Effects of Heat Temperature Stress on Coral's Symbiotic Algae Fluorescence Signature

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Abstract

Human and environmental factors such as climate change, can increase the sea surface temperature of the ocean, meaning oceanic life, specifically corals, are at high risk. Although coral reefs harbor a tremendous amount of biodiversity and contribute to medical and economic success, approximately 80% of corals have already undergone coral bleaching[1]. Coral bleaching damages the coral host fluorescence, which is a good indicator of their health according to previous work by Roth *et al*. 2013. Moreover, heat stress damages the symbiotic relationship between the coral and the algae. This can eventually lead to the death of the the coral, depending on the duration of the heat stress. In order to better understand the relationship between coral bleaching and fluorescence, we needed to test if the coral's symbiotic algae fluorescence was a proficient indicator of coral bleaching. We hypothesize that the algae fluorescence will be a good indicator of coral bleaching, and we expect the algae fluorescence to decrease as the coral bleaches since the algae will be expelled from the coral's gastrodermal cells. Furthermore, the corals are expected to bleach due to the heat stress and potentially die, effectively demonstrating the adverse effects of heat temperature stress on corals. Statistical analyses will also be performed to further validate the use of the algae fluorescence as a good indicator of coral bleaching.

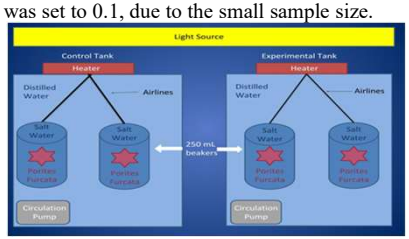
Introduction

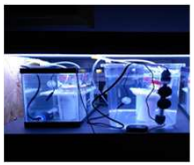
- Corals are both plant, mineral, and animal.
- Although they make up 1% of the ocean floor, they provide homes for aquatic life and are credited with economical success and medical advances.
- We are currently still in the third global coral bleaching event, which began back in mid-2014 (NOAA Coral Reef Watch).
- Corals already live near their thermal boundary limit, so as little as a 1°C increase in heat can cause them stress.
- Monitoring the fluorescence of the coral's symbiotic algae could provide a non-invasive way to survey corals health.
- Our objective is to determine whether algae fluorescence can be used to evaluate coral bleaching.

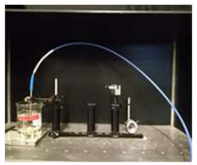
Methods

- Since algae fluorescence is more intense than the host fluorescence, it could easily be measured.
- We used the Caribbean coral, *Porites furcata*, and conducted a laboratory based heat stress experiment in which the temperature began at 26°C, and progressively increased from 32°C to 34°C over the course of 5 days.
- Each day fluorescent measurements were taken with an Ocean Optics USB 2000+ spectrometer and recorded.
- Using the statisitcal software R, the Mann-Whitney U-Test was used to compare the control and heat experimental groups. The p-value showed the statistical significance of the data.
- The alpha value was set to 0.1, due to the small sample size.

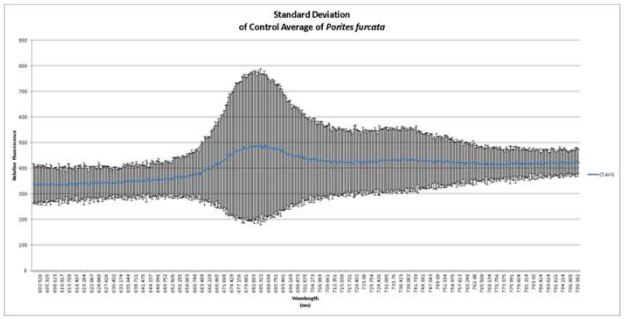
♦ Schematic of the experimental set-up

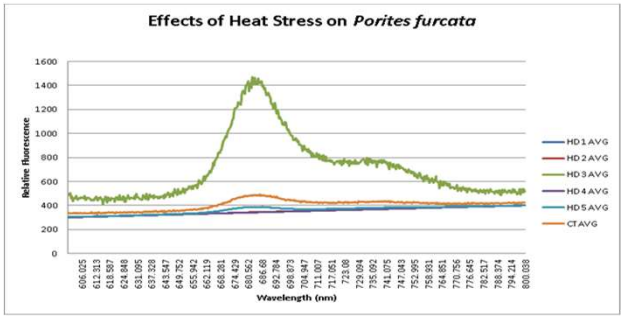






Results





♦ Graph depicting the algae fluorescence from days 1 to 5 of the experiment.

Discussion

- By Day 3, the coral had the highest fluorescence, implying that the coral could have been trying to combat the heat stress before it died.
- Since the ecological role of coral fluorecence is still not known, this could be due to the coral bleaching by the heat stress, causing it to fluorece before it dies.
- However, in this case, because none of the p-values were below 0.1, the values did not show any statistical significance. The closest statistical significance was found on Day 3.
- The standard deviation of the control avergages revealed a lot of variation between the control measumrents, and this could be due to *P. furcata* having a porous, yet very dense skeleton that can cause a lot of light to scatter, and can introduce more noise into the measurements.
- Overall, algae fluorescence is a good indicator of coral health.
- Due to the limited time, this experiment could have been improved if we had more time and a larger sample size.

Future Work

- Regarding future work, more time and a larger sample size would have yielded possibly statistically significant data.
- Working with another species and performing a cold stress experiment to compare and contrast between the heat stress would have been beneficial.

Heat Stress P-Values for *Porites furcata*

DAY	680(nm)	730(nm)
1	0.6667	0.3333
2	0.6667	0.6667
3	0.6667	1
4	1	0.6667
5	0.6667	0.3333

♦ P-values from the Mann-Whitney U-Test comparing the control and heat experimental groups from wavelengths 680 and 730 nm, which were the peaks that are associated with algae fluorescence.

Acknowledgments

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References

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