Community Structure of Coral Reefs in Pulau Tioman

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ABSTRACT

A study on the benthic community structure of coral reefs in Pulau Tioman around Teluk Kedor, Teluk Bakau and Pulau Renggis have been conducted to determine the coverage and benthic community structure to the lowest taxa of scleractinian coral. A total 26 genus and 76 species of scleractinian coral were recorded in this study. Genus *Acropora*, *Montipora* and *Porites* are the main scleractinian coral. Live scleractinian coral coverage showed reduction while dead scleractinian coral increased compared with previous studies (Harborne et al. 2000; Okashita 2003). This might be the effect of environment stress which is sedimentation. The live scleractinian coral coverage will increase if the impacts of environmental stresses are reduced.

ABSTRAK

Kajian terumbu karang di Pulau Tioman dijalankan di Teluk Kedor, Teluk Bakau dan Pulau Renggis untuk menentukan keliputan dan struktur komuniti bentik serta mengkaji taksonomi karang skleraktina sehingga tahap terendah. Sebanyak 26 genus dan 76 spesies karang skleraktina dapat dicatat dalam kajian ini. Genus Acropora, Montipora *dan* Porites *merupakan karang dominant. Keliputan karang skleraktina hidup menunjukkan penurunan manakala terdapat peningkatan dalam keliputan karang skleraktina mati berbanding dengan kajian lepas (Harborne et al. 2000; Okashita 2003). Ini mungkin disebabkan oleh tekanan persekitaran iaitu sedimentasi. Jumlah keliputan karang skleraktina hidup akan meningkat sekiranya impak daripada tekanan persekitaran dikurangkan.*

Keywords: Benthic community, coral reefs, scleractinian coral

Introduction

Coral reefs are the world's most biologically diverse marine ecosystems. For many coastal populations, coral reefs have provided food, materials for new medicine, and income from tourism and recreational, as well as protection for coastal communities from adverse effects of storms. Coral reefs are tropical shallow water ecosystems, which grow on a limestone substrate, formed usually by the skeletons of the coral organisms, their establishment and maintenance requires water temperature above 22°C, bright light and a stable high salinity (Silva et al. 1980). They are the most productive ecosystems in the world, serving as feeding, breeding and nursery grounds for the most marine species. Unfortunately, coral reef areas are threatened by degradation problems such as shell and fish collecting, dynamite fishing and unregulated tourism (Silva 1981, Gomez 1981). There is growing concern about the rapid decline of coral reefs in many parts of the globe. To ensure that coral reefs are continuously managed, Government of Malaysia enacted the Marine Park Act to conserve the complex ecosystems of reef surrounding most islands particularly in the east coast of Peninsular Malaysia (Zaki et al. 2000). Pulau Tioman which was included in the Marine Park are likely to be involved in many developments. Therefore, the purposes of the present study were 1) to describe the coral coverage and community structure and 2), to identify the coral taxonomic levels in Pulau Tioman.

Materials and Methods

Pulau Tioman is located in the east coast of Peninsular Malaysia. A total of 3 sites around the island were selected for the investigation, Teluk Kedor, Teluk Bakau (Pulau Tulai) and Pulau Renggis. Survey methodology was done by using ten transect line (10 m each) laid randomly by SCUBA diving at each station. The transect line was divided into 20 segments using color tape to calibrate the size of photographs. Benthic area of 0.5 × 0.5 m was taken with a digital camera (OLYMPUS C-5060 Wide Zoom). Twenty photographs were taken for each transect and a total of 200 photographs for one site were taken. A total of 600 photographs from the camera were transferred into the computer and data are prepared for image analysis. Some corals of complex polyps were identified from macro-photographs that were took earlier using digital camera (SONY DSC-P2).

The benthic community areas of 0.5 × 0.5 m were analyzed by using Halcon® and Analysis® software. The coverage of each coral was performed by using Analysis®, which can extract areas by tracing the edge of coral manually. However, it is not suitable for complicated morphology such as *Acropora* branching corals. Halcon® which can extract area by a difference of gray value color between live corals and other bottom was used to analyse *Acropora* coverage. Photoline transects data for 30 lines were summarized as percentage of three categories; live scleractinian coral, dead coral and other bottom. Dead coral included of the recently dead and those covered by algae. Other bottom included non-scleractinian coral such as *Heliopora*, invertebrates and substrate such as sand and rock. Ecological diversity was used to indicate the density of coral reef communities. This was calculated using the Shannon index as follow (Shannon & Weaver 1949),

$$H = -\sum_{i=1}^{s} (p_i)(\log p_i), \quad pi = \frac{ci}{C}$$

where *pi* means probability, *ci* means the coverage of i^{th} species, *C* means the total coral coverage, and *s* means the total number of species.

