Research article

Growth Rate of *Acropora nobilis* Attached to Table Type Framework

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Abstract The Municipality of Panglao has been experiencing constant pressures caused by human and natural factor that affect the resources within the municipality particularly the reefs. Reefs are underwater structures created by the growth of corals. It has the highest gross of primary productivity in marine systems. However, sustainable practices to maintain the state and well-being of reefs have been largely ignored. Transplanting coral fragments or ramets is one way of restoring damaged portion of reefs. Hence, this study aims to determine the survival and growth rates of ramets in a table type framework deployed at 5, 10, and 20 m depth in three months. Coral fragments found scattered on the reef bottoms were cut into smaller fragments (ramets). There were 16 ramets attached in a single coral nursery unit. One hundred forty three representing three levels of depths and three replicates per depth. Monitoring was conducted monthly. The survivorship of *Acropora nobilis was* found out to be at 88.7%. Ramets had overgrown the plastic cable ties as well as steel bars indicating three dimensional growths. The growth rate of the ramets were high but there was no significant difference found with depth (p=0.066). The highest growth rate was found out to be at 20 m, with a mean growth rate of 0.81 cm mo^{-} . The high survival and growth rate of *A. nobilis* proves that it is a good species for coral reef restoration in Panglao, Bohol.

Keywords coral, growth rate, framework, branching coral, survivorship

INTRODUCTION

Coral reefs have been in existence for many decades, an evident result of the complex constructive process. Among the five major marine ecosystems, coral reefs have the highest levels of marine biodiversity on earth, and play a big role in the highly tangible environment. In the Southeast Asia, a nearly 100,000 km of coral reef (34% of the world's total) can be seen. The species that are primarily abundant around the area are the branching corals, the same species that can be found in the coral reef ecosystem of Panglao, Bohol (USC, 2012).

Branching corals have been slowly declining due to illegal fishing practices, tourism, overfishing, global warming and pollution from land populated areas. A small change in the environmental parameters caused by the aforementioned activities can significantly affect up to 50% of the growth rate of this species (Crabbe and Smith, 2005; Jimenez and Cortes, 2003; Macdonald and Perry, 2003; Kaandorp, 1999). Hence, many have tried developing a technology that could conserve the coral reef ecosystem and mitigate the negative impacts (Lee et al., 2009:

Shaish et al., 2008; Raymundo et al., 2007; Rinkevich, 1995). Recently, researchers in the Philippines also started developing such technology, and pilot tested it at the different parts of the Philippines through the Coral Reef Rehabilitation Project. In this project, the itinerary is usually focused on the coral reef restoration and no studies have been done yet on the growth rate of ramets attached to nurseries deployed at different depths. It is in this context that this study will find its merits.

OBJECTIVES

This study aims to measure the growth rate of *Acropora nobilis* in 3 different water depth layers (i.e., 5, 10, 20 meters during the lowest low tide) in Alona Beach, Panglao Island, Bohol, Philippines.

Specifically, this study aims to

1. determine the survivorship of the ramets attached to the units, and
2. compare the growth rate of the *A. nobilis* in the 3 different water depth layers

METHODOLOGY

Site Description

This study was conducted in Alona Beach, Tawala, Panglao, Bohol (Fig. 1) from April-August, 2013. Alona beach is located at the south part of the island. It has fringing reef that experiences northeast monsoon from November to March and southwest monsoon from June to October, a shallow reef flats that are mostly composed of fine sediments, sands, seagrasses, seaweeds, and algae, and a fore reefs that extend up to several meters with coral cover of approximately 10 percent. Alona beach has been subjected to both natural and human induced destruction such as the typhoon Bupha or locally known as Pablo, improper anchorage, and poor buoyancy control of the divers.

