Stress responses of cryptic corals

Website: https://www.bco-dmo.org/dataset/997032
Data Type: Other Field Results
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Project
» Collaborative Research: How do selection, plasticity, and dispersal interact to determine coral success in warmer and more variable environments? (Palau coral selection plasticity dispersal)

Contributors	Affiliation	Role
Grupstra, Carsten G.B.	Boston University (BU)	Principal Investigator
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Abstract
This dataset contains coral bleaching, photochemical efficiency (Fv/Fm), and mortality data collected during a controlled thermal stress experiment on cryptic lineages of massive Porites corals from Palau, Micronesia. Coral colonies representing three genetically distinct lineages were collected from classic and extreme reef environments and fragmented for a 25-day common-garden heat challenge. Fragments were held in flow-through aquaria under control or elevated temperature regimes that simulated natural warming and acute heatwave conditions. Photosystem II photochemical efficiency (Fv/Fm) was measured daily or semi-daily after dark acclimation to quantify symbiont photosynthetic stress. Bleaching was assessed from standardized photographs analyzed for changes in colony coloration (paling) through time, and fragment survival was monitored throughout the experiment. These data provide a high-resolution time series of physiological and demographic responses to heat stress, enabling comparisons of thermal tolerance among cryptic coral lineages that dominate extreme reef habitats. This dataset supports research on coral resilience, thermal adaptation, and holobiont physiology under climate-driven warming and is associated with the manuscript "Holobiont traits shape climate change responses in cryptic coral lineages" (Grupstra et al., 2024, Global Change Biology).

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Coverage

Location: Rock Islands of Palau
Spatial Extent: **N**:7.36722 **E**:134.4766 **S**:7.16162 **W**:134.34922
Temporal Extent: 2022-04-26 - 2022-05-21

Methods & Sampling

Colonies resembling the gross morphology of *Porites lobata* Dana, 1846 were tagged at six sites, at the Rock Islands of Palau, in November 2021 in a transect along the shoreline (N=15 per site, 90 colonies total). All colonies were sampled using a hammer and chisel between 1 and 6 meters (m) depth, with the majority between 3 and 4 m. All selected colonies were at least 1-5 m apart to reduce the risk of sampling clone mates while maximizing the probability that the colonies were exposed to similar conditions within a site. Targeted

colonies were also relatively small in size (30-50 centimeters (cm)) to facilitate transportation to aquarium facilities for further analyses and experiments. The total area over which corals were collected was 250-500 square meters (m^2) per site. Tissue samples were taken from the center of each colony, immediately fixed in ethanol, and stored at -20 degrees Celsius (°C) (2 × 2 cm samples). Samples were transported to Boston University where 2bRAD sequencing was conducted to resolve host genetic lineage.

In April 2022, fragments from massive Porites colonies representing three cryptic lineages were collected from the tagged coral colonies described above and transported to the Palau International Coral Reef Center for a controlled thermal stress experiment. The 25-day thermal challenge consisted of a control treatment held at ~29.5 °C and a heat-stress treatment in which temperatures were raised ~3 °C over seven days, held for 12 days, and then increased by an additional ~1 °C to simulate an acute heatwave. Each colony contributed replicate fragments to both treatments. Maximum photochemical efficiency of photosystem II (Fv/Fm) was measured daily or semi-daily following >90 minutes dark acclimation using pulse-amplitude modulated (PAM) fluorometry to assess symbiont photophysiological stress. Coral fragments were photographed with a color standard at six timepoints, and bleaching severity was quantified as changes in grayscale intensity (paling) using ImageJ. Fragment survival was monitored throughout the experiment and analyzed using Kaplan-Meier survival estimates. Lineage- and treatment-specific responses in Fv/Fm, bleaching, and mortality were evaluated using linear mixed-effects models with colony identity as a random effect to account for repeated measurements.

Data Processing Description

Time-series data for Fv/Fm, bleaching (grayscale intensity), and fragment survival were compiled from daily or semi-daily measurements recorded during the 25-day experiment. Fv/Fm values were extracted directly from PAM fluorometer output files following dark-acclimation. Coral photographs were standardized using a color reference card and analyzed in ImageJ to quantify bleaching as changes in mean grayscale intensity over time. Mortality was recorded as a binary state at each timepoint. All data were quality-checked for entry accuracy, consistency across timepoints, and completeness; fragments lost were removed. Final datasets were organized by fragment ID, lineage, treatment, and timepoint.

BCO-DMO Processing Description

currently being processed

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Related Publications

Grupstra, C. G. B., Meyer-Kaiser, K. S., Bennett, M., Andres, M. O., Juszkiewicz, D. J., Fifer, J. E., Da-Anoy, J. P., Gomez-Campo, K., Martinez-Rugerio, I., Aichelman, H. E., Huzar, A. K., Hughes, A. M., Rivera, H. E., & Davies, S. W. (2024). Holobiont Traits Shape Climate Change Responses in Cryptic Coral Lineages. Global Change Biology, 30(11). Portico. https://doi.org/10.1111/gcb.17578
Results

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Parameters

Parameters for this dataset have not yet been identified

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Instruments

Dataset-specific Instrument Name	pulse-amplitude modulated (PAM) fluorometer (Junior PAM (Heinz Walz GmbH))
Generic Instrument Name	Fluorometer
Dataset-specific Description	Measured maximum photochemical efficiency (Fv/Fm) of photosystem II after dark acclimation.
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.

