Coral pulse amplitude modulation (PAM) fluorometry data from a heating experiment using samples collected from Nikko Bay and Rebotel Reef in Palau in the spring of 2018

Website: https://www.bco-dmo.org/dataset/855054
Data Type: Other Field Results
Version: 1
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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
Coral reefs surrounding Palau, Micronesia are living within a broad range of thermal habitats. Specifically, corals living on the offshore barrier reefs surrounding Palau reside in waters with low temperature variability compared to the much warmer and more acidic waters of near shore environments surrounding the Rock Island habitats. This study was designed to test the differences in thermal physiology among two species of reef corals that reside at both of these locations. Specifically, we examined how short-term elevated temperature influences the photochemistry of each coral species from each location before and after heating, as measured by active chlorophyll fluorescence recorded by pulse amplitude modulation (PAM) fluorometry.

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Coverage

Location: Palau International Coral Reef Center, Koror, Palau.
Spatial Extent: **N**:7.541333 **E**:134.8223 **S**:7.248333 **W**:134.2538
Temporal Extent: 2018-05-21 - 2018-06-03

Dataset Description

This work was conducted in the island nation of Palau. Coral colonies were sampled from an inshore location (Ngermid Bay, also known as Nikko Bay) and an offshore location on the western barrier reef surrounding Palau (Rebotel Reef). Sampled colonies were returned to land and treated in a thermal experiment at the Palau International Coral Reef Center in land-based aquariums.

Methods & Sampling

Eight colonies of the coral *Psammocora digitata* and *Pocillopora verrucosa* were sampled from the offshore western barrier reef, Rebotel reef (7.248833° N, 134.235817° E) at 5–10 m depth, and from Nikko Bay (also known by Ngermid Bay, 7.3245° N, 134.4939° E) at 5 m depth. Samples were transported to the Palau International Coral Research Center (PICRC), and each colony sample was cut into nine replicate ramets that were placed in flow-through sea water tables and allowed to heal for 48 hours before mounting on labeled PVC tiles with marine epoxy (Splash zone compound A-788).

Temperature experiments were conducted in indoor aquarium systems. Each system used a semi-enclosed design that consisted of a series of 44 L plastic bins connected to a central 220 L sump that was supplied by a continuous slow-feed supply of fresh seawater. The control system (4 bins) was maintained at an average temperature of 28.27 ± 0.33°C by an in-line chiller and titanium heater. The heated system (6 bins) was ramped from 28°C to 31°C (1°C day-1) and held at 31.86 ±0.14°C by an in-line titanium heater. All bins were lighted to an irradiance of 600 µmol photons m-2s-1 by LED lights set to daily ramping. Beginning on day zero, corals were dark acclimated for approximately 30 minutes after the lights turned off and active chlorophyll fluorescence was recorded from five ramets coral colony-1 species-1 with a diving PAM fluorometer (blue LED measuring light = 6, saturation intensity = 12, saturation width = 0.8 s, gain = 4, and damping = 2) in order to calculate the maximum quantum yield of photosystem II (PSII) (Fv/Fm). Once the target high temperature was reached in the experimental bins, corals were sampled for 12 more days for active fluorescence at noon, during peak light intensity, and at night, 30 minutes after the lights had switched off .

Measurements in the light were used to calculate the effective quantum yield of PSII in the light activated state (Fq'/Fm') as well as the excitation pressure over PSII (Qm).

Instruments:

- Active chlorophyll fluorescence was recorded with a Diving PAM fluorometer (Walz, Effeltrich)
- Seawater temperature was controlled by an in-line chiller and titanium heater DeltaStar DS-3, and Cygnet Mini (Aqualogic Inc.), and light was supplied to each experimental bin by a custom LED array (XP-G3 Cool White LEDs, Cree) controlled with a digital Storm Controller(Coralux).
- Water was continuously mixed in each bin by a small submersible pump (Sicce Micra, 90 GPH).

Data Processing Description

Some parameters were calculated either directly onboard the instrument (Fv/Fm and Fq'/Fm'), while excitation pressure (Qm) was calculated as = 1 – [(Fq'/Fm')/(Fv/Fm)].

BCO-DMO Processing Description

* Added sampling latitude and longitude. Offshore – Rebotel Reef (7.248833° N, 134.235817° E), Inshore – Nikko Bay (7.3245° N, 134.4939° E)
* Adjusted parameter headers to comply with database requirements
* Converted dates to ISO format (yyyy-mm-dd)

Problem Description

Some missing data cells were due to partial mortality on that particular coral ramet at the particular sampling interval and were not used in further data analyses.

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Data Files

File
855054_v1_palau_pam.csv (Comma Separated Values (.csv), 427.22 KB) MD5:b292e7e8010e84e436e494bdfce72ff4 Primary data file for dataset ID 855054, version 1

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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

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Parameters

Parameter	Description	Units
Location_Name	Name of sampled reef	unitless
Longitude	Sampling longitude, west is negative	decimal degrees
Latitude	Sampling latitude, south is negative	decimal degrees
Species	Coral species tested. Psammacora digitata or Pocillopora verrucosa	unitless
Date	Sampling date	unitless
Day	Day of measurement from start of experiment (time zero)	unitless
Treatment	Control (=28 degrees Celsius) or Heated (=32 degrees Celsius)	unitless
Location	Original collection location. Offshore – Rebotel Reef	unitless
Colony	Colony number (1–8 for each species)	unitless
Frag	Colony fragment number	unitless
Symbiont	Symbiotic dinoflagellate ID based on ITS2 nomenclature or formal genus and species	unitless
Fq_Fm	efficiency of photosystem II in the light activated state measured by PAM fluorometer (relative units)	unitless
Fv_Fm	Maximum quantum yield of photosystem II measured by PAM fluorometer (relative units)	unitless
Qm	Excitation pressure of photosystem II measured by PAM fluorometer (relative units)	unitless

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Instruments

Dataset-specific Instrument Name	Diving PAM fluorometer (Walz, Effeltrich)
Generic Instrument Name	Fluorometer
Dataset-specific Description	Active chlorophyll fluorescence was recorded with a Diving PAM fluorometer (Walz, Effeltrich)
Generic Instrument Description	A fluorometer or fluorimeter is a device used to measure parameters of fluorescence: its intensity and wavelength distribution of emission spectrum after excitation by a certain spectrum of light. The instrument is designed to measure the amount of stimulated electromagnetic radiation produced by pulses of electromagnetic radiation emitted into a water sample or in situ.

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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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Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-1719684
NSF Division of Ocean Sciences (NSF OCE)	OCE-1635695
NSF Division of Ocean Sciences (NSF OCE)	OCE-1636022

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