

Effect of Light on the Growth of Four Corals Species in Land-Based Nursery Systems

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ABSTRACT

Globally, coral reefs are becoming increasingly threatened by biological and physical factors. Florida's coral reefs have suffered considerable loss from a variety of impacts including dredging, ship groundings, pollution, illegal collecting and harsh weather conditions. Restoring damaged coral sites has been limited by the availability of coral colonies. Recent efforts have shown that many corals can be fragmented and grown successfully in land-based and ocean-based nursery systems. The potential for nursery systems to provide coral colonies for restoration provides a critical tool for conservation of these valuable ecosystems. In this study, we examined the effect of light on growth with four important reef-building corals in the Florida Keys: *Acropora cervicornis*, *A. palmata*, *Montastraea annularis*, and *M. cavernosa* were raised in an environmentally-controlled, recirculating aquaculture system to determine optimal light level for growth of each species. Corals of each species were secured at 6 different light levels in three 378-L tanks. Relative change in surface area was measured using digital images that were analyzed using an image analysis program. The 12-week experiment was conducted in fall 2008 and spring 2009 (n=6). We found light levels between 38 – 44 $\mu\text{mol m}^{-2} \text{s}^{-1}$ resulted in the highest growth of *A. cervicornis* colonies, whereas light levels above 49 $\mu\text{mol m}^{-2} \text{s}^{-1}$ resulted in reduced growth rates. Alternatively, *A. palmata* experienced the highest growth rates under light levels ranging from 49 – 60 $\mu\text{mol m}^{-2} \text{s}^{-1}$, compared to levels above 76 $\mu\text{mol m}^{-2} \text{s}^{-1}$ and below 44 $\mu\text{mol m}^{-2} \text{s}^{-1}$. *M. annularis* and *M. cavernosa* showed no clear pattern of growth in response to the light levels examined in this study. These data indicate that *A. cervicornis* colonies grown in laboratory or aquaria conditions should be cultured at light levels below 49 $\mu\text{mol m}^{-2} \text{s}^{-1}$, while *A. palmata* colonies should be exposed to light between 49 – 60 $\mu\text{mol m}^{-2} \text{s}^{-1}$. Understanding the parameters that promote the highest growth and survival of corals in captivity will benefit future coral aquaculture, restoration, and conservation efforts.

INTRODUCTION

Globally coral reefs have undergone drastic declines due to environmental and biological factors. Ever-increasing loss of coral species and cover in reef systems has led to increased efforts to conserve and restore these valuable ecosystems.

Production of corals in land and ocean based nursery systems to restore damaged and declining reef systems represents a viable tool to assist conservation efforts and reduce the overall loss of corals, while also reducing the time required for successful reef restoration.

Although the number of reef restoration projects is increasing globally, as well as in the Florida Keys National Marine Sanctuary (FKNMS), information on methodology for laboratory and/or large-scale culture techniques to produce Atlantic scleractinian coral colonies remains insufficient.

In this study we examined the effect of light on growth of four important reef-building corals in the Florida Keys: *Acropora cervicornis*, *A. palmata*, *Montastraea annularis*, and *M. cavernosa* raised in indoor aquaria to determine the optimal light levels for growth of each species.

METHODS

Growth rates for each coral species was assessed over a 12-week period in fall 2008 and spring 2009 in environmentally-controlled, recirculating aquaculture systems at Mote Marine Laboratory's Tropical Research Laboratory in Summerland Key, Florida, USA.

During each experimental trial coral fragments species were secured at 6 different light levels in 3 closed-system aquaria (1 coral per light level per aquarium, n=6) (Fig. 1a and 1b).

Each aquarium was equipped with a 250W metal halide light that provided an average light level of:

- 103 $\mu\text{mol m}^{-2} \text{s}^{-1}$ on the highest tier
- 76 $\mu\text{mol m}^{-2} \text{s}^{-1}$ on the second highest
- 60 $\mu\text{mol m}^{-2} \text{s}^{-1}$ on the third highest
- 49 $\mu\text{mol m}^{-2} \text{s}^{-1}$ on the fourth highest
- 44 $\mu\text{mol m}^{-2} \text{s}^{-1}$ on the fifth highest
- 38 $\mu\text{mol m}^{-2} \text{s}^{-1}$ on the deepest tier

Surface area was measured using digital photography and SigmaScan® imaging software. Photographs and surface area measurements were repeated after 12 weeks.

Percent change in surface area was square root transformed and analyzed using a one-way analysis of variance (ANOVA).

RESULTS & DISCUSSION

Although no significant differences in growth were found among the 6 light levels for any of the 4 species analyzed (*A. cervicornis*, *A. palmata*, *M. annularis*, and *M. cavernosa*), several trends were identified (Fig. 2).

- Growth of *A. cervicornis* was highest under light 38 – 44 $\mu\text{mol m}^{-2} \text{s}^{-1}$, whereas light $\geq 49 \mu\text{mol m}^{-2} \text{s}^{-1}$ resulted in reduced growth rates
- Growth of *A. palmata* was highest under light 49 – 60 $\mu\text{mol m}^{-2} \text{s}^{-1}$, compared to light $\geq 76 \mu\text{mol m}^{-2} \text{s}^{-1}$ and $\leq 44 \mu\text{mol m}^{-2} \text{s}^{-1}$
- *M. annularis* and *M. cavernosa* showed no clear pattern of growth in response to light



Figures 1a & 1b. Indoor tank setup at Mote's Tropical Research Laboratory at the beginning (1a; left) and end of a 12 week trial (1b; right). Coral species from left to right: *Montastraea annularis*, *Acropora cervicornis*, *Acropora palmata*, *Montastraea cavernosa*. Numbers represent light readings ($\mu\text{mol m}^{-2} \text{s}^{-1}$) next to each colony (1b).

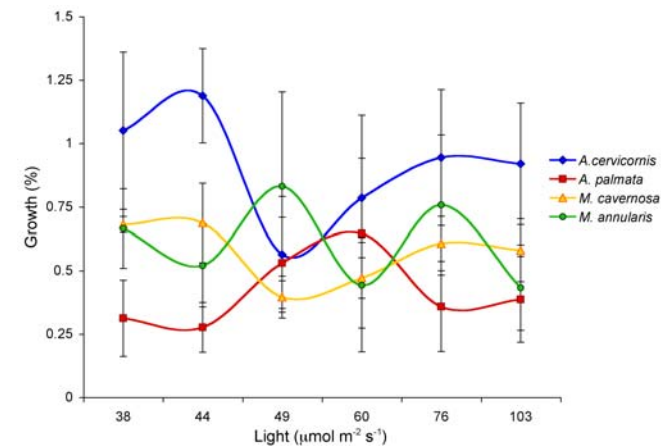


Figure 2. Percent (+/- SE) change in weight over time (growth) of *Acropora cervicornis*, *A. palmata*, *Montastraea annularis* and *M. cavernosa* based on light level ($\mu\text{mol m}^{-2} \text{s}^{-1}$).

These data indicate that *A. cervicornis* colonies grown in laboratory or aquaria settings should be kept under light levels below 49 $\mu\text{mol m}^{-2} \text{s}^{-1}$, while *A. palmata* colonies should be exposed to light between 49 – 60 $\mu\text{mol m}^{-2} \text{s}^{-1}$. While *M. annularis* and *M. cavernosa* did not exhibit a pattern of growth in response to light, consistent growth under all light conditions indicate that these species are ideal for production in aquaria. Understanding the parameters that promote the highest growth and survival of corals in captivity will benefit future coral aquaculture, restoration, and conservation efforts.

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