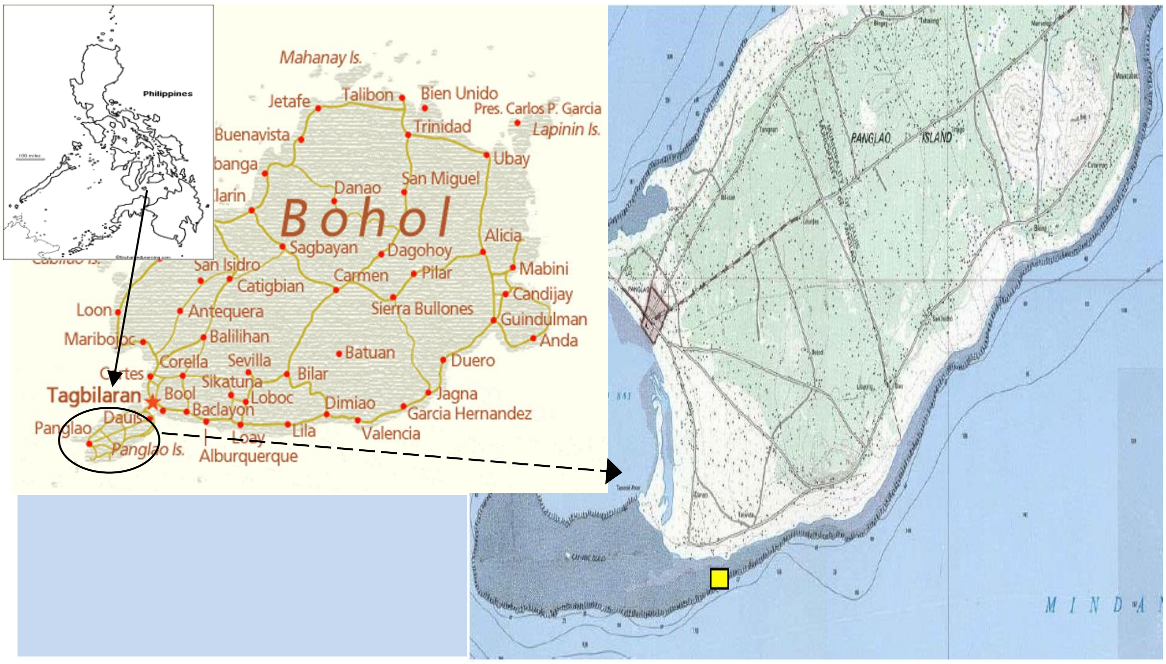

Fig. 1 Map of the study site in Panglao

Coral Nursery Construction

The coral nursery units, Table type were constructed from March 28-April 3, 2013 at Tawala, Panglao, Bohol. The nurseries were made up of 9 mm round bar materials, measuring 50 cm length by 50 cm width, and 40 cm depth with four fixed series of 9 mm round bars running the whole length with 10 cm gap in between and another four fixed series of 9 mm round bars running the whole width with the same gap in between. Additionally, a steel plate was connected to each of the nursery's foot so that it can be fixed on the bottom minimizing movement due to waves and currents. Each nursery was tagged randomly.

Collecting Fragments and Transplanting in Nursery

Fragments of *Acropora nobilis* were collected along the Alona strips. These were placed in red or yellow crates and were brought to waist level seawater. The fragments were cut into 5 cm (SD±0.05) smaller fragments (ramets) using hack saw. A plastic caliper was used to measure the maximum height of the ramets for growth rate determination. Tagging of ramets using dymo tags were done. All ramets were tied firmly with plastic cable ties for anchorage and will be attached to the coral nursery unit in a complete randomize manner. There were 16 ramets in a single coral nursery unit. Overall, there were 144 ramets representing three levels of depths, and three replicates per depth.

Deployment of the Framework Units

A pumpboat was rented when the framework units were deployed. Three framework units were deployed everyday for three consecutive days. The frameworks were attached to PVC rafts that were tied to the outriggers of the pumpboat so that the ramets will remain submerged in the seawater. The units at (20, 10, and 5 m) were placed perpendicular to the shoreline.

Survival and Growth Rate Determination

Survival was monitored every month for three months by recording the status of each ramet as dead, partially dead, bleaching, live, or missing.

After one week of deployment of the units, ramets were photographed with underwater camera. Growth measurement was done using a plastic caliper for calibration. Growth rate was calculated by using Eq. (1):

$$DGR = (Lf - Li) / t_2 - t_1 \qquad (1)$$

where: Lf = final length, Li = initial length, t_2 = days terminated, and t_1 = start of study. The same procedures were done after three months.

Maintenance

A monthly dive was done to remove fouling organism (algae, sponges, etc), predators (crown of thorns, sea stars, corallivore snails, etc.), and other debris.

Data Analysis

Statistical analysis was performed using Systat 12. In lieu of one-way analysis of variance (one way-ANOVA) for the growth rate, a non-parametric analysis, Kruskall-Wallis test was used since the data failed to meet the assumptions even after transformation.

RESULTS AND DISCUSSION

Survivorship of the Ramets

Fig. 2 shows that the nurseries deployed in five meters had the highest number of live ramets while the nurseries at ten meters depth had the highest number of partially dead and dead ramets. Survival of all ramets was 88.7% for *Acropora nobilis* which is lower compared to the 94.8-95.8% of the Andaman Sea (Putchim et al., 2007) but is more or less equivalent to the 87% survivorship of the transplanted corals in the outfall of North Florida, USA (Thornton et al., 2000). The cutting and attachment process did not apparently affect their survival. One of the principal concerns about coral transplantation is the effect of relocation. Many have moved corals to different environments and experienced difficulties due to many changes in its habitat (Thornton et al., 2000). The high survival rate of the ramets in this study could be due to the lack of relocation effects.