Results

Teluk Kedor

The depth of Teluk Kedor site was about 5.1 m, and had a bottom composition of sand. Live coral cover was 23.57%, which dead coral constitute of 29.41%. Other benthic substrate made up to 46.02%. The site was dominated by a dense mixture of branching corals *Acropora* (75.72%). Meanwhile *Montipora* constitute of 2.78%, while *Diploastrea* and *Pavona* made up to 2.66% and 2.64%, respectively. The remaining coral genera coverage was less than 2.0%. Teluk Kedor has the highest diversity with 24 genera and 52 species of coral. However, it has the lowest Shannon index value amongst the 3 stations with H’ = 0.950.

Teluk Bakau

Teluk Bakau site was 2m in depth, and had an average coverage between of live coral, dead coral and other benthic composition. Live coral coverage was 34.30%, while dead coral coverage was 32.49%. Other life forms and substrate made up to 33.12%. *Acropora* corals (44%) predominated, followed by *Porites* (24.16%) and *Montipora* (5.3%). Meanwhile there was an unidentified coral that made up to 2.94%. This coral is encrusting with surface resemble *Millipore*. The rest of the coral genera covered less than 2%. A total of 15 genera and 36 species with the lowest number of coral genera between 3 station were recorded at this sites, the average of Shannon index was H’ = 1.047.

Pulau Renggis

This sampling site had the depth of 6.5 m. Live coral cover was the highest (62.40%), followed by other benthic (59.26%). Dead coral contributed a low percentage of 8.34%. The most common coral was *Acropora* with 58.44%, followed by *Porites* (18.19%) and *Montipora* (12.98%). Meanwhile *Echinopora* constitute of 9.43% and the remaining genera were less than 2.0 %. A total of 17 genera and 45 species were recorded and with the highest Shannon Index value of H’ = 1.1.52.

Overall

A total 10 family, 26 genera and 76 species were identified from 30 transect lines. Coral communities were typically dominated by *Acropora*, *Porites* and *Montipora*. Acroporidae is the most dominan family with the highest total species from 2 genera, *Acropora* and *Montipora* with 19 species and 8 species, respectively (Table 1). Each sampling site had different benthic community structure (Fig. 1) and the differences in species composition between the sites are relatively small (Table 2).

TABLE 1: List of Coral Family, Genus and Species of the Study Area in Pulau Tioman

Genus	Species	Genus	Species
Family Pocilloporidae		*Goniopora*	*Goniopora sp.*
Pocillopora	*Pocillopora damicornis*	Family Agariciidae	
	Pocillopora verrucosa	*Pavona*	*Pavona cactus*
	Pocillopora danae		*Pavona decussate*
	Pocillopora sp. 1		*Pavona danai*
Seriatopora	*Seriotopora hystrix*	*Pachyseris*	*Pachyseris rugosa*
Stylopora	*Stylopora subseriata*	Family Fungiidae	
Family Acroporidae		*Fungia*	*Fungia concinna*
Montipora	*Montipora aequiteberculata*		*Fungia paumotensis*
	Montipora confusa	*Ctenactis*	*Ctenactis echinata*
	Montipora deliculata	*Herpolitha*	*Herpolitha limax*
	Montipora foliosa	*Polyphyllia*	*Polyphllia talpina*
	Montipora tuberculata	*Sandalolitha*	*Sandalolitha robusta*
	Montipora turtlensis	Family Faviidae	
	Montipora vietnamensis	*Echinopora*	*Echinopora pacificus*
	Montipora sp. 1		*Echinopora sp. 1*
Acropora	*Acropora aspera*		*Echinopora horrida*
	Acropora austera	*Diploastrea*	*Diploastrea heliopora*
	Acropora bruggemanni	*Favia*	*Favia maxima*
	Acropora cerealis		*Favia veroni*
	Acropora cytherea		*Favia maritime*
	Acropora digitifera		*Favia palllida*
	Acropora florida	*Favites*	*Favites complanata*
	Acropora formosa		*Favites abdita*
	Acropora gemmifera		*Favites pentagona*
	Acropora hyacinthus	*Platygyra*	*Platygyra sinensis*
	Acropora latistella		*Platygyra lamellina*
	Acropora loripes	*Goniostrea*	*Goniostrea retiformis*
	Acropora microphthalma		*Goniostrea edwarsi*
	Acropora nasuta		*Goniostrea pectinata*
	Acropora nobilis	Family Mussidae	
	Acropora robusta	*Symphyllia*	*Symphyllia agaricia*
	Acropora samoensis		Symphyllia radians
	Acropora sp. 1		*Symphyllia recta*
	Acropora sp. 2	*Lobophyllia*	*Lobophylisa hemprichii*
Family Poritidae		Family Ocilinidae	
Porites	*Porites cylindrica*	*Galaxea*	*Galaxea fassicularis*
	Porites nigrescens		*Galaxea sp.1*
	Porites rus	Family Pectiniidae	
	Porites solida	*Pectinia*	*Pectinia teres*
	Porites lutea	Family Euphyllidae	
	Porites lobata	*Euphyllia*	*Euphyllia sp.*
	Porites monticulosa	Unidentified	CME

