Physiological response of eight Palau coral colonies to thermal stress as seen in temperature experiments in 2014 and 2015

Website: https://www.bco-dmo.org/dataset/862346
Data Type: experimental
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Project
» Collaborative Research: Stability, flexibility, and functionality of thermally tolerant coral symbioses (Thermally tolerant coral)

Contributors	Affiliation	Role
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Abstract
Physiological dataset for Palauan corals. 15 day experimental treatments carried out in 2014 and 2015.

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Coverage

Spatial Extent: **N**:7.541333 **E**:134.822333 **S**:7.248833 **W**:134.235817
Temporal Extent: 2014 - 2015

Methods & Sampling

Sampling and analytical procedures:

Coral Collection: A total of 8 colonies of each species were collected at each site at a depth between 5–10 meters (offshore) or 1–5 meters (Inshore) and at least 10 meters apart. Differences in collection depth were necessary due to the natural distribution of these species at each site and in order to ensure all colonies were collected from similar light conditions (maximal mid-day *in situ* light of 800-1000-µmol quanta m-2 s-1). Colonies were transported back to the Palau International Coral Research Center (PICRC) and fragmented into five replicate nubbins and placed into a 1200L flow-through aquarium and held at 27.5°C. Seawater was collected directly off of a nearby pier at a depth of 3 m and then passed through a pressurized sand filter and aquarium filter pads prior to use in flow-through and experimental treatment systems. Coral nubbins were attached to 2-inch square PVC tiles with marine epoxy (Splash zone compound A-788) and held at ambient

conditions in flow-through bins as described above for 12-16 days prior to the start of the experiment. Control and experimental bins (see below) were maintained outdoors underneath clear plastic film (Sun Selector, Ginegar Plastic Products) to block periodic rainfall and a 60% shade cloth providing a peak midday light intensity of 800 µmol quanta m-2 s-1, as measured with a light sensor (LiCor LI-192).

Experimental System: Each treatment system consisted of 7–12 (56 L) plastic treatment bins connected to a central (~1200 L) sump. Seawater within each sump was set to either heated or ambient temperature conditions prior to being sent to the treatment bins. Ambient temperature was maintained via a chiller system and a series of titanium heating elements were used for high temperature treatments. For each treatment, three replicate fragments from each colony were placed within separate treatment bins. For the heated treatment, the temperature was gradually ramped from 27.5°C to 32°C over 4 days, and then maintained at 32°C for an additional 10 days for a total of 14 days of heating. Temperature within the control treatment was maintained at 27.5°C throughout the 14-day experiment. Treatment bins and PVC tiles were cleaned every other day to prevent algal fouling, and coral fragments were rotated within their respective bins every other day to ensure a uniform light exposure and minimize possible tank effects.

At the start of the experiment (day 0), one fragment from each coral colony was removed from control and treatment tanks and processed for symbiont photo-physiology and biomass metrics (described below). Additional fragments were then sampled on days 9 (4 days of temperature ramping + 5 days at 32°C) and 14 (4 days of temperature ramping and 10 days at 32°C). Coral tissue was removed by airbrush (100 psi) with filtered (0.22 m) seawater. The resulting slurry was homogenized with a Tissue Tearor (BioSpec products, Inc), and then divided into 2 mL aliquots. One aliquot was preserved with 1% glutaraldehyde for cell enumeration and stored at 4°C. All other aliquots were centrifuged for 2 minutes (5,000×*g*) and the supernatant was discarded. Algal subsamples from each colony were suspended in DNA preservation buffer (Seutin et al. 1991) and stored at 4°C. The remaining algal samples were immediately frozen (-20°C) and shipped back to the United States and stored at -20°C until further analyses.

Remaining information on procedures can be found in Hoadley et al., 2019.

Data Processing Description

BCO-DMO processing:
- Variable/parameter names modified to fit BCO-DMO protocol
- xxxxx
- xxxxx

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Related Publications

Hoadley, K. D., Lewis, A. M., Wham, D. C., Pettay, D. T., Grasso, C., Smith, R., Kemp, D. W., LaJeunesse, T. C., & Warner, M. E. (2019). Host–symbiont combinations dictate the photo-physiological response of reef-building corals to thermal stress. Scientific Reports, 9(1). https://doi.org/10.1038/s41598-019-46412-4
Methods

Seutin, G., White, B. N., & Boag, P. T. (1991). Preservation of avian blood and tissue samples for DNA analyses. In Canadian Journal of Zoology (Vol. 69, Issue 1, pp. 82–90). Canadian Science Publishing. https://doi.org/10.1139/z91-013
Methods

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Parameters

Parameters for this dataset have not yet been identified

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Instruments

Dataset-specific Instrument Name	airbrush
Generic Instrument Name	Airbrush
Dataset-specific Description	Coral tissue was removed by airbrush (100 psi) with filtered (0.22 m) seawater.
Generic Instrument Description	Device for spraying liquid by means of compressed air.

Dataset-specific Instrument Name	Flow-through aquarium
Generic Instrument Name	Aquarium
Dataset-specific Description	Coral colonies were fragmented into five replicate nubbins and placed into a 1200L flow-through aquarium and held at 27.5°C
Generic Instrument Description	Aquarium - a vivarium consisting of at least one transparent side in which water-dwelling plants or animals are kept

Dataset-specific Instrument Name	chiller system
Generic Instrument Name	Aquarium chiller
Dataset-specific Description	Ambient temperature was maintained via a chiller system
Generic Instrument Description	Immersible or in-line liquid cooling device, usually with temperature control.

