GROWTH RATE OF TWO CORALS SPECIES UNDER DIFFERENT NATURAL LIGHT INTENSITIES IN A PROPAGATION TANK

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ABSTRAK

Tiga spesies karang, dua terdiri daripada karang keras, *Porites* sp. dan *Pavona* sp., satu karang lembut, *Sinularia* sp. telah dibiak menggunakan tiga rawatan keamatan cahaya yang berbeza iaitu satu lapis jaring horticulture, dua lapis jaring horticulture dan tiga lapis jaring horticulture di dalam tiga tangki yang berbeza. Kajian ini dijalankan untuk menentukan keamatan cahaya yang manakah dapat meningkatkan kadar pertumbuhan karang. Kajian ini juga dijalankan untuk melihat perbezaan kadar pertumbuhan karang dibawah keamatan cahaya yang berbeza. Karang lembut dan keras dibiak selama empat minggu. Ukuran-ukuran seperti berat basah, berat di udara, lebar dan panjang karang diukur pada setiap minggu. Setiap rawatan antara tidak menunjukkan perbezaan yang signifikan (p>0.05). *Sinularia* sp. menunjukkan kadar pertumbuhan tertinggi dalam minggu ke 3 dibawah rawatan satu lapis jaring horticulture (2.0538 Gday⁻¹), *Porites* sp. menunjukkan kadar pertumbuhan tertinggi dalam minggu ke 2 dibawah rawatan dua lapis jaring horticulture (5.1333 Gday⁻¹), dan *Pavona* sp. menunjukkan kadar pertumbuhan tertinggi dalam minggu pertama dibawah rawatan satu lapis jaring horticulture (4.4762 Gday⁻¹). Kajian ini menunjukkan bahawa karang-karang yang mendapat keamatan cahaya yang bersesuaian akan meningkatkan kadar pertumbuhan karang.
ABSTRACT

Three species of corals, two are hard coral, *Porites* sp. and *Pavona* sp., one soft coral, *Sinularia* sp. was propagated using three different type of natural light intensities treatment which are one layer of horticulture net, two layers of horticulture net, and three layers of horticulture net in three different tanks. This study is to determine at which light intensity promotes the best growth rate of the corals. This study also looks at the comparison of the growth rate of the corals under the different light intensity. The corals were propagated for four weeks. The corals is measured weekly for the wet weight, wet in the air, width and height. The growth rate of the three species of the corals is measured weekly. Every treatment between species shows no significance difference (p>0.05). *Sinularia* sp. shows the highest growth rate in week 3 under one layer of horticulture net treatment (2.0538 Gday\(^{-1}\)), *Porites* sp. shows the highest growth rate in week 2 under two layers of horticulture net treatment (5.1333 Gday\(^{-1}\)), and *Pavona* sp. shows highest growth rate in week 1 under one layer of horticulture net treatment (4.4762 Gday\(^{-1}\)). This study showed that corals that get appropriate light intensity will increase the growth rate.
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CHAPTER 1

INTRODUCTION

1.1 Hard Coral

Corals can exist as individual polyps or in colonies and communities that contain hundreds to hundreds of thousands of polyps. Coral polyps are multicellular and their cells exhibit specialization to perform various function. Unlike other Cnidarians, corals show very limited of organ development. They share two anatomical features with other Cnidarians, which are a gastrovascular cavity (simple stomach) that opens only on one end, and a ring of tentacles.

Hard corals, also known as scleractinian or stony corals that produce a rigid skeleton made of from calcium carbonate (CaCO$_3$) in crystal form called aragonite. Anatomic structure such as septa, tentacles and mesenteries are found in sets of six. Therefore, hard corals are also often termed as hexacoral. Hard corals are the primary reef-building corals. Living corals grow on top of the skeleton of their dead predecessors.

Hard corals that form reefs are called hermatypic coral. Other stony coral species are incapable to produce sufficient qualities of calcium carbonate to form reefs. Many of these corals do not rely on algae metabolites produced by zooxanthellae, and live in deeper or colder water. The rate at which a stony coral colony lays down calcium carbonate depends on the species, but some of the branching species can increase in height or length as much as 10 cm a year. Other corals, like the dome and plate species
are more bulky and may only grow 0.3 cm to 2 cm per year.

1.2 Soft coral

Soft coral, also known as ahermatypic coral, do not produce a rigid calcium carbonate skeleton. They do not form reefs though they may be present in a reef ecosystem. The term 'soft coral' was given because these corals have numerous tiny and needle-like spicules in their tissue. Soft corals have a leathery appearance and form numerous broad, lobed or finger type branches attached to a stalk. Soft coral are mostly colonial.

Soft corals are classified under subclass Octocorallia together with gorgonians and sea pens. Most soft corals are under the order Alcyonacea containing family Xeniidae, Neptheidae, and Alcyoniidae. Family Alcyoniidae contains genera Sinularia sp., Sarcophyton sp. and Lobophyton sp.

