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THE POTENTIAL OF ARTIFICIAL LIVE ROCK AS SUBTRATE FOR CORAL SPAT AND EPIBENTHIC ORGANISMS

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Abstract

Over-exploitation on natural live rock promotes the degradation of ocean ecosystem. This concern has been raised since harvesting may reduce the density of marine ornamentals and degrade marine habitat quality. This study aims to develop artificial live rocks (ALR) that potentially to be used as one of the alternatives to reduce the overharvesting activity toward natural live rocks. The study was conducted at Bidong Island, Terengganu started from April to October 2014. There were 2 types of ALR used in this study; rough and smooth surfaces. A total of 64 pieces of ALR were deployed in April 2014 and retrieved in June, August and October 2014 respectively. Identification in terms of coral spat species and macrobenthic organisms was done after the each retrieval. Coral spat was identified based on the morphology of their columella, septa and corallite wall by using Dinolight Digital Camera. Four species of coral juveniles (*Pocillopora damicornis, Stylophora pistillata, Seriatopora hystrix* and *Acropora millepora*) were found attached on ALR surfaces. Whereby, there were 11 phyla of epibenthic organisms were found to attach on ALR which dominated by turf algae and red algae. Percentage coverage of epibenthic calculated using Coral Point Count with Excel extension (CPCe) shown ALR was dominated by turf algae after 2 months (69%) and 4 months (20%) of deployment respectively. Afterward, Red algae (31%) dominated after 6 months of deployment. There was significant difference between coral species and the surfaces ($p<0.05$). However, no significant difference between types of surfaces with sessile macrobenthic organisms ($p>0.05$). This finding showed that ALR has a potential to be upgraded as artificial reef towards marine habitat restoration.

Keywords: Artificial live rock, coral recruitment, epibenthic organisms,artificial reef

1.0 INTRODUCTION

Live rock delineate as ocean base rock that is concealed by various types of encrusting algae and assemblage with numerous marine invertebrate [1]. Moreover, the structures contain beneficial microorganism of nitrifying and denitrifying bacteria that crucially balancing the nitrogen cycle in the ocean [2]. Apart from that, live rocks also play a crucial role in providing the substrate for coral juveniles and macrobenthic organisms [1]. These exclusive capability makes live rocks widely used as reef ornamentals in aquarium as biological filter and give aesthetical satisfaction among aquarium traders [3]. Abruptly, the demands of live rock become so rampant until it reach the level of concern [4]. Based research done on 2005, live rock trade has reached a peak of 2,527mt and it will continue to increase if no proper action taken [5].

Constant harvesting of live rocks may destruct the coral reef ecosystem. Live rock provides a site for coral juveniles to attach and propagate [1]. In addition, it also serves as substrate for various types of marine benthic organisms and become source of food for herbivorous fish [6]. Prolonged exploitation might give enormous devastation to coral ecosystem and potentially decrease the fish population [7].

This study aimed to produce artificial live rock that can be one of the solutions towards natural live rocks exploitation. This study was expected to give an alternative in fulfilling the high demand of aquarium trade and at the same time can preserve the ocean biodiversity. In this study, the artificial live rocks were designed to resemble the natural live rock that can become the substrate for coral spat and habitat for epibenthic organisms. The study also included the surface differences which compare the effectiveness between rough and smooth surface of artificial live rocks in terms of coral recruitment and macrobenthic organisms.

2.0 EXPERIMENTAL

2.1 Sampling Station

Study was conducted in Bidong Island, Terengganu. Sixty-four pieces of ALR were deployed at site known as Pasir Cina (Figure 1). ALRs were deployed at three stations as replication. This location was selected due to low human disturbance, high diversity of marine organisms and easy to access for samples retrieval.

The rough surface artificial live rock have grumbled surface and have a grooved exterior's structure. Meanwhile, the smooth surface was designed to have a flatter surface to reduce efficiency in trapping sediments. The size of each structure was similar, approximately 17cm x 14cm x 3cm each. In total, 64 pieces of both ALRs were constructed and deployed at range of 7-8 meter depth.

