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Effect of Light Intensity on Growth Rate and Survival of *Euphyllia paradivisa* Coral Ex-Situ

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Abstract. Coral reef ecosystems are vulnerable to damage. The rehabilitation process naturally takes a long time. This study aims to determine the growth rate and survival of Euphyllia paradivisa corals ex-situ at PT Agung Aquatic Marine, Bali. Seawater used in the aquarium has very maintained water quality to keep the corals alive even though they are outside their natural habitat. This research employs an experimental method, with data analysis conducted using the independent sample T-test. We collected data eight times, once every two weeks for four months. Each of the six aquariums, comprising three with sunlight treatment and three with LED light, houses 10 transplanted corals. A caliper is used to measure the width and height of the corals. The growth rate of Euphyllia paradivisa corals under different treatments (sunlight vs. LED light) was determined by analyzing the results. There is a significant difference in the width and height of Euphyllia paradivisa corals. The growth rate of Euphyllia paradivisa corals in ex-situ under the treatment of sunlight is 0.016 mm wide and 0.017 mm high per month, and then in the treatment of LED light, the growth rate of Euphyllia paradivisa corals in ex-situ is 0.009 mm wide and 0.007 mm high per month. The growth rate of Euphyllia paradivisa corals in ex-situ with sunlight treatment is better than LED light treatment.

Keywords*: *Euphyllia paradivisa; coral growth; ex-situ; sunlight; LED light

I. INTRODUCTION

Coral reefs are very diverse and have an important role in maintaining environmental balance. Indonesia has about 16% of the world's coral reefs [1]. Corals are animals that live individually or in groups. In general, corals have a mouth located at the top and surrounded by tentacles, as well as polyps that are shaped like tubes. Indonesian waters are at the center of the Coral Triangle, which is a coral reef area with a high index of coral reef diversity (most abundant) in the world. Indonesia has a coral reef area of 39,583 km^2 [2].

Natural factors such as rising sea water temperatures due to global warming are also the cause of coral reef destruction in the world, including in Indonesia [3]. Light intensity is one of the limiting factors for coral reef life [4]. Brightness intensity related to light intensity certainly impacts the growth rate; the intensity of light that penetrates the water will decrease with increasing depth [5]. The difference in light intensity that reaches coral reefs will affect the rate of photosynthesis and the formation of calcium carbonate in coral growth by Zooxanthella [6]. Coral animals have a compensation point for light around 200-700 footcandles, or equivalent to 2152.8-7534.7 lux [7]. High intensity of light can cause excess energy absorbed by Zooxanthella so that it can disable the photosynthetic system, while low light received will reduce the rate of photosynthesis. Low light intensity can inhibit Zooxanthella photosynthesis, so that the ability will be reduced in producing calcium carbonate, reef formation, and coral color [8]. Corals that lose Zooxanthella in coral reefs will lose about 75-79% of their food source [9]. Light absorption is determined by the duration of light intensity. Coral reefs are vulnerable to unstable conditions such as climate change and changes in light intensity in their natural habitat.

Coral transplantation is an effort to restore coral reefs through grafting or cutting live corals to be planted in other locations. One of the problems in coral transplantation activities is the selection of

transplantation locations. The area chosen to conduct coral transplantation activities must take into account the physical and chemical conditions of the waters [10]. This aims for the recovery or formation of natural coral reefs. The process of repairing or rehabilitating naturally on coral reefs whose habitat conditions have been damaged is relatively very long and requires environmental conditions that are truly suitable and undisturbed by human activities.

It is very important to know about the growth rate and survival of *Euphyllia paradivisa* corals ex-situ. In this case, this research needs to be conducted outside the original coral habitat as an alternative to cultivating marine corals by utilizing the intensity of sunlight and LED light.

II. METHODS

Time and Place of Research

The research was conducted for 4 months, starting from October 2022 to January 2023. The research location is PT Agung Aquatic Marine, an exporter of marine biota. The marine biota that is kept there are ornamental fish and coral reefs.

Experimental Design

The method used in this research is the experimental method. This study used 2 treatments, namely treatment A (Sunlight) and treatment B (LED Light), with 3 repetitions.

Data Analysis

The data used a correlation test for analysis, carried out obtained a value called the correlation coefficient [14]. Also, the data used T-test is a test method with independent variables that have a significant or insignificant influence on the dependent variable [15].

The data used in this research are Absolute Growth, Growth Rate, and Survival Rate. Then, the data will be tested using the Independent T-test method using the SPSS application with a confidence level of 95%. The calculation of absolute growth value can be calculated using the formula:

$$\beta L = Lt - Lo$$

βL = Absolute growth in height
Lt = Average height at the end of the research
Lo = Average height at the beginning of the research

The calculation of the growth rate value can be calculated using the formula:

$$P = \frac{Lt - Lo}{t}$$

P = Length/height gain of corals
Lt = Average length/height after the time observation
Lo = Average length/height at the beginning of the research
t = Observation time (month)

The calculation of the Survival Rate value can be calculated using the formula:

$$SR = \frac{Nt}{No} \; x \; 100\%$$

SR = Survival rate (%)
Nt = Number of individuals at the end of the research
No = Number of individuals at the beginning of the research

III. RESULTS AND DISCUSSION

Absolute Growth

Absolute growth of *Euphyllia paradivisa* corals for 4 months in Ex-situ showed different results between sunlight and LED light treatments. The absolute growth of coral width and height of *Euphyllia paradivisa* coral with sunlight treatment is 0.06 mm and 0.067 mm for 4 months in Ex-situ. While in the LED light treatment, the absolute growth of width and height of *Euphyllia paradivisa* coral was 0.03 mm and 0.029 mm for 4 months Ex-situ (Figure 1). This is possible because of the light intensity that different corals receive.