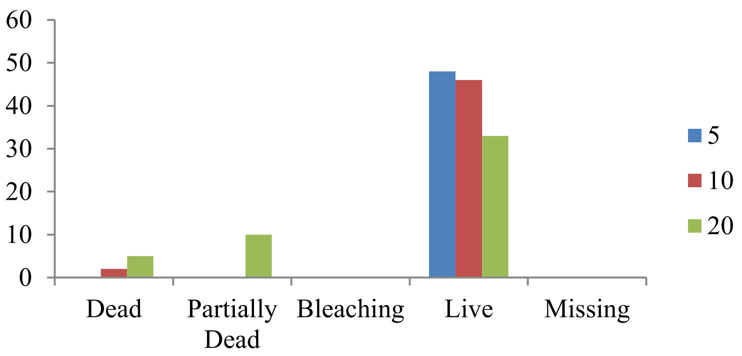

Fig. 2 Survivorship of the ramets at 20, 10, 5 meter depth

Growth Rate

First month after deployment, the ramets started to form new branches (Fig. 3). After three months, the ramets had overgrown the plastic cable ties as well as steel bars (Fig. 4).These indicates that the ramets deployed in three different depths have actually grown three-dimensionally. But, these growth rate showed no significant difference ($p=0.066$) with depth (Fig. 5). The mean growth rate at 20 m is 0.081 cm/d^{-} (SD ± 0.005) while, 10 m has a mean growth rate of 0.078 cm/d^{-} with (SD ± 0.009) and 5 m depth has a mean growth rate of 0.052 cm/d^{-} with (SD ±0.008). If computed monthly, 20 m has a mean growth rate of 0.81 cm mo^{-} while, 10 m has a mean growth rate of 0.78 cm/mo^{-} and 5 m depth has a mean growth rate of 0.52 cm/mo^{-} which is higher compared the 0.41 cm/m^{-} of the *A. grandis* and 0.23 cm/m^{-} of the *A. muricata* deployed at 8-10 m of the Andaman Sea (Putchim et al., 2007).

Fig. 3 Ramets forming new branches

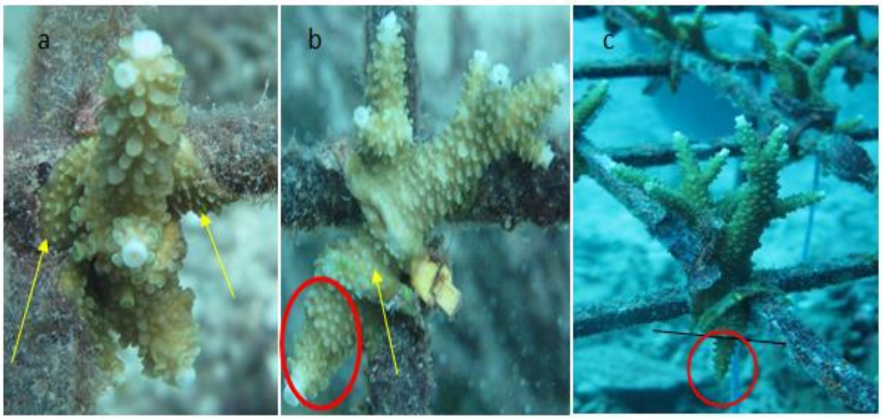

Fig. 4 Ramets overgrowing the steel bar and cable ties

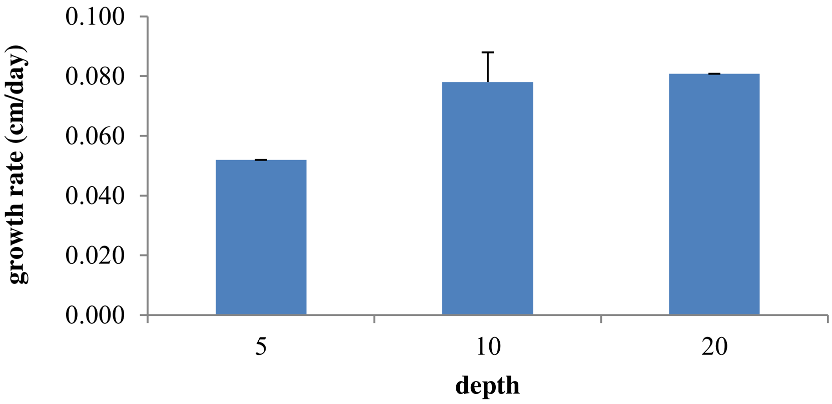

Fig. 5 Growth rate at 20, 10, 5 meter depth

CONCLUSION

In view of the results and discussion, the following generalizations are drawn:

1. Fix-to-bottom framework type is an ideal technique in doing coral reef restoration as it can eliminate the natural predators (e.g., crown of thorns, corralivore snails) from eating the corals that causes mortality to the nurseries. Secondly, it requires lesser maintenance compared to other types of nurseries.
2. Broken live fragments that measures 5 cm (SD±0.05) used as initial growth can give an assurance that the transferred ramets can survived and healed when attached to the nurseries.
3. Ten meter depth is so far the most ideal in doing coral reef restoration using *Acropora nobilis* due to its fast growth rate and less mortality rate.

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