Dataset-specific Instrument Name	titanium heating elements
Generic Instrument Name	Immersion heater
Dataset-specific Description	a series of titanium heating elements were used for high temperature treatments
Generic Instrument Description	Submersible heating element for water tanks and aquaria.

Dataset-specific Instrument Name	LiCor LI-192
Generic Instrument Name	LI-COR LI-192 PAR Sensor
Dataset-specific Description	Light intensity measured with a light sensor (LiCor LI-192).
Generic Instrument Description	The LI-192 Underwater Quantum Sensor (UWQ) measures underwater or atmospheric Photon Flux Density (PPFD) (Photosynthetically Available Radiation from 360 degrees) using a Silicon Photodiode and glass filters encased in a waterproof housing. The LI-192 is cosine corrected and features corrosion resistant, rugged construction for use in freshwater or saltwater and pressures up to 800 psi (5500 kPa, 560 meters depth). Typical output is in um s-1 m-2. The LI-192 uses computer-tailored filter glass to achieve the desired quantum response. Calibration is traceable to NIST. The LI-192 serial numbers begin with UWQ-XXXXX. LI-COR has been producing Underwater Quantum Sensors since 1973. These LI-192 sensors are typically listed as LI-192SA to designate the 2-pin connector on the base of the housing and require an Underwater Cable (LI-COR part number 2222UWB) to connect to the pins on the Sensor and connect to a data recording device. The LI-192 differs from the LI-193 primarily in sensitivity and angular response. 193: Sensitivity: Typically 7 uA per 1000 umol s-1 m-2 in water. Azimuth: < ± 3% error over 360° at 90° from normal axis. Angular Response: < ± 4% error up to ± 90° from normal axis. 192: Sensitivity: Typically 4 uA per 1000 umol s-1 m-2 in water. Azimuth: < ± 1% error over 360° at 45° elevation. Cosine Correction: Optimized for underwater and atmospheric use. (www.licor.com)

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Project Information

Collaborative Research: Stability, flexibility, and functionality of thermally tolerant coral symbioses (Thermally tolerant coral)

Coverage: Coral Reefs of Palau, Micronesia

NSF abstract:

All reef-building corals require large numbers of internal symbiotic microalgae (called Symbiodinium) for their survival and growth. These mutualisms have shown considerable sensitivity to changes in the environment in recent decades, especially due to global increases in ocean temperatures. When exposed to severe thermal stress, corals loose their symbionts and often die. However, recent experiments show that some symbionts may be more stress-tolerant. Corals with these heat-resistant symbionts continue to receive high amounts of algal derived nutrients and grow under elevated temperatures. If the global trend in seawater warming continues to increase, these heat-resistant symbioses may become more ecologically prevalent on reef systems around the world and could play a critical role in maintaining healthy and productive coral communities. This project will examine the ecological and physiological attributes of stress-tolerant symbioses from the Indo Pacific where coral communities are the largest, most diverse, and productive in the world. The researchers will conduct a series of experiments to (1) evaluate host and symbiont attributes that contribute to thermal tolerance and (2) characterize the relative flexibility and functionality of various corals and symbionts exposed to typical ambient and stressful temperatures. Broader impacts of the project include the training of several Ph.D. students, undergraduates, and high school students in the disciplines of physiology and ecology. The researchers will partner with Global Ocean Exploration, Inc. to communicate this research to the general public through short documentary videos, editorials, and podcasts. An interactive K-5 program, "Invertebrates on the Road," will introduce elementary students in Pennsylvania to marine invertebrate diversity. Research results will also be disseminated to the public at the University of Delaware via educational seminars, as well as through hands-on research displays and demonstrations presented at the annual open

house "Coast Day" festival in each year of the project.

This project will examine several attributes important to the functional ecology of coral-dinoflagellate symbioses. Specifically, the research team seeks to understand the interplay between coral and symbiont physiologies under different environmental conditions and determine the relative influence of biotic factors crucial to the performance of stress tolerant symbioses. Results from recent experiments on Indo-west Pacific corals found that Clade D (S. trenchii) symbionts are stress-tolerant. These symbionts are able to maintain function and provide nutrients to their hosts under high temperatures that typically elicit the breakdown of symbioses involving many other species of symbiont. A number of questions arise about how enhanced thermal tolerance symbioses may be aided by a combination of factors; for example: Are symbionts physiologically hardier in corals that are routinely feeding? Do host genotypes that are adapted to high temperatures affect the physiology of their symbionts in ways that make the partnership more stress-tolerant? A series of experiments over three years will examine the functionality of different coral-symbiont pairings exposed to ambient and high temperatures. Reciprocal transplants between inshore (stress-tolerant) and offshore (stress-susceptible) reef sites will be used to produce specific host-symbiont parings. Controlled experiments will test the relative importance of coral trophic status (nutrient content) while holding symbiont type constant and how changes in both coral trophic status and symbiont species identity of the resident affect thermal tolerance. Tank experiments on shore will track rates of photosynthesis as well as carbon translocation and assimilation from symbiont to host tissues and skeletons. Long-term growth rates via skeletal density, linear extension, and biomass gain will also be measured. This project will help elucidate how biochemical, physiological and ecological differences among host-symbiont pairings may respond to rising ocean temperatures and enhance the future viability of coral reefs.

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