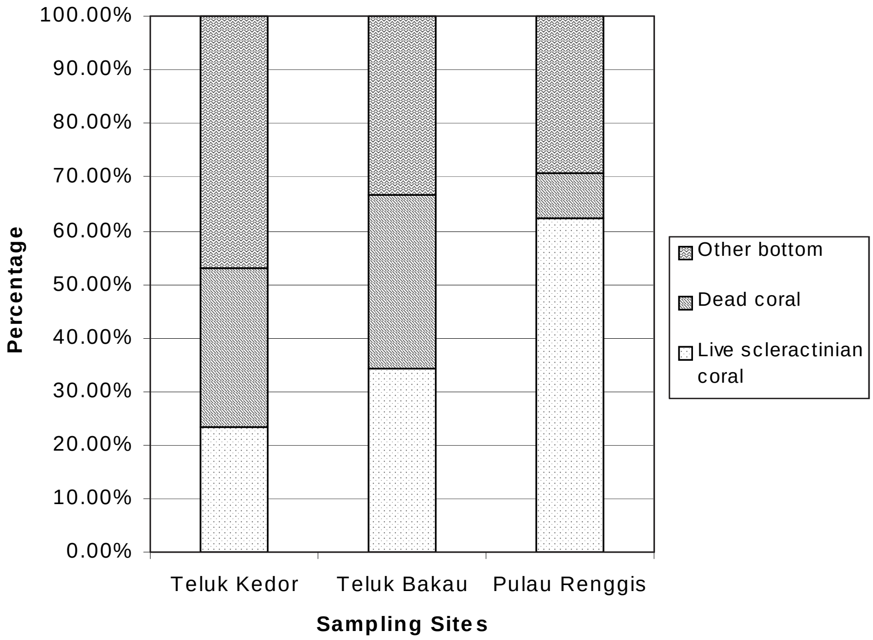

FIGURE 1: A Comparison of Percentage Coverage in Each Sampling Sites

TABLE 2: The Number of Genera and Species, Diversity Was Measured with Shannon Index (Shannon & Weaver 1949) Per Site in Pulau Tioman in 2004

Sampling Sites	Genera	Species	Diversity (H’)
Teluk Kedor	26	54	0.92
Teluk Bakau	17	38	0.98
Pulau Renggis	19	47	1.16

Discussion

In this study, 26 genera and 76 species of corals have been identified. The number of genera was relatively lower than Okashita (2003) whom had recorded a total of 28 genera in Pulau Tioman, which might due to the degradation processes in this past few years. Meanwhile the number of species recorded was also much lower then Silva et al. (1980) and Harborne et al. (2000) with 122 species and 183 species, respectively.

Returning to the results of this study compared with Kok (2003), differences in number of genera between Pulau Tioman and Pulau Redang showed that Pulau Tioman had a higher diversity compare to Pulau Redang, which only recorded 18 genera Another study by Harborne et al (2000) also shown that Pulau Tioman had a higher diversity with 188 species compare to Pulau Redang with 149 species.

Studies of Pulau Tioman coral reefs have been periodic and not always repeated on the same site. However, the percentage of corals cover had been compare to understand the changes of structure communities in different years. Harborne et al. (2000) reported that live hard coral covers of 45.2%, meanwhile Okashita (2003) recorded 44.8% of live hard coral is relatively higher then this study with the average live hard coral of 40.12%. Changes of live coral coverage also can be seen from the increase of dead coral cover, which Harborne et al. (2000) and Okashita (2003) recorded dead coral coverage of 8.5% and 32.4%, respectively. However, between the year 2000 and 2001, there was a high increase in the dead coral cover. The causes of coral reef degradation have been reported in various papers [high sedimentation loads (Grigg 1983; Tomascik & Sander 1987); increases of human settlement or unwise land-use activities related to deforestation and agriculture (Grigg 1983; Gomez et al. 1994; Ridzwan 1994)].

