Shapes, substrates, and monsoon patterns that affect live rock culturing among the coastal communities in Southern Sri Lanka

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1. Introduction

Marine live rock culture can be identified as an alternative livelihood method to the unsustainable marine ornamental fishing industry in Sri Lanka that is almost depending on the wild catch with bad practices and overexploitation (Dhanasundara et al., 2020). Although breeding marine ornamental fishes in captivity is difficult than freshwater fish breeding (Cato and Brown, 2008), marine live rock culturing could be identified as one of the simplest processed commodities, but also have higher demands in the global market (Parks et al., 2003). Live rocks are live specimens of invertebrates, algae, coralline algae, and other microbiota attached to a rock that are not included in the Convention on International Trade in Endangered Species (CITES) appendices and which are transported in moist conditions (CITES, 2000). Due to their biological and aesthetic roles, they are important in the ornamental aquaria industry. Therefore, it is necessary to culture instead of harvesting them from natural marine environments. Since the southern coastal zone in Sri Lanka is rich with rocky shores, fringing coral reefs ecosystems, and high biodiversity (Rajasuriya, 2009), there is a copious possibility to culture live rocks by enriching them with naturally occurring marine algae and invertebrates with attractive colours in order to add them higher ornamental values. Through this study, important factors such as the season, growth period, shape, substrates, and locations on culture of live rocks are investigated. The knowledge acquired can be utilized for the implementation of live rock cultures for commercial purposes by abolishing the baseline limitations.

2. Materials and Methods

Rounded, semi branched and branched shaped cement structures were made by using different sized particles (substrate) as very coarse sand (1-2 mm), very fine gravel (2-4 mm), and fine gravel (4-8 mm) respectively. Those nine types were marked with their Shape and Particle size as S1P1, S1P2, S1P3, S2P1, S2P2, S2P3, S3P1, S3P2, and S3P3 respectively. These structures were firmly placed on specially designed holding structures made of concrete bases and metal mesh covered wooden frames ensuring uniform height from the bottom in different study locations; Dondra, Madiha, and Ahangama reefs along the southern coast. When selecting the above locations, criteria such as least disturbances to fisherman, least disturbances to tourism and recreational activities, easy accessibility, available spaces, protective environment, and surrounding biodiversity were considered. Forty-five structures as five structures of each nine types (9*5=45 types) were attached on one holding structure and three of such setups (45*3=135 types) to cover the maximum extent of the site were placed for one growth cycle at a monsoon period in a location. Cup-shaped cement structures were used as controllers. Thus, four cycles were completed as covering four monsoon patterns; 1st Inter Monsoon (March-April), Southwest Monsoon (May-September), 2nd Inter Monsoon (October-November), and Northeast Monsoon (December-February) during 2020-2021. Percentage of biota attachments were analysed by image analysis and counting after every 03 months and 06 months growth period. Sensory evaluation by 100 independent responders was performed after 06-months growth period as relevant to all types of live rocks and locations for different monsoon patterns.

3. Results and Discussion

The rapid attachments of microcolonies such as macroalgae, fungi, and lichen covering the cement rock structures were prominent after installing them at all three study locations. However, macro-organisms such as macroalgae, seagrass, cnidarians, molluscs, and echinoderms were attached at a higher rate after the 03 months (Table 01).

Table 01. Levels of attachments of different biota to rock structures after 03 months and 06 months period concerning four different culture cycles at different monsoon patterns in different study locations.

Study location	Initiated monsoon	Summary of the observations of all types of live rocks	
		Approximate percentage (%) after 03 months period	Approximate percentage (%) after 06 months period
Dondra	1st Inter Monsoon	Microcolonies: 50% Macro-organisms: 0% Total: 50%	Microcolonies: 75% Macro-organisms: 20% Total: 95%
	Southwest Monsoon	Microcolonies: 60% Macro-organisms: 20% Total: 80%	Microcolonies: 55% Macro-organisms: 45% Total: 100%
	2nd Inter Monsoon	Microcolonies: 60% Macro-organisms: 25% Total: 85%	Microcolonies: 60% Macro-organisms: 40% Total: 100%
	Northeast Monsoon	Microcolonies: 50% Macro-organisms: 5% Total: 55%	Microcolonies: 65% Macro-organisms: 15% Total: 80%
Madhiha	1st Inter Monsoon	Microcolonies: 55% Macro-organisms: 5% Total: 60%	Microcolonies: 50% Macro-organisms: 50% Total: 100%
	Southwest Monsoon	Microcolonies: 70% Macro-organisms: 20% Total: 90%	Microcolonies: 70% Macro-organisms: 30% Total: 100%
	2nd Inter Monsoon	Microcolonies: 60% Macro-organisms: 40% Total: 100%	Microcolonies: 40% Macro-organisms: 60% Total: 100%
	Northeast Monsoon	Microcolonies: 65% Macro-organisms: 5% Total: 70%	Microcolonies: 80% Macro-organisms: 10% Total: 90%
Ahangama	1st Inter Monsoon	Microcolonies: 50% Macro-organisms: 5% Total: 55%	Microcolonies: 60% Macro-organisms: 40% Total: 100%
	Southwest Monsoon	Microcolonies: 60% Macro-organisms: 30% Total: 90%	Microcolonies: 40% Macro-organisms: 60% Total: 100%
	2nd Inter Monsoon	Microcolonies: 60% Macro-organisms: 35% Total: 95%	Microcolonies: 45% Macro-organisms: 55% Total: 100%
	Northeast Monsoon	Microcolonies: 50% Macro-organisms: 10% Total: 60%	Microcolonies: 60% Macro-organisms: 20% Total: 80%

