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Corals Transplantation Using Rack and Substrate Method at Badul Island Ujung Kulon, Indonesia

[Lily Surayya Eka Putri and Fahri Fahrudin]

***Abstract*----Coral transplantation had been conducted to soft coral *Sarcophyton* sp. dan *Nephthea* sp. using rack and substrate method at Badul Island, Ujung Kulon, Indonesia. The research aimed at comparing survival rate and growth rate by both transplanted soft corals. It was found that both soft coral had 100% survival rate, but *Nephthea* transplants grew faster than *Sarcophyton* transplants. *Nephthea* transplants had 11,33 mm of width growth and 15,16 mm of length growth. *Sarcophyton* transplants showed less width and length growth, that was 9,76 mm and 7,37 mm. Overall, the transplants could grow on rack and concrete substrate and reached 100.81 mm (*Nepthea*) and 54.41 mm (*Sarcophyton*) in length. Nephtea transplants grew on vertical pattern while *Sarcophyton* sp grew horizontally. Therefore it can be concluded that rack and concrete substrate can be used as alternative media for soft coral transplantation.**

***Keywords*---coral transplantation, survival rate, growth rate, *Sarcophyton* sp., *Nephthea* sp.**

I. Introduction

Coral reefs are one of the most potential biological resource which have both ecological and economical values. Indonesia is the largest country with abundant small island more than 17.000 islands [1,2,3], located at Seribu Island district which remained 7% of coral reefs in a good condition [2].

Lily Surayya Eka Putri
Biology Department, Faculty of Science and Technology, State Islamic University Syarif Hidayatullah
Indonesia

Fahri Fahrudin
Biology Department, Faculty of Science and Technology, State Islamic University Syarif Hidayatullah
Indonesia

Antrophogenic factors are the most common threats for degradation of coral reefs, including catchment uses that result in degraded water quality, unsustainable and destructive fishing, less law enforcement [4,5,6,7]. Rural fishing communities are implicated in routine practices that break and kill corals, leading to serious coral reef decline [7]. Among these problems are blast fihing [8] fishing net damage [7], anchor damage [8], and dredging and sand mining [7].

Badul Island is one of buffer zone located at Ujung Kulon National Park. Local people living in this buffer zones area generally have less or even no attention to the preservation of marine resources, such as catching fish by using bombs and poisons (blast fishing) causing considerable damage to the coral reef area [9]. The blast fishing has serious negative impacts on corals leading to mass fragmentation of coral skeleton and only several months can survive [10]. Fortunately, the location of Badul island is far away from the town and so difficult to reach it. Thus, less tourists come to this island so that the impacts of tourisms activities is still low, as it is perfect location for pilot study of coral transplantation.

Several studies of coral transplantation had been conducted on *Acropora* sp [11,12]; and stone corals [6,13]. Most of them are stony coral fragments. Less studies were published concerning to transplantation of soft coral fragments.

Soft coral transplantation was chosen in this study because cultivation is easy to do, the time required is not very long and high success rate as long as placed at suitable cultivation sites. Besides, artificial substrate is also needed to support development of corals. Abillity to avoid abrasion, dislodgement and transport due to water movement is exactly required by artificial substrate [14]. It can be used rubble coral [11,15], or attached to rack [12]. This study was used concrete media to hang coral fragments and then analyze survival and growth rate of soft coral, *Sarcophyton* sp. and *Nephthea* sp. This study is usefull for various parties for rehabilitation of damaged coral reef ecosystems.

II. Materials and Method

This study was conducted over four months at Badul Island, Ujung Kulon, Pandeglang, Banten Province. Study site was located on the southern side of Badul Island, Ujung Kulon – Banten. Artificial substrates used were rack and concrete and placed into two different depths (7 m and 10 m), representative of shallow and deep water. There were two racks each for the two coral species. Each rack contains 20 fragments of samples. The distance between the racks was approximately 50 cm

The method used in this study was the rack/shelf and substrate. In this method (shelf and the substrate) materials and equipment used in the form of rack were made of concrete with a length of 100 cm, 50 cm width and 30 cm high. While the substrate width, length, and thickness were 5 cm, 10 cm and 2.5 cm. The distance of each fragment of coral was approximately 15 cm.

