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Determining genotypic response of *Acropora cervicornis* to ocean acidification

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ABSTRACT

There is growing evidence that genotypes within coral species can vary greatly in their response to rising temperatures and ocean acidification. To evaluate the effect of elevated pCO_2 exposure on the growth of the coral *Acropora cervicornis*, we monitored 180 individual fragments snipped from 23 parents held at a constant temperature of 30ºC for 10 months in one of two target pCO_2 levels: ambient seawater (about 400ppm) and a scenario projected to occur by the end of the century (about 1000ppm). CO_2 enrichment significantly slowed the growth of 16 of the tested genotypes, with the most sensitive genotype experiencing a 54% reduction in growth in CO_2 enriched seawater. However, other genotypes proved to be more tolerant to higher concentrations of CO_2 and actually grew faster in CO_2 enriched seawater. One genotype showed a 28% increase in growth in more acidic water. It is predicted that ocean acidification could have a significant effect on growth and survivorship of calcifying corals like *A. cervicornis* in the future.

OBJECTIVE

The aim of this study is to investigate the effects of elevated pCO_2 (1000ppm) on the calcification rates of specific genotypes of *Acropora cervicornis*

INTRODUCTION

- Increased heat stress in ocean environments has proven to be a huge threat to coral reefs, resulting in significant loss and bleaching [1]
- It is much less understood the effects of increased anthropogenic CO_2 and ocean acidification on corals, particularly the reduction in their ability to calcify
- Slower calcification could result in longer periods of time until juvenile corals reach sexual maturity and reduced reproduction [2]
- Specific genotypes have been identified as more resistant to higher temperatures, but not higher acidity
- Restoration efforts to ensure survival of coral species include growing corals in nurseries and out-planting them on reefs. Out-planting genotypes identified as more resistant to warmer, more acidic ocean waters should improve the success of these restoration efforts.

METHODS

- 146 fragments were collected sourced from two Rescue a Reef nurseries along the Florida Reef tract from 23 presumptive genotypes (Fig.1)
- Corals were distributed between three control tanks with ambient/ low CO_2 exposure (400ppm) and three treatment tanks with high CO_2 (1000ppm) twenty coral fragments in each tank. All tanks were maintained at a constant temperature of 30± 0.1ºC.
- Measurements of buoyant weight were taken on a weekly basis over a 10 month period. The change in buoyant weight and the density of the calcium carbonate skeleton and seawater were used to calculate calcification rates.
- The surface area for each coral fragment was calculated using the "wax dipping" method [3].
- Data analyses were conducted using R software and Microsoft Excel

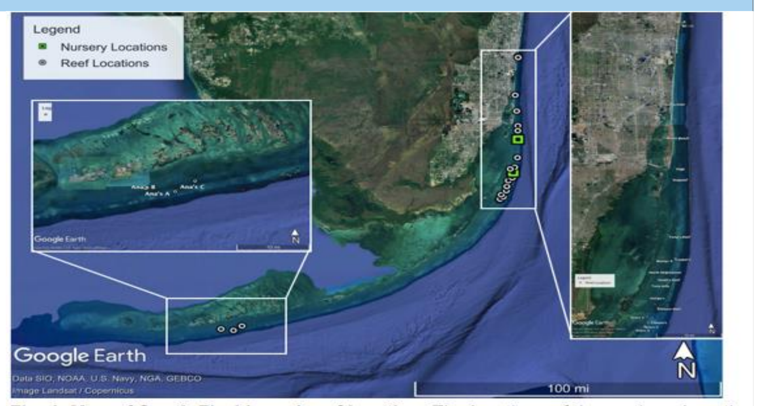

Fig. 1. Map of South Florida and reef location. The locations of the north and south nursery sites are depicted using green squares. White circles represent the origin reefs of nursery-reared corals between Broward County and the Lower Florida Keys.

RESULTS

- A one-way ANOVA test found that CO_2 had a statistically significant effect on calcification rate when all genotypes were pooled by treatment ($F=533$, $P<1e-16$).
- Mean calcification rate (mg cm^{-2} d^{-1}) of corals by treatment were as follows (mean ± SD): 0.73 ± 0.14 (1000ppm) and 1.02 ± 0.20 (400ppm)
- A two-way ANOVA showed that there was a significant interaction between CO_2 and genotype ($F=4.5$, $P<3e-11$).
- A Tukey post-hoc means test showed that CO_2 significantly reduced the calcification of some genotypes and increased for others.
- The log response ratio (lnRR) reports the ratio of the rate under high CO_2 to the rate at ambient CO_2.
- Figure 2 shows a histogram of lnRR values for all genotypes measured in the study (n=23). The data show that the distribution of the effect of 1000ppm CO_2 on calcification of *A. cervicornis* genotypes is slightly skewed to negative values of lnRR.
- The average effect is a 18% (95% CI -38% to -12%) reduction in the rate of calcification
- Figure 3 shows the lnRRs for the same ten genotypes ordered from most negatively to most positively effected by elevated CO_2.

