The survey sea area is close to human living quarters, coral reef ecosystems are very easy to interfere with human activities (Graham et al., 2017). Therefore, we should strengthen the Daao Bay ecosystem surveillance to protect the degenerative coastal coral reef resources.

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