Dataset-specific Instrument Name	Hammer and chisel
Generic Instrument Name	Manual Biota Sampler
Dataset-specific Description	Colonies were sampled using a hammer and chisel.
Generic Instrument Description	"Manual Biota Sampler" indicates that a sample was collected in situ by a person, possibly using a hand-held collection device such as a jar, a net, or their hands. This term could also refer to a simple tool like a hammer, saw, or other hand-held tool.

Dataset-specific Instrument Name	Onset HOBO Pendant® Temperature Data Logger (UA-001-64)
Generic Instrument Name	Onset HOBO Pendant MX2201 temperature logger
Dataset-specific Description	Recorded tank temperatures throughout the experiment to verify treatment stability and precision. Factory-calibrated; accuracy ±0.53 °C.
Generic Instrument Description	The Onset HOBO MX2201 is an in-situ instrument for wet or underwater applications. It supports soil temperature, temperature, and water temperature. A one-channel logger that records up to approximately 96,000 measurements or internal logger events with 8K bytes memory. It has a polypropylene housing case. Uses Bluetooth to transmit data. Can be used with a solar radiation shield. Measurement range: -20 deg C to 70 deg C. Accuracy: +/- 0.50 deg C from 0 deg C to 50 deg C. Water depth rating: 30.5 m

Dataset-specific Instrument Name	Olympus Tough TG-6 DSLR with standardized underwater color calibration card
Generic Instrument Name	Underwater Camera
Dataset-specific Description	Used to document coral fragments at six timepoints. Color standard enabled quantitative analysis of bleaching via grayscale intensity in ImageJ.
Generic Instrument Description	All types of photographic equipment that may be deployed underwater including stills, video, film and digital systems.

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Project Information

Collaborative Research: How do selection, plasticity, and dispersal interact to determine coral success in warmer and more variable environments? (Palau coral selection plasticity dispersal)

Coverage: Palauan coral reefs

NSF Award Abstract:
Coral reefs host thousands of marine species, help protect coastlines from storm damage, generate tourism, and house fish used for human consumption. However, corals are vulnerable to increasing water temperatures, which can lead to coral death. One way for reefs to survive in warming oceans is for corals that are well-suited to warmer waters to repopulate reefs that have less temperature-tolerant individuals. For this strategy to succeed, however, the more temperature-tolerant corals need to be able to disperse to and survive in these different environments. This project takes advantage of reef systems in the Pacific nation of Palau that naturally experience a wide range in temperatures across short geographic distances. Using cutting-edge ecological and genomic techniques, the team of investigators is directly testing whether young corals from Palau's warmest reefs can successfully be carried by ocean currents to Palau's currently cooler reefs and subsequently survive and thrive in these habitats. Given the relevance of this research for the local ecology, the team is disseminating results to the Palauan government through a written report in conjunction with Palauan scientists who are interning with the team, and to the Palauan people through public presentations. As part of this work, the investigators are maintaining a blog and are organizing a music-lecture series combining dance, music, and science to promote awareness of the coral reef crisis across English and Spanish-speaking communities in the US. Results from this project are informing restoration and conservation practices of the Coral Conservation Consortium as well as other efforts worldwide.

A major question in evolutionary biology is how plasticity and adaptation interact to influence survival under novel environments. Understanding these processes is increasingly important as rising temperatures associated with climate change influence species globally. For marine organisms with pelagic larval phases, including reef-building corals, the post-settlement period constitutes a critical bottleneck for adaptation and plasticity, with the added complexity that the conditions experienced and time spent as larvae can incur carryover effects. This project leverages reefs in Palau that span a steep environmental gradient to study how environmental variation drives selection and plasticity and to examine if dispersal between reefs limits success across habitats due to carryover effects. The investigators are testing the overarching hypothesis that corals from warmer and more variable environments are adapted to warmer temperatures and exhibit increased plasticity, but that dispersal between reefs incurs a fitness cost. The team integrates field and molecular techniques to: 1) investigate the degree of selection occurring on warmer and more variable reefs, 2) test whether corals transplanted to more variable environments improve their thermal tolerance through developmental plasticity, and 3) examine whether delays in metamorphosis required for dispersal across reefs comes at a fitness cost due to carryover effects.

This award reflects NSF's statutory mission and has been deemed worthy of support through evaluation using the Foundation's intellectual merit and broader impacts review criteria.

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Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-2048589
NSF Division of Ocean Sciences (NSF OCE)	OCE-2048678

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