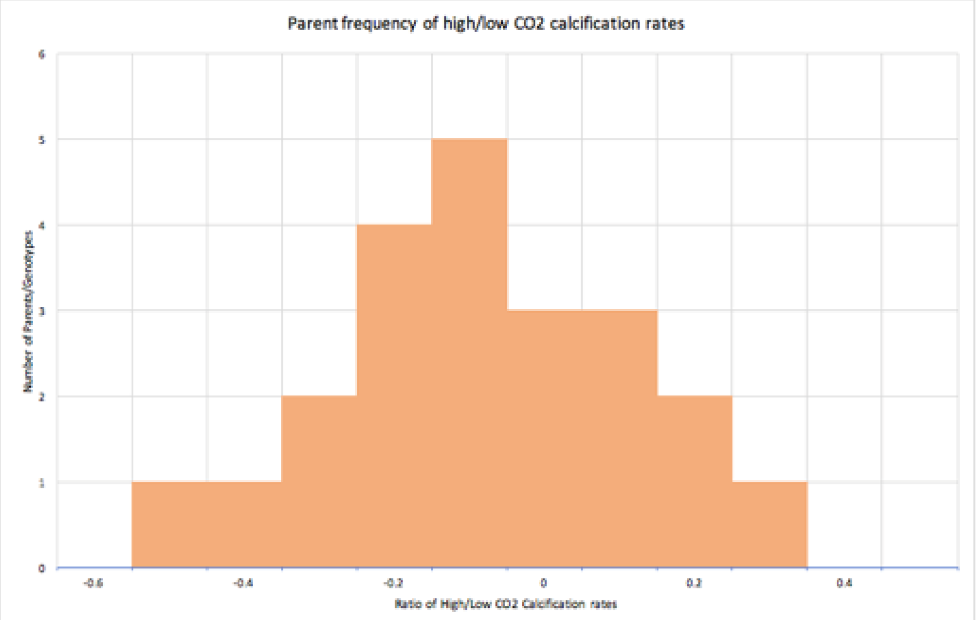

Fig. 2. Calcification log response ratio distribution of genotypes of *A.cervicornis*. N=23

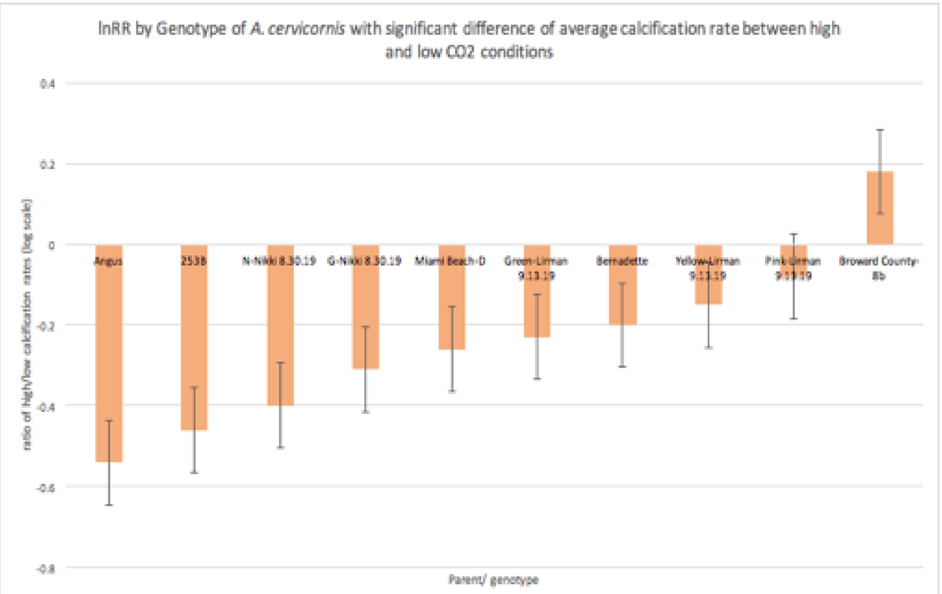

Fig. 3. Log response ratio rate of each genotype with a significant difference in calcification between high and low CO2 conditions.

DISCUSSION

- High CO_2 can reduce the calcification rate of many genotypes within the species *A. cervicornis*.
- **A statistically significant reduction in the calcification rate of corals was observed, averaging 18% slower growth in high CO_2 conditions**
- Reduced growth and calcification would significantly reduce the colony sizes of corals and their strength.
- Predicted end-of-century levels of CO_2, will cause ocean acidification to a degree not seen in human existence [4]
- The consequences of this could be detrimental to the future of coral reefs and their reliant species
- The genotypes Pink-Lirman and Broward County-8B were **least** affected by elevated CO_2 based on their significant difference in growth between high and low CO_2 conditions and ability to have a positive calcification ratio.
  - Broward County-8B was able to calcify 18% faster in high CO_2 conditions than in ambient CO_2
- **The strongest candidate genotypes for out-planting and coral gardening would need to be resistant to ocean acidification and bleaching.**[5]

REFERENCES

1. Hughes et al., 2017, 2018a, 2018b
2. Sabine et al., 2011
3. Stimson and Kinzie, 1991.
4. Collins et. al., 2013
5. Hesley et. Al., 2017

ACKNOWLEDGEMENTS

Special thanks to Dr. Chris Langdon, Dr. William Drennan, Dr. Diego Lirman, and Dr. Liza Merly for their advising in this project. Thanks to Emma Pontes, Hannah Babbitz, Khadija Haider, Kelly McLoughlin, and Nicole Krampitz for assistance in the lab.