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Diversity and Distribution of Coral Lifeforms in Tioman Island

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ABSTRACT

Assessing coral morphology is to predict coral reefs conservation value. Coral lifeforms at four stations in Tioman Island were observed and recorded by using Coral Video Transect (CVT) method. The stations were Renggis and Terdau in the west coast and Benuang and Teluk Dalam in the east coast of Tioman Island. The captured images were analyzed using Coral Point Count with Excel extension (CPCe) software to find out the diversity and distribution of coral lifeforms in each study area. Three stations obtained "good" condition of reef with more than 60% of live coral coverage and one station obtained "fair" reef condition. Generally, the most dominant coral lifeform in Tioman Island is *Acropora* branching followed by massive. *Acropora* branching was the most abundance lifeform in Renggis. Terdau was dominated by massive lifeform and in the East coast, Benuang plate was the most abundant lifeform. By using the coral morphology triangle, conservation value of reefs in all four stations was predicted using the percentage of coral lifeforms. Renggis and Teluk Dalam need to be conserved the most since the reefs are classified as ruderals (fast growing but very fragile). Reef in Benuang are classified as competitor. It grows slower than ruderal but has higher tolerance. Terdau's reef is mix of all categories.

Introduction

Coral reefs provide food, medicine and income to millions of people around the globe. Mustapha *et al.* (2014) proclaimed, the world's coral reefs have provided substantial economic benefits by its supreme diversity. A study conducted by Toda *et al.* (2007) found that, coral communities of *Acropora*, *Porites* and *Montipora* dominate 74.5% of total live coral coverage in Peninsular Malaysia. Reef in Renggis has 68.6% of live coral coverage, which is the highest in Peninsular Malaysia, and Dedan Bay in Pangkor Island has the lowest coral coverage with 17.9%.

This study will help in coral conservation and preservation in the area of study by providing a record concerning the coral lifeforms existed in the area and the trend can be monitored by times. The changes in coral lifeforms dominancy may cause by several factors. These factors can be controlled if the changes in coral lifeforms percentage are detected. Physical environment is one of the factors that affect coral lifeforms. Different coral lifeforms may have different adaptability towards different physical environment. Muzaki and Saptarini (2012) ascertained that, there is likelihood that coral of

the different lifeforms and species to bleach at different depth. They found in their study, massive coral, *Acropora* branching, *Acrapora* tabulate and *Acrapora* digitate are the lifeforms that tend to bleach at 3 meter depth. On the other hand, foliose coral, coral mushroom, sub- massive and massive coral are likely to bleach at the depth of 8 meter. By using the coral morphology triangle, the conservation values of reefs in all four stations were predicted using the percentage of coral lifeforms.

Non-taxonomic reef classification based on its morphology were classified into a ternary diagram according to the study conducted by Edinger and Risk (1999) to measure the conservation value of coral reef in an area. Four conservation classes (CC) were assigned which are CC 1, CC 2, CC 3 and CC 4.

Methodology

Description of the study area

Data were collected at Renggis, Teluk Terdau, Teluk Dalam and Teluk Benuang (Figure 1). Tioman Island is located 32 km off the east coast of Peninsular Malaysia in the state of Pahang. Tioman Island Marine Park harbours 183 coral species, which has become a home to a large diversity of marine organisms (Harborne *et al.*, 2000). The sampling stations were selected because of the coral availability, tourist hotspot and near to the residential area or resorts.

Figure 1. Location of sampling sites in Tioman Island.

Coral Video Transect (CVT) and analysis of coral lifeforms diversity

Coral Video Transect (CVT) method was used in this study (Abdo et al., 2004). In each station, 4 transects was set at 5 meters interval. Each transect was 30 meter long. The transects were placed loosely above the substrate. For Teluk Benuang and Teluk Dalam stations, the videos were recorded on 28th April 2015. Videos in Renggis and Teluk Terdau were recorded on 29th April 2015. The videos were recorded by using an underwater camera along each transects at 20 to 25 cm distance perpendicular to the substrate. To get a clear and sharp image, the video will be recorded

approximately at six meter per minute. The video in each transect will be cut into 150 still images. Hence, 600 still images were analyzed for each station. Ten random points was assigned on each image by using Coral Point Counting with Excel extension (CPCe) software. Each point was identified to determine the benthic communities and the type of lifeform presents in the sampling site. The percentage of live coral and other benthic communities in all four stations were calculated (Table 1). The assignation coral reef condition based on live coral percentage was according to the study conducted by Gomez *et al*. (1994). The percentage of each coral lifeforms inhibited in each station was calculated to find its diversity and distribution in all sampling stations.