Live fragments of *Sarcophyton s*p. and *Nephthea* sp. from healthy colonies were obtained using a pair of pliers which were collected from depth of 3-4 m at Cimarende coast, 3-4 km distance from the study side . They were trimmed to the required length on the parent colonies. All fragments were transported to the study site location carefully using plastic bucket contaning water to prevent stress on the reef. Afterward, each fragments were placed on the cement substrate and bound to the substrate by using ribbon net. Cement substrates have previously had been tied by ribbon attached nets. The total sample size was 20 fragments in 7 m and 20 fragments in 10 m. We use scuba gear to dive at certain experimental site to put construction in position.

For calculation of survival rates, the number of surviving fragments at post-research was divided by the number of surviving fragments at pra-research multiplied by 100%. Moreover, for calculating growth rates it uses mathematical formula as below [6], both vertical and horizontal growth:

$$\beta = Lt - Lo$$

Where: β: growth rate of transplanted coral fragment; $L_{:}$ lenght/width of fragment after time to I; L_o: length/width of fragment at time to 0.

Meanwhile, for calculating the growth based on length or width of soft coral fragment considers with this equation [13] :

$$\alpha = \frac{Li + 1 - Li}{ti + 1 - ti}$$

Where α: growing length or width fragment; $L_{i+1:}$ average of fragment length or width at time to i+1; L_i: average of fragment length or width at time to I; $t_{i+1:}$ time to i+1; and t_i : time at i.

Water condition was also measured once every month including temperature, salinity, and current velocity. Finally, data was analyzed by t-test method to know the differences of survival and growth rate between *Sarcophyton* sp. and *Nephthea* sp.

Figure. 1. Site study: Badul Island at Ujung Kulon National Park

III. Results and Discussion

In a number of experiments, the transplants were increasing their length over time. Some fragments were also increasing the number of branches indicating that they can grow on the substrates. The stability of the rubble which is created by the net is suitable for coral transplantation. In this experiment, all the transplants survived until the forth month of transplanted activity. They all have 100% of survival rate and it can be said that transplantation process was sucessful. According to [16], coral transplantation declared successful if survival rate of transplanted coral fragments reaches more than 50%.

In the process of coral transplantation, the most important thing is the process of attachment to the substrate made of coral fragments. In addition, the carrying capacity or environmental factors also contribute significantly in the process of coral transplantation. If a fragment of rock has been strongly attached to the substrate, then the success rate is quite high indicated with high living coral fragments. This occurs in the transplanted soft corals which the process of placing the substrate fast enough. *Sarcophyton* sp. needed time to stick to the substrate approximately 12 days, while *Nepthea* sp.was at day 14th and at that time majority of the fragments has been attached to artificial substrates. It was meant that *Sarcophyton* sp. and *Nepthea sp.* have a high adaptability. If the rock fragments can not adapt well, then the fragment will be easy to get stress which was indicated with mucus discharge, so it is difficult to stick to the rock fragments on artificial substrates.

The corals transplant showed different growth pattern. *Sarcophyton* sp. transplants grew horizontally, while *Nephthea* sp. transplant tended to grow vertically.

During the research, the wide growth of *Sarcophyton* sp. was greater than the length growth whereas *Nephthea* sp. was lower (Table 1).