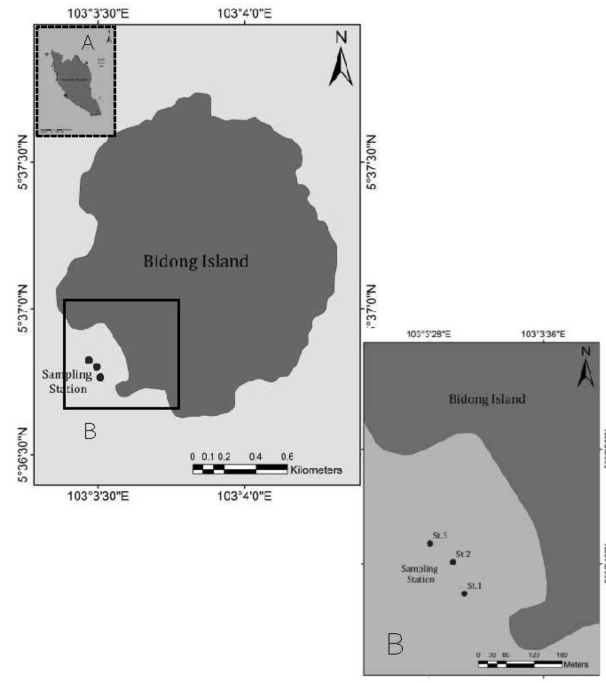

Figure 1 Map of study area, A: map of malaysia B: Location of Pasir Cina,Bidong Island

2.2 Construction of ALR and Deployment

ALR were constructed with the same material with two different types of surfaces; rough and smooth as shown in Figure 2.

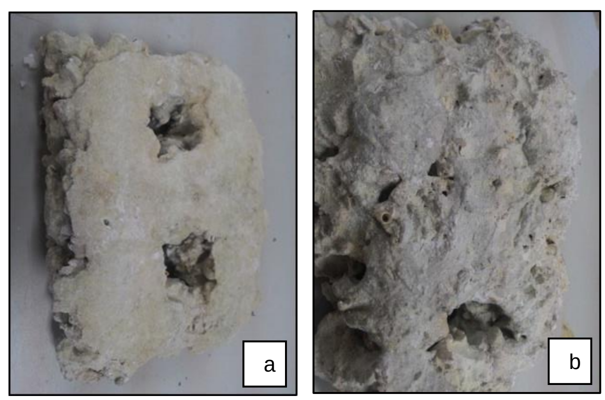

Figure 2 Types of ALR; a) smooth surface; b) rough surface

2.3 Samples Retrieval

ALR were deployed in 22 April 2014 and the first retrieval was done in June, August and October 2014 correspondingly to 2, 4 and 6 months of deployment. Retrieved ALR were taken to the laboratory for further analysis.

2.4 Epibenthic Analysis

Samples of epibentic were soaked in 10% formalin solution and preserved for identification. Epibentic organism was identified using Zeiss Stemi DV4 stereomicroscope. The percentage coverage of epibentic organisms was determined using Coral Point Count with Excel extensions (CPCe) software version 4.1.

2.5 Coral Spat Analysis

Retrieved ALR was soaked in NaOH solution to appear the skeleton of coral spat [9]. Then, it was rinsed with freshwater and dried in 60°C of temperature for 48 hours. Samples were then examined under Zeiss Stemi DV4 stereomicroscope and the maximum diameter of coral spat were measured. The density of coral spat was determined by dividing the number of counted coral spat with surface area.

3.0 RESULTS AND DISCUSSION

3.1 Epibenthic Organism

There were 11 phyla of epibenthic organisms found attached to ALR, throughout the study. Phyla found were consist of phylum Porifera, Rhodopyta, Phaeophyta, chlorophyta, Cnidaria, Chordata, Annelida, Phoronidea, Bryozoa, mollusca and Turnicata.

3.2 Percentage Coverage of Epibenthic Organisms

Figure 3 shown the percentage coverage of epibenthic after; a) two months; b) four months and c) six months after the deployment.
After two month of deployment, turf algae found to be dominant with 69% coverage. While bivalve, bryozoan and tunicate had the least coverage which was 2% each. Less than 1% of corals, coralline algae, hydroid and tube worm were found attached to ALR. After four months of deployment, turf algae as still found dominant. However, the percentage decreased to 20%. Meanwhile, bryozoan, red algae and coralline algae somehow showed increase in percentage coverage. After six months of deployment, red algae was found to dominate with percentage coverage of 31%. Whereas, percentage coverage of turf algae decrease to 18%.

In natural ecological succession process, new surfaces that placed in the marine environment will promptly develop a layer call biofilm then followed by attachment, metamorphosis, growth of algal and invertebrate taxa [8, 10, 11]. At the early stage, epibionts were particularly consist of filamentous algae such as turf algae and hydrozoan, followed by encrusting algae such as coralline algae and red algae [12]. Therefore it is normal to find turf algae dominant after 2 months of deployment. After 4 months of deployment, the percentage of turf algae decreasing and at after six months of deployment, the dominant epibiont was replaced by red algae. This process was a complex development of successor process.