Table 1. Coral reef condition based on live coral percentage according to Gomez *et al.* (1994).

Percentage	Coral Condition
75% - 100%	Excellent
74.9% - 50%	Good
49.9% - 25%	Fair
24.9% - 0%	Poor

Reef conservation value based on coral morphology

The coral lifeforms was used to identify the conservation class of the sampling station. Edinger & Risk (2000) proposed the method of assessing reef conservation class using ternary diagram. The coral morphology was identified and classified into the r-K-S group (Table 2). The classifications of coral reef in the stations were classified according to the percentage of abundance of standardized coral lifeforms category. The station will be classified under CC 1 if the percentage of coral lifeforms dominancy according to r-K-S group classification equal to or exceeding 60%. For CC2 and CC 3, the station must have the percentage of coral lifeforms dominancy equal to or exceeding 50%. If none of the coral lifeforms in the r-K-S group have percentage as explained above, the station was classified under CC 4. CC 4 was regarded as mixed coral lifeforms. The Shanon-Wiener Diversity Index and Pielou Evenness Index of coral lifeforms in all stations were calculated using Paleontological Statistic (PAST) software.

Table 2. The classification of coral morphology in r-K-S group.

r-K-S group	Conservation	Morphology	Percentage
Ruderal (r)	CC 3	All *Acropora* coral, Tabulate coral (non-*Acropora*), *Heliopora, Millepora*	≥ 50%
Competitors (K)	CC 2	Non-A*cropora* branching, Plate, Foliose, Encrusting, Free-living	≥ 50%
Stress-tolerator (S)	CC 1	Massive, Submassive	≥ 60%

Result and discussion

Coverage of benthic communities and coral condition

Renggis shown the highest percentage of live coral cover compared to the other three stations. While, Teluk Terdau had the lowest live coral cover percentage. From Figures 2, live coral coverage in Renggis exceeded the coral coverage in Teluk Terdau by 36%. Teluk Terdau has a higher percentage of dead coral, algae and abiotic element. Toda *et al*. (2007) in their research found out that Renggis has 68.6% live coral coverage and 17% of dead coral. In this study, the coral reef condition in Renggis was categorized as "good" condition and the corals were maintaining its population by showing only 1.6% population reduction since 2007. However, the method that was used by *Toda et al.* was different from the method used in this study. *Toda et al.* was using line transect method. The other two stations, Teluk Dalam and Teluk Benuang stations did not show much significant difference in all categories. Teluk Dalam had a higher number of live coral coverage compared to Teluk Benuang by 1.9%. The second highest percentage was the algae for both stations. Coral condition at Teluk Benuang and Teluk Dalam were classified as "good" condition with more than 50% of live coral cover.

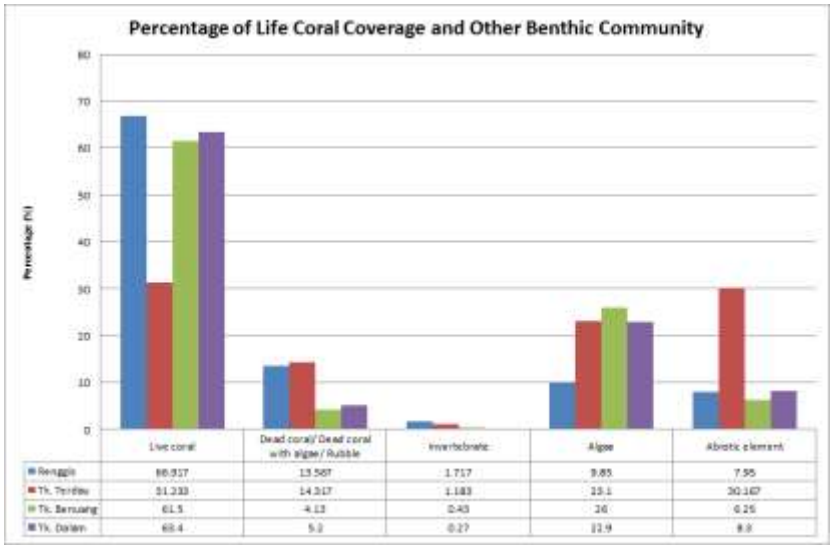

Figure 2. Live coral cover and other benthic community in Renggis, Teluk Terdau, Teluk Benuang and Teluk Dalam.

