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, Other Field Results
Version: 1
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Project
» Collaborative Research: The physiology and ecology of widespread 'stress tolerant' coral endosymbionts: coral 'saviors' or opportunistic invaders? (Coral Endosymbionts)

Contributors	Affiliation	Role
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Abstract
Physiological dataset for Palauan corals. 15 day experimental treatments carried out in 2014 and 2015. **** Need more information from PI/submitter! *****

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Coverage

Location: Nikko Bay and Rebotel reef in Palau
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). Sampling was performed offshore at Rebotel Reef (7.248833, 134.235817) and inshore at Nikko Bay (7.3248, 134.4934). 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.

BCO-DMO Processing Description

- Loaded data from two source files
- Combined data from two source files into a single data table
- Added columns for Latitude and Longitude corresponding to coordinates for the offshore site (Rebotel Reef) and the inshore site (Nikko Bay)

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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

Parameter	Description	Units
Year	Year of sampling	year
Location	Location of coral sampling, either offshore (Rebotel reef) or inshore (Nikko Bay)	unitless
Reef_site	Reef site that was sampled, either Rebotel Reef (offshore) or Nikko Bay (inshore)	unitless
Latitude	Latitude of reef site where sampling occurred	units
Longitude	Longitude of reef site where sampling occurred	units
local	???	unitless
Treatment	Type of treatment, either control (C), ambient, or hightemp	unitless
Host	???	unitless
Symbiont	???	unitless
Experimental_day	???	???
Colony_Fragment	???	unitless
Colony_Name_Frag_Code	???	unitless
Tau_PSII	Rate constant for reoxidation of the Qa site of the D1 protein within the PSII RC	microseconds
Tau_PQ	Rate constant for reoxidation of the plastoquinole pool.	microseconds
ETR	RCII-specific electron transport rate	moles of electrons transferred per mole of PSII reaction centers per hour (mol e- mol RCII^-1h^-1)

NPQ	Non-photochemical quenching	relative units
FvFm	Dark acclimated maximum quantum yield of PSII	relative units
Connectivity_rho	Connectivity between PSII reaction centers	relative units
Sigma	Dark acclimated effective absorption cross section of PSII	squared angstroms per quantum (Å2q^-1)
Lipid	Lipid concentration per cell	micrograms per cell (?g cell^-1)
Protein	Protein conenctration per cell	micrograms per cell (?g cell^-1)
Carbohydrate	Carbohydrate concentration per cell	micrograms per cell (?g cell^-1)
Symb_cell_volume	Symbiont cellular volume	cubic micrometers (?m^-3)
Gross_Photo	Gross algal photosynthesis	milligrams oxygen per liter per minute per cell (mg O2 L^-1 min^-1 cell^-1)
Chlorophyll_a	Chlorophyll concentration per cell	picrograms per cell (pg cell^-1)
Cell_Density	???	???
resource_name	Filenames of original data files. ** Why don't filenames indicate 2014 and 2015? **	unitless

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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	EVOS digital fluorescent microscope
Generic Instrument Name	Fluorescence Microscope
Generic Instrument Description	Instruments that generate enlarged images of samples using the phenomena of fluorescence and phosphorescence instead of, or in addition to, reflection and absorption of visible light. Includes conventional and inverted instruments.

Dataset-specific Instrument Name	BioSpec Tissue Tearor
Generic Instrument Name	Homogenizer
Dataset-specific Description	The resulting slurry was homogenized with a Tissue Tearor (BioSpec products, Inc) which is a rotor/stator type tissue homogenizer which rapidly homogenizes, disrupts, and emulsifies plant and animal samples in 0.5 - 1000 ml of liquid.
Generic Instrument Description	A homogenizer is a piece of laboratory equipment used for the homogenization of various types of material, such as tissue, plant, food, soil, and many others.

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)

Dataset-specific Instrument Name	Fibox 4 fiber optic oxygen system (PreSens)
Generic Instrument Name	Oxygen Sensor
Generic Instrument Description	An electronic device that measures the proportion of oxygen (O2) in the gas or liquid being analyzed

Dataset-specific Instrument Name	FLUOstar Omega plate reader (BMG Labtech, Germany)
Generic Instrument Name	plate reader
Generic Instrument Description	Plate readers (also known as microplate readers) are laboratory instruments designed to detect biological, chemical or physical events of samples in microtiter plates. They are widely used in research, drug discovery, bioassay validation, quality control and manufacturing processes in the pharmaceutical and biotechnological industry and academic organizations. Sample reactions can be assayed in 6-1536 well format microtiter plates. The most common microplate format used in academic research laboratories or clinical diagnostic laboratories is 96-well (8 by 12 matrix) with a typical reaction volume between 100 and 200 uL per well. Higher density microplates (384- or 1536-well microplates) are typically used for screening applications, when throughput (number of samples per day processed) and assay cost per sample become critical parameters, with a typical assay volume between 5 and 50 µL per well. Common detection modes for microplate assays are absorbance, fluorescence intensity, luminescence, time-resolved fluorescence, and fluorescence polarization. From: http://en.wikipedia.org/wiki/Plate_reader, 2014-09-0-23.