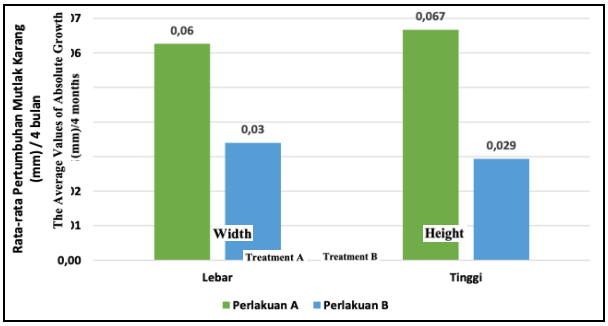

Figure 1. Average Value of Absolute Growth

Growth Rate

Sunlight treatment A has an average growth rate of 0.016 mm per month in width and 0.017 mm per month in height. Then, the LED light treatment B has an average value of the growth rate of width in the aquarium, which is 0.009 mm, and height is 0.007 mm per month (Figure 2). Light contributes to coral growth through the life of Zooxanthellae microsymbionts that live inside coral polyps. Almost 90% of food comes from photosynthetic products of Zooxanthellae [10]. The correlation of sunlight intensity to coral width growth is 80%, and coral

height growth is 85%. It can be said that sunlight intensity makes corals have vertical growth.

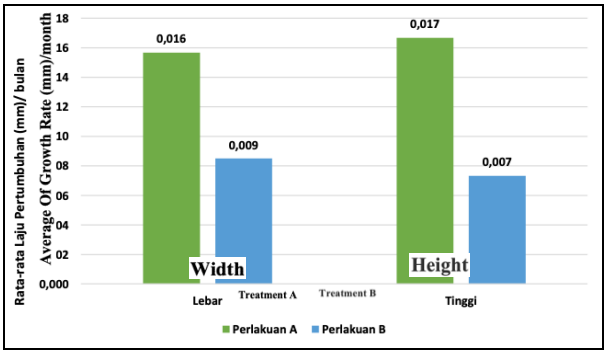

Figure 2. Average Coral Growth Rate

Meanwhile, the correlation between LED light intensity and coral width growth is only 9%, and coral height is 18%. The role of Zooxanthellae is not only in providing food intake to corals, but also helps in the process of forming calcium carbonate frames. The ability of corals to absorb calcium is optimal during the day until the afternoon compared to at night [11].

TABLE I
INDEPENDENT T-TEST DATA

Comparator Type	Variable	Criteria	Result	Descrit
Significance Comparison	Coral Width	Significance	0.001	Sig < α
		Confidence level: 95%	0.05	
	Coral Height	Significance	0.01	Sig < α
		Confidence level: 95%	0.05	

Survival Rate

Ex-situ survival *of Euphyllia paradivisa* corals for 4 months with a total of 10 corals in each aquarium. Sunlight treatment with aquarium A has a survival rate of 87% because 4 corals die. Meanwhile, LED light treatment with aquarium B has a coral survival rate of 97% because there is 1 dead coral (Figure 3).

The variation in coral survival rates is due to environmental factors that are disturbed by human activities, causing corals to experience stress and death. Stress on corals can lead to fading coral colors known as bleaching. The effects of external and internal factors are influenced by physiological conditions and activities that affect metabolism, growth, behavioral responses to the environment, and reproductive biology [12]. The presence of macroalgae that grow around the fragments affects the survival rate of corals. Macroalgae may outgrow corals due to competition, which is usually won by macroalgae. Huge biomass of macroalgae may cover corals and thus have an effect similar to the covering of corals by large sediment particles [13].

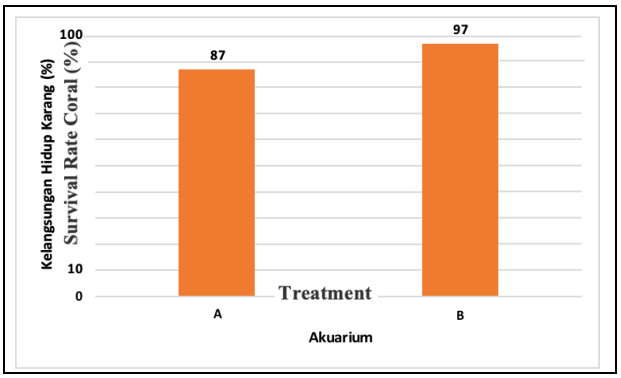

Figure 3. Average Value of Survival Rate (%).

IV. CONCLUSION

The effect of the sunlight intensity on the growth of *Euphyllia paradivisa* has better results than the LED light intensity. The difference in results is shown from the growth rate, absolute growth, and survival rate of *Euphyllia paradivisa*, which is reared ex-situ. However, further research is recommended to control and set the light intensity in the LED light treatment.

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