Diversity and distribution of coral lifeforms

A total of 10 coral lifeforms was found in Teluk Terdau and Renggis (Figure 3). The coral lifeforms found in Renggis were quite similar with Teluk Terdau with an addition of non-*Acropora* tabulate and absence of *Heliopora*. Massive was the lifeform with the highest percentage in Teluk Terdau follow by soft coral and *Acropora* tabulate. In the other hand, Renggis has a low percentage of soft coral and *Acropora* tabulate compared to Teluk Terdau. *Acropora* branching was the most abundant lifeform in Renggis follow by non-*Acropora* branching. Total of 11 coral lifeforms were found in Teluk Benuang and nine lifeforms in Teluk Dalam. The plate-like coral was the most abundance lifeform in Teluk Benuang with percentage of 37.36%, exceeding a quarter of the total percentage of all lifeforms.

Subsequently the number was followed by non-*Acropora* branching lifeform. In contrast, Teluk Dalam had a relatively low percentage of both of these coral lifeforms.

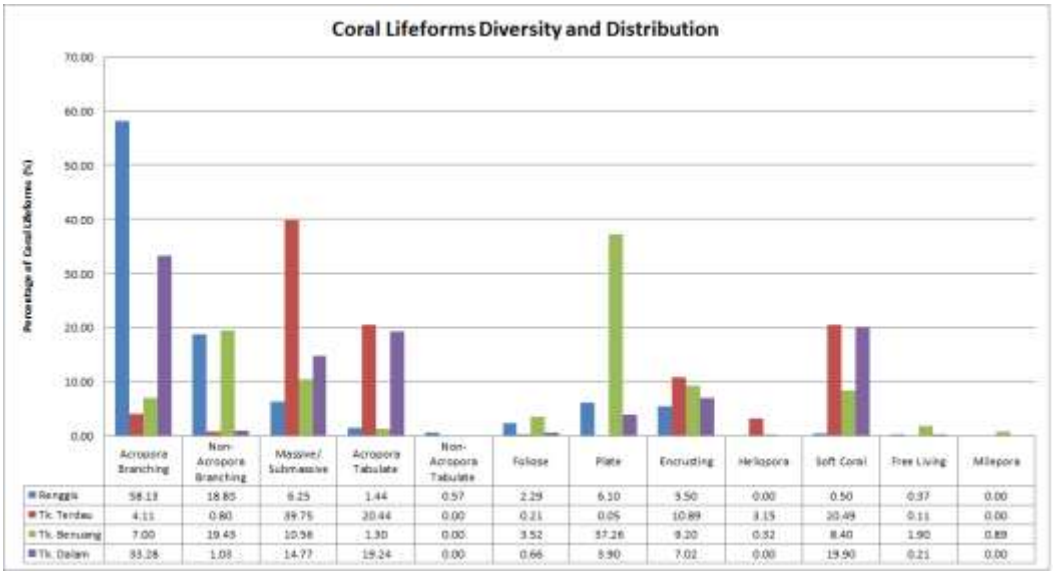

Figure 3. Percentage of coral lifeforms in all stations.

Total number, Shannon-Wiener Diversity Index (H') and Pielou Evenness (J') of coral lifeforms

Among all stations, Teluk Benuang had the highest coral lifeforms diversity with the diversity index of 1.852 (Table 3). On the other hand, Renggis had the lowest coral lifeforms diversity eventhough this station harbours the highest number of live coral. Teluk Benuang also had the highest Pielou Evenness Index with the value of 0.580. This result showed that, Teluk Terdau had an approximately equal distribution of all lifeforms compared to the other three stations. In contrast, Renggis had the lowest evenness index among all three stations with the value of 0.3888.