Anatomic structures such as tentacles and mesenteries are found in sets of eight, so soft corals are often called octocorals. Soft coral contain spiny skeletal elements called sclerites in the cells on the outside of the colony. Sclerites are found in jelly-like tissue, called coenenchyme. Sclerites are made of protein and calcium carbonate and give soft coral support to allow them achieve their vertical structures. The sclerites also give grainy texture to soft coral surface.

1.3 Porites sp., Pavona sp., and Sinularia sp.

Porites sp. also known as boulder corals or pore corals and they form large massive colonies covered in irregular lumps. The growth rate of Porites sp. coral is very slow, perhaps only nine millimeters a year. Therefore, these coral colonies may be up to 1,000 years old, and the oldest life forms on earth (Veron, 1986). These species are very hard to distinguish underwater, and can only be separated on internal characteristics such as septa inside the small polyps. Corallites are small and embedded and the color is
typically pale brown, purple – blue, and grey colonies are also can be found. *Porites* sp. corals can be found in a wide range of coral environments. Many *Porites* sp. coral are very common in shallow water, and most species are tolerant of areas where sediment accumulates (Veron, 2000).

*Cavona* sp. is a scleractinian coral, meaning that it is hard coral with a limestone skeleton (Willis and Ayre, 1985). It is pale brown or greenish-brown in color and typically has thin, upright fronds and twisted branches. They may develop thicker fronds when growing in shallow areas with strong wave. *Pavona* sp. may grow as an isolated colony or may form large colonies that can cover ten meters. *Pavona* sp. can be found in lagoons and on the upper slopes of reefs, where there is a slight current (Erhardt and Moosleitner, 1998), as well as turbid waters protected from waves.

*Sinularia* sp. is also known as Finger Leather Coral, Knobby Leather Coral and Ruffled Leather Coral. *Sinularia* sp. have a stalk with tree-like branches, and form little branch from it. The branches have small autozooid polyps which have ability to fully retract. Their polyps usually embedded in the surface of the stalk itself. Several species are considered as a reef building as they encrust over most surfaces and sclerite will fuse together near their base. In addition, *Sinularia* sp. is one of the largest, most toxic genera of all soft corals and most predominant, forming low, flat, fingered, and encrusting colonies. *Sinularia* sp. is frequently the most common soft coral in the shallow waters. They are an extremely hardy soft corals that are able to withstand massive pruning and growing at surprising rates in the aquarium.
Photo 1.3 (a) *Porites* sp.

Photo 1.3 (b) *Pavona* sp.

Photo 1.3 (c) *Sinularia* sp.
1.4 The Importance of Light for Coral

Survival of corals is strongly influenced by light. Most popular reef aquariums contain corals that photosynthetic and depend on proper illumination for their growth and sustenance. Most of the symbiotic corals derive their nutrition from the products of photosynthesis. Since the late nineteenth century, biologist knew about existence of zooxanthellae, the single celled algae which reside in the coral’s gatroderm. By using the energy trap in sunlight, zooxanthellae were able to convert carbon dioxide and water into organic molecules and oxygen. If too little light is provided, the algae produce fewer nutrients for the corals and limiting the growth of the corals. While, if too much light is provided, the algae may damage themselves and their host by the production of oxygen radicals.

1.5 Objectives

The objectives of the study are:

i. To compare the growth rates of two corals species under the different natural light intensity.

ii. To determine at which light intensity promote the best growth of the two corals species.

1.6 Hypotheses

i. *Sinularia* sp. has a faster growth rates compared to *Porites* sp. and *Pavona* sp.

ii. The two corals species that gets enough light intensity shows a good growth rates.
1.7 Significance of Study

The significance of this study is to determine at which light intensity promote the best growth of the selected hard corals. The aim of coral propagation is to maximize the growth rate of hard corals. Stony corals are in high demand especially in the ornamental aquarium industry. Therefore, faster growth stony corals are required. Every sector wants to maximize their profit in a business. In order to make it happen, one could increase their market price or decrease the cost of the production. Besides that, the study can be linked with what happen in natural environment, which is the effect of availability of sunlight on coral growth. By determining the suitable light intensity that can enhance the hard coral growth, the cost of production could be determined. Hence, if the cost of production is low, the ornamental aquarium industry will gain a lot of benefits as they could minimize their coast and also decrease the period for the corals to grow, matured and harvested.
CHAPTER 2

LITERATURE REVIEW

2.1 Coral Reef Status

Coral reefs provide important ecosystem services, including income from tourism and food from small-scale fisheries as well as coastal protection against extensive erosion (Sutthacheep et al., 2013). Coral reefs, popularly termed as Earth’s marine rainforest, are highly productive ecosystem with annual gross production rates in the range of 2000 – 5000 gcm\(^{-2}\) obtained through efficient retention and recycling of nutrients (Mann, 1982). Although coral reefs are economically significant resources to most tropical countries, they are among the most vitally threatened ecosystem on the globe.