TABLE 1. GROWTH OF THE FRAGMENTS (mm)

Parameter	month	*Sarcophyton* sp	*Nephthea* sp
Width Growth	July-Aug	11,61	16,42
	Aug-Sept	8,68	8,00
	Sept-Oct	8,99	9,57
Total		**29,28**	**33,99**
Average		**9,76**	**11,33**
Length Growth	July-Aug	7,74	25,54
	Aug-Sept	7,5	10,14
	Sept-Oct	6,86	9,80
Total		**22,1**	**45,48**
Average		**7,37**	**15,16**

Growth of the transplanted coral fragments will vary, depending on the species of corals, the colony form and branching, the size of the fragment, and the condition of aquatic environment. Influence of various factors will give different responses to the behavior of coral colony growth. A species of corals from the same genus can have different growth forms varied. One type is the same but occupy different areas will have a different colony morphology [6].

Growth pattern *Sarcophyton* sp. tends to horizontal growth due to several factors. The main factor is the nature of its growth that usually grows wider. In this study, the growth pattern of *Sarcophyton* sp. The other is the water depth in the study sites that can be reach 10-70 m where less sunlight penetrate into the water. The light was the important factor for the coral growth [17]. The growth of corals in shallow water tends to move upward. In the living coral in the deeper waters of coral growth tend to move sideways [11].

In July the length of *Sarcophyton* transplants was 31.39 mm and *Nephthea* was 55.46 mm. In August the length of *Sarcophyton* transplants was 39.25 mm and *Nephthea* was 80.89 mm. In September the length of *Sarcophyton*. Transplants reached 47.60 mm and *Nephthea* was 91.01 mm. In October, the end of study, the length of *Sarcophyton* transplants was 54.41 mm and *Nephthea* reached 100.81 mm. At the first time of study, there was no significant difference in growth rate between the transplants ($p>0.05$), but it was significantly different on August, September and October observation.

The width growth of *Sarcophyton* transplants, at the end of the study (October), reached 71.77 mm while *Nephthea* sp. was 73.32 mm. There was no significant difference statiscally ($p>0.05$).

Thus, it can be assumed that the transplants were increasing their length over time indicating that they can grow on the substrates. The average transplants growth was 0.0737-0.1516 cm/month in 10 m depth. Compared to other studies which used the hard coral, this result was relatively low. It was reported that Acropora increased their length by 0.88 cm/month [13], 1.1 cm/month [18], 1.14 cm/month (3 m) and 0,76 cm/month [19], and 0.374 cm/month [20]

Differences in the increment of transplants were caused by environmental factors that were always changing. So, it is difficult to quantify that the substrate affect the transplants growth. According to Suharsono [21], the main factors influencing the spread and intensity of coral reef growth include temperature, light, oxygen and water clarity. Environmental factors are always affect the growth and development of corals. The transplants have higher survival and growth when the water quality is good [22]. Yap and Molina [23] stated that chemical pollution or anthropogenic activities may have negative impact to the growth and survival of corals. The good water quality is very important for transplants survival [22].

Survival and growth of corals is strongly influenced by environmental conditions of the waters. Coral requires specific environmental parameters such as salinity, temperature, light intensity, and speed of flow to grow and develop properly. From the results of field observations, environmental conditions in the waters enough to support the research sites for the development and growth of the transplanted corals. Environmental parameters contained in the study area is relatively stable.

During the study, the weather in surrounding area of study several times change, and it affected the growth of transplants. Average water temperature in the study site was between 28-30°C with relatively low volatility of 2^{o}C. According to Supriharyono [24], the suitable temperature for the growth of corals are between 25-29^{o}C.

After corals transplantation conducted for four months, it looks incredibly different where many marine biotas come and live in the study site. It means that the more corals alive in the area, the more biota will live and it will increase marine diversity.

IV. Conclusion

There was no significant differences on survival rate of transplanted *Sarcophyton* sp. and *Nephthea* sp., indicating that the rack and concrete substrate can be used as alternative media for soft coral transplantation. Otherwise for growth rate it was different between both transplanted soft corals ($p<0,05$). *Nephthea* sp. grew faster than *Sarcophyton* sp.

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