

Assessing Symbiont Responses to Heat Stress in *Acropora pulchra*

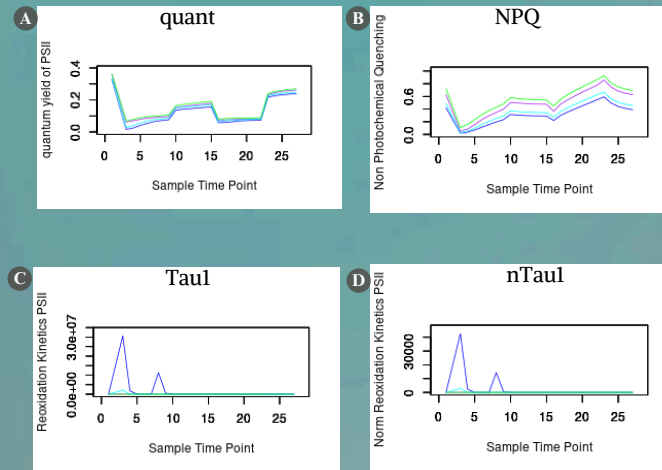
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Introduction

Coral reefs are vital to island ecosystems such as Guam, providing habitat, coastal protection, and cultural value. However, rising sea surface temperatures driven by climate change have intensified coral bleaching events, threatening reef biodiversity. Bleaching occurs when corals lose their algal symbionts (Symbiodiniaceae), which are essential for photosynthesis and energy production. Understanding how coral-algal partnerships respond to heat stress is crucial for developing adaptive management strategies. This study examines *Acropora pulchra*, to determine how its symbionts respond to thermal stress through changes in chlorophyll-a fluorescence, photosynthetic efficiency, and photoprotective mechanisms. By identifying fluorescence-based indicators of resilience, this work contributes to predicting bleaching vulnerability and improving restoration approaches for Guam's reefs.

Materials & Methods

1. *Acropora pulchra* fragments were collected from Urunao Beach.
2. Coral fragments were transported to a controlled laboratory environment. Corals were then exposed to increasing temperatures, reaching 32–34 °C, to simulate thermal stress. The temperature of the tanks were controlled with aquarium heaters. Light and flow conditions were maintained to replicate natural reef environments. As these factors influence coral resilience to thermal stress (Darling et al., 2012)
3. A single-turnover fluorometer was used to assess symbiont health through:
 - Maximum quantum yield (Fv/Fm): Indicator of photosynthetic efficiency.
 - Rapid light curves (RLCs): Response to variable light exposure.
 - Non-photochemical quenching (NPQ): Photoprotective mechanisms (Hoadley et al., 2023).
4. Statistical tests were used to compare fluorescence parameters and mortality rates across treatments. Findings with this experiment will help identify thermal resilience biomarkers, supporting coral conservation and restoration efforts in Guam.



- Figure A. Baseline measurements of photosynthetic efficiency in *Acropora pulchra* fragments under ambient conditions. Coral fragments maintained consistent energy production, indicating healthy symbiont function and stable light response prior to heat exposure.
- Figure B. Change in energy dissipation over the five-minute light-response test. Gradual increases indicate activation of photoprotective processes as corals adjusted to changing light conditions.
- Figure C. Baseline reoxidation kinetics of Photosystem II showing rapid electron flow at the start of light exposure, followed by stabilization. These patterns reflect normal, active photosynthetic activity in unstressed coral fragments.
- Figure D. Variation in electron transport responses among fragments under baseline conditions. Early peaks represent brief adjustments to light exposure, while stable values over time suggest healthy symbiont performance prior to heat stress treatment.



Figure 1. Experimental setup used to assess coral thermal response. *Acropora pulchra* fragments were placed in separate tanks with controlled temperature, light, and flow conditions. Fragments were gradually exposed to 32–34 °C to simulate heat stress. A single-turnover fluorometer was used to measure photosynthetic performance and symbiont health throughout the experiment.

Objectives

- Determine how *Acropora pulchra* symbionts respond to elevated sea surface temperatures through changes in chlorophyll-a fluorescence, photosynthetic efficiency, and physiological shifts. Rising ocean temperatures are a primary driver of coral bleaching, as they disrupt the coral-algal symbiosis and lead to the loss of dinoflagellate endosymbionts (Symbiodiniaceae) (Raymundo et al., 2017).
- Investigate potential differences in symbiont functional traits across coral genets under thermal stress.
- Detect fluorescence-based indicators of symbiont stress response and resilience to heat stress.

Discussion

Baseline data show that *Acropora pulchra* fragments were photosynthetically healthy under normal temperature conditions. Corals maintained stable energy production, suggesting that the symbiotic algae were functioning efficiently and adjusting well to the laboratory environment. Small variations among fragments likely reflect natural genetic or symbiont differences, confirming that all samples began in a healthy, unstressed state.

After two weeks of exposure to 32–34 °C, photosynthetic performance is expected to decline as heat disrupts energy transfer between coral and algae. The algae may become less efficient at processing light and shift toward protective pathways that release excess energy as heat. Prolonged stress could lead to bleaching if the coral expels its symbionts and becomes more vulnerable to mortality.

Fragments that maintain stronger photosynthetic activity or recover more quickly after heat exposure are likely more thermally resilient. Recognizing these differences helps identify stress-tolerant genets and supports coral restoration and conservation efforts in Guam's reef ecosystems.

References

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