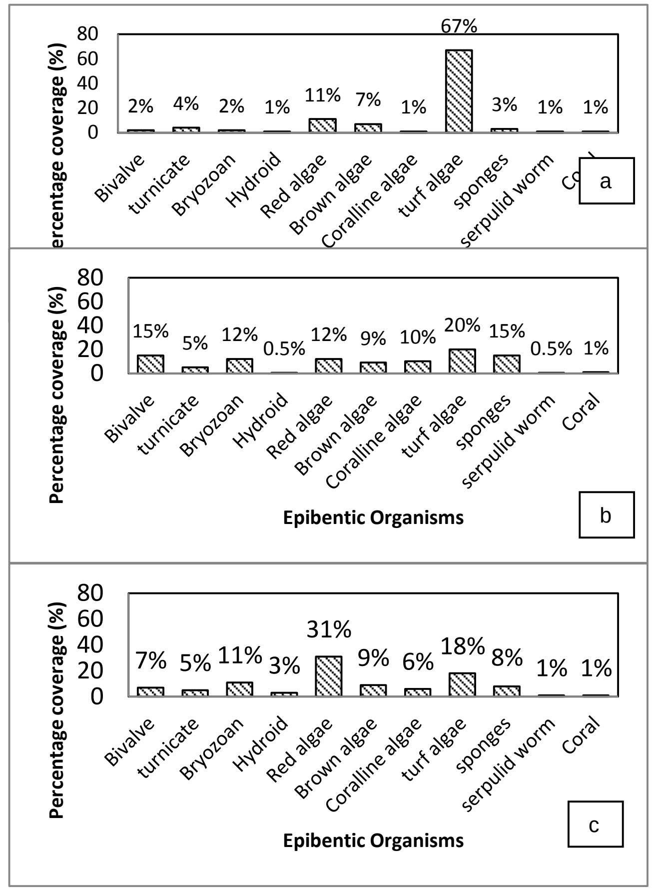

Figure 3 Percentage coverage of epibenthic organisms per months of deployment

Percentage coverage of epibenthic organisms may differ based on surface of substrates [13]. However, in this study, the percentage difference was too small. Based on analysis of variance (ANOVA), no significant difference was found between these two surfaces; rough and smooth ($p>0.05$). Possibly, it was influenced by larval supply of benthic organisms [14].

3.3 Number of Coral Spat Colonies

Two families from four genera of coral spat were identified. From family Pocilloporidae, coral spat identified were *Stylopora pistillata, Seriatopora hystrix* and *Pocillopora damicornis*. Whereas under family Acroporidae, *Acropora millepora* was identified. Figures 4. and 5 shows SEM photography of coral species found.

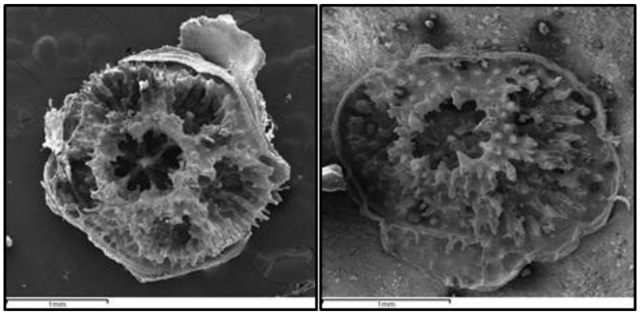

Figure 4 SEM picture of coral spat found on ALR surface; a) *Pocillopora damicornis;* b) *Stylopora pistillata*

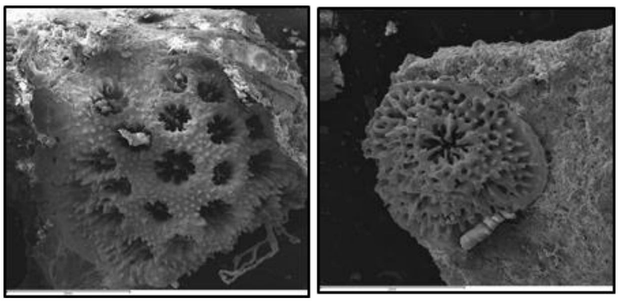

Figure 5 SEM picture of coral spat found on ALR surface; c) *Seriatopora hysterix;* d) *Acropora millepora*

Table 1 Number of coral spat colonies based on types of surfaces and months of deployment

coral species	Month 2		Month 4		Month 6	
	R	S	R	S	R	S
P. damicornis	11	11	12	13	8	41
S. pistillata	4	5	10	12	23	51
S. hystrix	-	1	-	6	5	23
A. Millepora	-	-	-	2	-	-
total	**15**	**17**	**22**	**33**	**36**	**115**

Total number of coral spat colonies that attached on ALR was shown in Table 1. Higher number of coral spat was observed on smooth surface compared to rough surface of ALR. Based on Independent t-test, there was a significant difference between types of artificial live rock's surfaces and number of corals spat attached. Throughout of the analysis, most of the coral spat attached on ALR was consist of pocilloporidae family. The only acroporidae family was found in month 4 after the retrieval. Pocilloporidae is a common coral family on reef in Malaysia and spawn almost every month [15]. Therefore it is abundantly found attached in this ALR. The result also shown the number of coral spat was increased with increasing months of deployment.