Dataset-specific Instrument Name	Fluorescence Induction and Relaxation (FIRe) fluorometer (Satlantic Inc., Halifax)
Generic Instrument Name	Satlantic Fluorescence Induction and Relaxation of Emission Spectrometer
Generic Instrument Description	The Satlantic FIRe (Fluorescence Induction and Relaxation) System is a bio-optical technology used to measure variable chlorophyll fluorescence in photosynthetic organisms. Based on the Fast Repetition Rate Fluorometry (FRRF) technique, the FIRe was developed in collaboration with Dr. Maxim Gorbunov and Dr. Paul Falkowski from Rutgers University. More information on FIRe (PDF).

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Project Information

Collaborative Research: The physiology and ecology of widespread 'stress tolerant' coral endosymbionts: coral 'saviors' or opportunistic invaders? (Coral Endosymbionts)

Coverage: Rebotel Reef and Nikko Bay in Palau

NSF Award Abstract

Ocean warming is affecting life on our planet in many ways. High temperature can disrupt the endosymbioses between dinoflagellate algae (Symbiodinium spp.) and reef-building corals (i.e. coral bleaching), thereby risking the global loss of a critical marine ecosystem. The physiological, ecological and evolutionary responses of coral-dinoflagellate symbioses to environmental stress brought on by global climate change are complex. The spread of certain types of symbiotic algae may increase the thermal stress tolerance among corals and help them persist in warmer oceans, but perhaps not without trade-offs to the health of the coral. The dinoflagellate tentatively named Symbiodinium trenchi has become increasingly more common in numerous corals throughout the Caribbean, but is often at low-abundance relative to other symbionts. While S. trenchi can increase in abundance during and after warming, it is often displaced by other symbionts following a return to normal conditions. Genetic evidence indicates that S. trenchi recently invaded and/or expanded in the Caribbean and has developed associations with many corals that seem to be poorly optimized, or mal-adapted, relative to the symbioses it maintains with corals in the Indo-Pacific. This project will investigate the symbiosis ecology and physiology of S. trenchi in corals from the Atlantic and Pacific Oceans. Bleaching experiments will examine the effects of increased temperature on transfer of carbon from the algae to the host coral (via stable isotopic tagging), as well as photosynthesis and growth among colonies harboring S. trenchi compared to colonies harboring other Symbiodinium spp. The potential for symbiont community shifts as well as altered long-term colony growth based on bleaching severity and recovery time will be investigated. A reciprocal transplant study will examine the competitive interaction and stability of symbionts among Pacific corals. These studies will test if the continued spread of S. trenchi will affect coral growth in the Caribbean and whether it might behave similarly in the Indo-Pacific if environmental conditions worsen. The results from this project have the potential to supply transformative information regarding how (or if) a widely distributed symbiotic algal species may influence the resilience of reef-building corals and their potential to survive projected increases in ocean warming due to climate change. In addition to training one postdoctoral scholar and several graduate students, this project will enhance scientific discovery and participation of underrepresented groups via several outreach efforts with the Palau National Aquarium, Palau International Coral Reef Center, and local schools. Educational units in marine symbioses and science will be developed with several local high school teachers and students, and unique research opportunities will be provided to students at the Palau Community College. Likewise, a new educational display addressing how global climate may impact coral reefs, and describing the current research to better understand the physiology of coral-algal symbioses, will be developed and presented at the University of Delaware open house "Coast Day." The display will be donated subsequently to the Palau Aquarium for future use. This award is co-funded by NSF's Office of International and Integrative Activities.

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Funding

Funding Source	Award
NSF Division of Integrative Organismal Systems (NSF IOS)	IOS-1719675
NSF Division of Integrative Organismal Systems (NSF IOS)	IOS-1258058
NSF Division of Integrative Organismal Systems (NSF IOS)	IOS-1258065

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