*** Macro-organisms attached over microcolonies were countered to the macro-organism percentages.

In some cases, these attachments caused changes of the original shape of the placed live rocks. Fish species of family Gobiidae and fish larval stages of family Pomacentridae, were inhabitants in or on some live rock structures which were covered by macro sessile organisms

and sediments after 03 months' period. The attachment nature of micro and macro biota to artificial rock structures after 03 months and 06 months periods differed significantly ($P < 0.05$) with initiated monsoon patterns and study locations. All together 20 macro species in Dondra, 26 macro species in Madiha, and 25 macro species in Ahangama have been recorded on live rock structures after 06 months' growth period. A higher amount of nutrient runoff with the southwest monsoon to the coastal water of the southwestern zone (Silva et al., 2005) is strongly suggested as the cause for the higher attachment rate of microalgae, macroalgae, and other biota to the live rock structures. Loading of those nutrients at the end of the southwest monsoon period and the calm sea condition may highly affect the rapid growth of those biota on top of the artificial rock structures which subsequently showed the lowest growth period than in any other monsoon pattern. Further reduction of nutrients levels due to lower amount of terrestrial runoff during the Northeast monsoon and the 1st inter monsoon, may cause to longer growth period observed on live rock structures during those seasons. When comparing study locations, Madiha showed a relatively higher growth rate and higher number of species attachments followed by Ahangama and Dikwella. Madiha is situated closer to the Nilwala river mouth, which would be the reason to show a higher growth rate with the help of terrestrial nutrient runoff by the river. Subsequently, Ahangama location is closer to Koggala lagoon mouth which may loading nutrients to the coastal area.

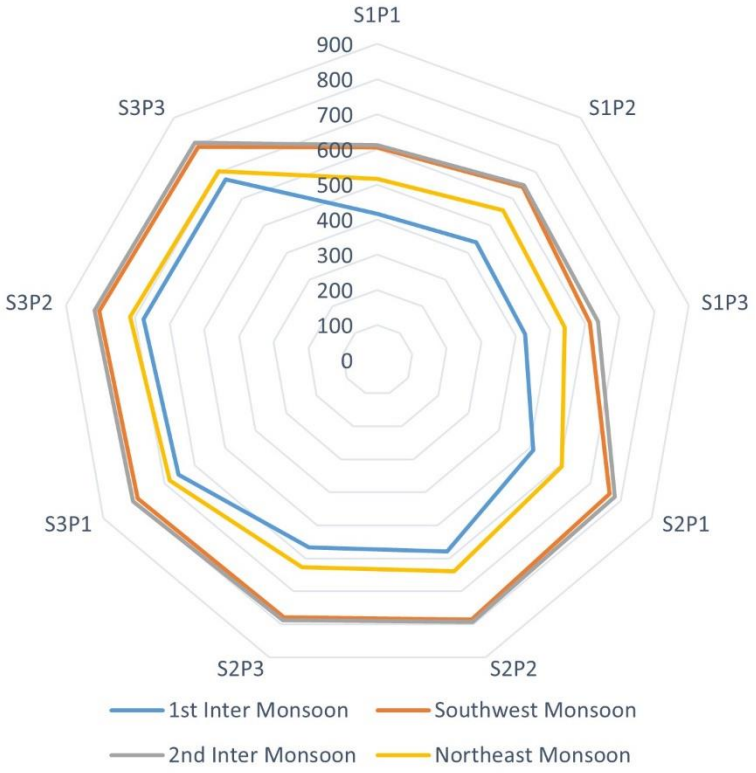

Figure 1. The radar chart shows the sum of the ranks performed by the Friedman test. 90 volunteer responder's preferences on live rock structures after 06 months period grabbed through the 0-10 ranking system concerning four different culture cycles at different monsoon patterns for the sensory evaluation are visualized.

Responder's insights were also more or less coincided with the level of biota attached to different types of live rocks (Figure 01). Most preferences were received for branched typed rocks followed by semi branched and rounded types. Cement structures made by very fine gravel (2-4 mm) substrate had the highest preferences followed by fine gravel (4-8 mm) substrate and very coarse sand (1-2 mm) substrate. Sequentially, culture cycles initiated with the 2nd Inter Monsoon, Southwest Monsoon, Northeast Monsoon, and 1st Inter Monsoon have obtained the preferences of responders.

Branched rocks made with very fine gravels (2-4 mm) and cultured during the 2nd Inter Monsoon period had the heights preferences while rounded rocks made with very coarse sand (1-2 mm) and cultured during the 1st Inter Monsoon period had the lowest preferences by the sensory evaluation.

4. Conclusions

Marine live rock culturing can be performed easily without higher knowledge on aquaculture and techniques at any reef or rocky shore environment of the southern coast during any period of the year. However, the biota attachment (growth rate) depends on the monsoon pattern, location, shape, and the substrate of the initial rock structure placed. Therefore, this can be introduced as an alternative livelihood to the coastal community who are suffering from issues of resource utilization due to overharvesting, climatic changes, anthropogenic factors, and natural effects.

5. References

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