3.4 Coral Spat Densities

There was an increase number of coral spat densities with increasing months of deployment. As shown in Figure 6, coral spat densities were found higher on smooth surfaces of ALR compared to rough surfaces. Based on ANOVA test, there were significant interactions ($p<0.05$), between coral spat densities with months of deployment (month two, month four and month six) and type of surfaces (rough and smooth).

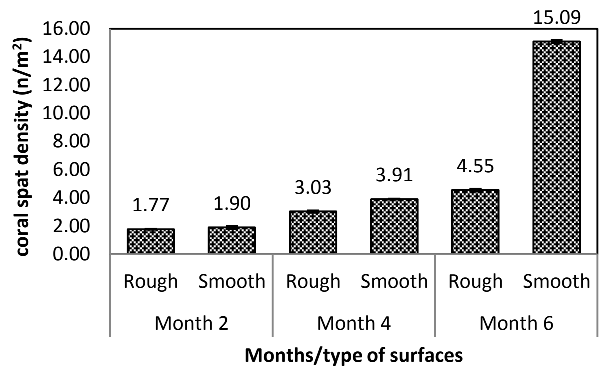

Figure 6 Coral spat densities based on types of surfaces and months of deployment

3.5 Diameter of Coral Spat

Mean diameter of coral spat was not showed the clear distinction between types of ALR's surfaces (Table 2). Based on the result from Independent t-test, there was no significant difference between diameter of coral spat with rough and smooth surfaces of ALR. However Repeated Measures ANOVA has shown that there was significant relationship between diameter of coral spats with coral species and months of retrieval ($p<0.05$)

3.6 Interaction Between Coral Spat and Epibenthic Organisms

There are mechanisms between corals and algae competition; overgrowth, shading, abrasion, allelopathic chemical effects, space pre-recruitment barrier and epithelial sloughing [16, 17]. However, some studies indicated that many benthic algae may enhance or inhibit coral spat settlement [16, 18, 19]. Many studies suggested that certain Crustose coralline algae (CCA) species was able to induce coral larval settlement and metamorphosis [20, 16]

Succession process occurred in the ocean had caused the surfaces of artificial live rock to be employed by different series of macrobenthic organisms settlement including corals throughout the deployment. At the end of this study, the surfaces of artificial live rock had been grown with developed algae that had different color, shape and diverse pattern of attachment. Sediment, turf algae, and macroalgae generally covered the top surfaces of the plates; therefore, the majority of coral spats settled on the bottom surface and/or the vertical edges of plates. Other benthic organisms, such as ascidians, bryozoans, barnacles, and sponges could also be commonly found on the plates [21]. Since this study was conducted in short time of period, a clear interaction cannot be seen.

Table 2 Mean diameter (mm) of coral spat by months

coral species	Month 2		Month 4		Month 6	
	R	S	R	S	R	S
Pocillopora damicornis	1.89 ± 0.29	1.92 ± 0.16	3.26 ± 0.33	2.64 ± 0.44	1.42 ± 1.26	2.42 ± 0.60
Stylopora pistillata	1.22 ± 1.06	1.77 ± 0.51	0.85 ± 0.78	1.96 ± 0.24	2.06 ± 0.43	2.52 ± 0.06
Seriatopora hystrix	-	0.98 ± 0.85	-	1.03 ± 0.14	-	1.74 ± 0.25
Acropora Millepora	-	-	-	0.40 ± 0.68	-	-

4.0 CONCLUSION

As a conclusion, the study proved that artificial live rock was able to become substrate for epibentic organism and corals juverniles. There were 11 phyla of epibenthic organisms found and 4 coral species attached on the artificial live rock. Positive growth of coral species concluded that the ALR were able to promote as substrate for coral spat. This study proved that the material of ALR was suitable for organisms' settlement. The study also proved there was a significant different between the rough and smooth surfaces and the recruitment of corals. Finding from the study shown the ALR has a potential as artificial reef towards marine habitat restoration

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