Reefs have in the vicinity of rivers with transient streams, will have increasing level of siltation which are anthropogenic in origin. These are often attributable to unwise land-use activities related to deforestation and agriculture (Yap & Gomez 1895). High sediment load are most likely to happen with more development in Pulau Tioman. Thus, more development in Pulau Tioman can cause coral reefs areas to be effected. Development would lead to more human settlement and increase in the number of tourist on the coast. This may lead to the fore problems of sewage and other pollutants in the marine environment. Aside from the increased sewage inputs, the construction of marina and concrete breakwaters on the reef itself contributed to the deterioration on the landscape and the changes in sedimentary depositional processes (Gomez et al. 1994).

In this study, three genera namely *Acropora*, *Porites* and *Montipora* were found to be dominant and most abundant around Pulau Tioman. The genus *Acropora* shown high coverage at every sampling sites and it is the highest in Teluk Kedor. Holt (1982) reported that all *Acropora* died over most areas in Dubai, the southern Arabian Gulf, between July 1979 and February 1982, because *Acropora* had no tolerance to water temperature variation. Reigl (1999) reported acroporids, including *Acropora* and *Montipora* have lower tolerance to sedimentation. The extensive coverage of *Acropora* and *Montipora* at every sampling sites has showed that there might not have high variation of seawater temperature in these past few years in Pulau Tioman.

In Teluk Bakau of Pulau Tulai, *Porites* showed a high coverage compared to other sampling sites. Teluk Bakau also showed the highest coverage of dead coral. This may due to illegal and destructive fishing. According to Silva et al. (1980), many reefs in Pulau Tulai have been subjected to heavy damage. This island is apparently heavily fished by the use of explosive as evidence such as large crater like areas of damaged coral admidst a good coral area. Although it has been more than 20 years where illegal fishing was banned in Pulau Tioman when it was included in the Marine Park jurisdiction, the coral reef areas showed high dead coral coverage. Alcaca & Gomez (1979) have suggested that it may take some 40 years for areas which have been destroyed by explosive to recover. However, it might not always recover to their original state as they might get covered by algae resulting in a deflected climax as is often observed.

However, *Porites* are most likely not affected by the die-back event. Sediment-resistant corals like faviids and poritids have advantage in area of high re-suspension and re-settlement, while acroporids, with a low tolerance to sediment, only dominate in areas with little resident sand and therefore lower re-suspension (Reigl 1999). Jokiel et al. (1990) also reported that *Porites* has a tolerance against critical threshold temperatures caused by coral bleaching compared with *Pocillopora*. Thus, *Porites* can survive in more harsh condition. Meanwhile, after so many years, *Acropora* begin to grow faster than other corals and increase the coral coverage. On the community scale, the aggressive *Acropora* species should, over time, out compete slower growing, less aggressive like *Porites* in areas where the substratum suits *Acropora* (Sheppard 1979). These suggest that some coral reef sites in Teluk Bakau were under very heavy stress.

High correlation between environment variables and biotic patterns indicate that the effects of eutrophication processes were directly and/or indirectly affecting the community structure of scleractinian coral assemblages (Tomascik & Sander 1987). In general, species diversity was most sensitive in delineating among reef which was attributed to intensification of eutrophication processes (Tomascik & Sander 1987). Thus, diversity index is the most frequently used in coral reef studies.

The value of diversity indices of corals in this study ranged from 0.95 to 1.15. Pulau Renggis recorded the highest diversity index with high coral coverage, although it has a lower number of genus. On the other hand, Teluk Kedor had a highest number of genus. and species but showed the lowest value of diversity index and low coral coverage. According to Paulay (1997), diversity does not only refer to the total number of taxa and species, it also refers to the coverage of the taxa. Diversity index in Pulau Tioman are higher than in Pulau Redang. Kok (2003) recorded diversity index between 0.40 and 0.77. This may due to the zonation of dominant species and growth forms of coral reefs in it natural community.

Due to the causes of coral reef degradation as stated, more management considerations should be taken to prevent further degradation of coral reefs. Environmental awareness and education should be conducted frequently to educate the community the importance of our coral reefs. Hopefully, with this study conducted, it can lead to better considerations in sustainable ecological developments and managements.

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