The world trade value of the aquarium industry in 1995 was estimated between US 4 to US 15 billion with plant and animal sales alone estimated about US 900 million. Marine species make up only 9% of the aquarium per trade, but due to high value represent 20% of livestock revenues. The keeping of marine aquaria, especially they so-called “reef tanks” which contained live corals, is a rapidly growing sector of the aquarium industry. This expansion primarily attributed to recent advances in technology that does not allow corals and other marine invertebrates to thrive in home aquarium. The world trade value of the aquarium industry in 1995 was estimated between US$ 4 to US 15 billion with plant and animal sales alone estimated about US 900 million.
2.2 Coral Propagation

Coral propagation in closed seawater system has commonly used, as it is simple in process and cost effective (Borneman, 2001). Propagation of coral can replant the propagated fragment into the wild, reduce the impact of wild coral harvesting and can be used to find medical value in the selective propagated coral all this would save the further destruction of the coral reef ecology (Schalacher et al., 2007). Fragmentation of coral and mariculture are two main basic form used to propagate coral (Green and Shirley, 1999). Coral propagation has been commonly used for the production of daughter colonies, rather than harvesting naturally grown ones (Soong and Chen, 2003; Fox et al., 2005).

One approach gaining acceptance is the use of coral colonies for active reef restoration (Rinkevich, 1995). The coral gardening methodology involved three stages: (1) the initial collection of limited amount of coral biomass from wild or propagated population; (2) the grow out of the coral fragment within a nursery setting; and (3) the out planting of nursery-reared coral to depleted or damaged reef (Shafir et al., 2001; Shafir and Rinkevich, 2008; Rinkevich, 2006; Epstein et al., 2003). While recently gaining wider acceptance, the science of coral reef restoration is still in its early stages, and science-based guidelines for reef restoration methods are needed to evaluate the impact and effectiveness of propagation and restoration approaches (Precht, 2006).

One of the largest knowledge gaps and a source of criticism for reef restoration programs is the potential negative effect of fragmentation on parent colonies (Forsman et al., 2006). For a coral restoration and propagation program to be successful, it is required to minimize the impacts of collection on the parent stock, and after some period of recovery, resulted in a net increase in tissue and skeleton production through the aggregate growth of the donor colonies and the coral propagules extracted from the parents stock (Lirman et al., 2010).
2.3 The Importance of Light in Corals Culture

Successful coral culture is influenced by numerous factors, such as water movement (Riegl et al., 1996), temperature (Shella and Benayahu, 2010), nutrients and heterotrophic feeding (Ferrier – Pages et al., 2003; Houlbreque and Ferrier – Pages, 2009; Orejas et al., 2011), and light (Schalacher et al., 2007). Light is considered as one of the most important factors influencing coral production ex situ. The cost associated with the implementation of lighting system, maintenance, and electrical power consumption play a key role on the economic viability of coral aquaculture (Osinga et al., 2011).

In addition, the intensity and spectral quality of light largely affect the efficiency of photoautotrophic processes (Khalesi et al., 2009). Shift in light regimes are known to condition the density of symbiotic zooxanthellae, the concentration of photosynthetic pigments and their photosynthetic efficiency (Lesser et al., 2010). Besides that, light regimes also affect the contribution of zooxanthellae for coral growth, metabolism (Apprill et al., 2007), physiology and survival (Venn et al., 2008).

2.4 Factors Affecting the Growth of Corals

2.4.1 Light

Previous studies have indicated that the various parameters can affect the growth of coral, including light (Meesters et al., 1994), temperature (Yap and Gomez, 1984), and sedimentation and water movement (Montebon and Yap, 1995). Yap et al., (1998) used stepwise multiple regression analysis indicated that light to be the only variable significantly related to coral growth rather than other than parameters. This outcome similar to Guzman and Cortes (1989), which was studied on coral in Costa Rica where transplanted coral grew significantly faster at 1m depth than at 10m depth. It showed that light significantly affect the coral growth.
2.4.2 Water Flow

Previous studies have indicated that the water flow speed will affect the growth of the coral. In nature, water flow depends on wave action and the wind speed. In a closed system tank, the speed of water flow can be controlled by regulating the outflow of the water. The water flow will affect the particle capture, nutrient uptake, respiration and the photosynthesis of the corals (Sebens et al., 1996). Water flow enhanced photosynthesis process through symbiotic algae and increased respiration rates of coral tissue as well as growth rate, calcification and uptake of dissolved nutrients. The optimum velocity is $11 \text{ cms}^{-1}$. Other than that, water flow is the most important factor that affects coral morphology.

2.4.3 Nutrient Content in Seawater

There are several ways nutrification may poorly affect coral and coral reef ecosystem. Nutrient enrichment in ecosystem may enhance algal growth. Over the past 50 years, an increase in nutrient concentration has been observed in several reef systems (Ferrier-Pages et al., 2003). Besides that, increase in nutrients loads have been recognized as a major threat to reef. In actual, how reefs respond to the increase of nutrients is poorly understood.
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