Table 3. Shanon-Wiener Diversity Index and Pielou Evenness Index of coral lifeforms in Teluk Terdau and Renggis.

Station	Total lifeforms	Total of life coral	Diversity Index (H')	H' max	Pielou Evenness Index (J')
Teluk Terdau	10	1874	1.561	1.595	0.4762
Renggis	10	4009	1.358	1.391	0.3888
Teluk Benuang	11	3500	1.852	1.879	0.580
Teluk Dalam	9	3690	1.649	1.673	0.578

Reef conservation value based on coral morphology

The r-K-S ternary diagram in Figure 4 showed that the coral reef in Renggis and Teluk Dalam were classified in conservation class 3 (CC 3), coral reef in Teluk Terdau was classified as CC 4 and Benuang was fell into CC 2. Renggis was dominated by *Acropora* branching by 58% thus, Renggis

was considered as ruderals. In Teluk Dalam, the total of *Acropora* branching and tabulate corals gave percentage coverage exceeded 50%; hence it is regards as ruderals. Teluk Terdau had massive as the most abundant lifeforms but the percentage of coverage did not exceed 60%. Stress-tolerator was the only class in r-K-S group that requires percentage exceeding 60% of coral lifeforms coverage as Grime (1975) claimed that, stress-tolerator were usually found abundant in all community but only dominated those with high environmental stress.

Branching coral especially *Acropora* was more susceptible to breakage and cannot withstand high current impact. Ruderals also had a high growth rate compared to the other coral lifeforms classes. Therefore, it was easy for this type of coral to dominate an area (Edinger & Risk, 2000). This may be the reason for its abundance in Renggis. In the other hand, coral lifeforms such as foliose and plate had higher tolerance to wave action compared to branching but their growth rate is much slower.

CC 1 was observed having special characteristic to tolerate sedimentation. Goh and Sasekumar (1980) ascertained that, *Porites* massive is usually found in high sedimentation area and had cleaning mechanism to remove the sediment by mucus secretion. Massive was the lifeform with the strongest protection against mechanical break. Eventhough, massive was the most abundance lifeform in Teluk Terdau but its percentage relatively low compared to the dominant lifeform in Renggis. This is because this type of coral is slow growing (Edinger & Risk, 2000).

Edinger and Risk (2002) concluded that reef communities with higher conservation class (CC 4) harbor more species diversity, habitat complexity and rare species occurrence compared to lower class. They further suggested that, the conservation act should be focused on CC 2, CC 3 and CC 4. Different approach of conservation could be taken based on each classes characteristics. Example of coral conservation act that can be done is coral replanting based on coral lifeforms dominancy acording to the r-K-S group classification. Edinger and Risk (2002) further explained that CC 1 often occurred in land- based pollution and only can be conserved if the source of the pollutants were eliminated.

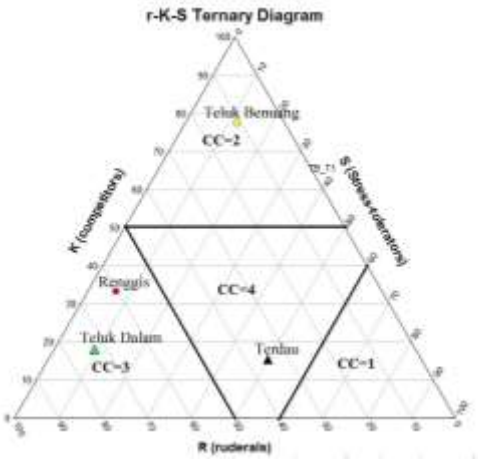

Figure 4. The r-K-S ternary diagram for coral lifeforms in selected area in Tioman Island.

Conclusion

According to the r-K-S group, Teluk Dalam and Renggis that dominated by ruderals corals were assigned to CC 3. Teluk Benuang that dominated by competitors coral was assigned to CC 2. Teluk Terdau that assigned to CC 4 as it considered to have mixed coral lifeforms. All stations had high conservation class and deserved more protection for the coral reefs survival. Strict regulation on residential waste management and having a limited carrying capacity for tourist visit in each station can be applied.

Acknowledgements

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