Coral biometrics 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/855036
Data Type: Other Field Results
Version: 1
Version Date: 2025-03-10

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

Contributors	Affiliation	Role
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Abstract
Using samples collected from Nikko Bay and Rebotel Reef in Palau in the spring of 2018, this dataset examines coral physiology of two species of coral, Psammacora digitata and Pocillopora verrucosa, as part of a short-term heating experiment.

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Coverage

Location: Palau International Coral Reef Center, Koror, Palau.
Spatial Extent: **N**:7.3245 **E**:134.4939 **S**:7.248833 **W**:134.235817
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. On day zero and after 13 days of heating, one ramet colony-1 treatment-1 was sampled for the following biometric parameters: photosynthesis and respiration, algal symbiont density, chlorophyll a, animal protein. Algal DNA was also sampled at time zero.

For photosynthesis and respiration, corals were placed in filtered seawater (0.45µm) in sealed acrylic chambers fitted with magnetic stir bars and fiber optic oxygen sensors. Chambers were held in temperature-controlled water baths to match the respective treatment temperature. Light was provided as above at constant intensity. After respiration measurements, coral tissue was removed by airbrush with filtered seawater (0.45µm), homogenized with a hand-held grinder, and coral homogenates were sampled for algal density and preserved in 0.3% glutaraldehyde. Animal and algal fractions were separated from each other in the remaining material by centrifugation. The resulting algal pellets were resuspended and sampled for chlorophyll a, and DNA. For chlorophyll a analyses, pellets were immediately frozen at -20°C until extracted in 100% methanol and read on a plate reader at 630, 664, and 750 nm.

Instruments:

- 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).
- Coral tissue was removed with an airbrush (Paasche VL-3AS) at 100 psi and homogenized with a hand-held homogenizer (Tissue tearor, Biospec Products, Inc).
- Coral homogenates were centrifuged in a clinical centrifuge (IEC)
- Oxygen production and respiration was recorded with fiber-optic oxygen optodes (Pre-sens or FireSting).
- Algal cells were counted with a Neubauer hemocytometer on a light microscope (Fisher Scientific).
- Chlorophyll extractions and animal proteins were sampled for absorbance on a Fluostar Omega plate reader (BMG).
- Algal genomic DNA was extracted with a Wizard DNA purification kit (ProMega), and DNA sequencing was performed on using a BigDye Terminator 3.1 Cycle Sequencing Kit (ThermoFisher Scientific) at the at the Penn State University Genomics Core Facility.
- Coral skeletal surface area was quantified by 3D scanning with an HDI 120 scanner (LMI Tech Inc.).

Data Processing Description

Measured variables were typically normalized to either coral skeletal surface area or algal cell number (detailed in data Parameters description).

BCO-DMO Processing Description

* Added LSID of species to the dataset

* Converted species name to full scientific name

Problem Description

Some missing data cells were due to sample loss for that variable when samples were processed in Palau or in the U.S.

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Data Files

File
855036_v1_palau_biometrics.csv (Comma Separated Values (.csv), 12.64 KB) MD5:a3b522493ba57544a6b70a7a91822fe0 Primary data file for dataset ID 855036, 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	Location name	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
LSID	Life Science Identifiers of tested coral species	units
Date	Sampling date	unitless
Day	Day of measurement from start of experiment (time zero)	unitless

Symbiont	Symbiotic dinoflagellate ID based on ITS2 nomenclature or formal genus and species (when known)	unitless
Treatment	Control (=28 degrees Celsius) or Heated (=32 degrees Celsius)	Degrees Celcius (°C)
Colony	Colony number (1–8 for each species)	unitless
Cell_Density	Number of algal cells normalized to surface area of coral skeletal area	number of cells per square centimeter of coral
Chl_a	Weight of chlorophyll a normalized to algal cell	picograms chlorophyll a per algal cell
Host_protein	Weight of coral soluble protein normalized to coral skeletal area	micrograms soluble protein per square centimeter of coral skeleton
Gross_photosynthesis	Gross oxygen production rate normalized to algal cell and time	micrograms of oxygen per algal cell per hour
Respiration	Oxygen consumption rate normalized to coral soluble protein and time	milligrams oxygen per milligrams animal protein per hour
Photosynthesis_Respiration	Ratio based on rates of oxygen produced and consumed of whole coral fragment	unitless

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Instruments

Dataset-specific Instrument Name	
Generic Instrument Name	3D scanner
Generic Instrument Description	A 3D scan captures digital information about the shape of an object with equipment that uses a laser or light to measure the distance between the scanner and the object.

Dataset-specific Instrument Name	Neubauer hemocytometer
Generic Instrument Name	Hemocytometer
Dataset-specific Description	Algal cells were counted with a Neubauer hemocytometer on a light microscope (Fisher Scientific).
Generic Instrument Description	A hemocytometer is a small glass chamber, resembling a thick microscope slide, used for determining the number of cells per unit volume of a suspension. Originally used for performing blood cell counts, a hemocytometer can be used to count a variety of cell types in the laboratory. Also spelled as "haemocytometer". Description from: http://hlsweb.dmu.ac.uk/ahs/elearning/RITA/Haem1/Haem1.html.

Dataset-specific Instrument Name	fiber-optic oxygen optodes (Pre-sens or FireSting)
Generic Instrument Name	Optode
Dataset-specific Description	Oxygen production and respiration was recorded with fiber-optic oxygen optodes (Pre-sens or FireSting).
Generic Instrument Description	An optode or optrode is an optical sensor device that optically measures a specific substance usually with the aid of a chemical transducer.

Dataset-specific Instrument Name	Fluostar Omega plate reader (BMG)
Generic Instrument Name	plate reader
Dataset-specific Description	Chlorophyll extractions and animal proteins were sampled for absorbance on a Fluostar Omega plate reader (BMG).
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.

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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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