Temperature data from a standardized short-term (18 hour) heat stress assay of Montipora capitata and Porites compressa collected at a patch reef in Kane'ohe Bay, O'ahu, Hawai'i in September of 2022

Website: https://www.bco-dmo.org/dataset/914715
Data Type: Other Field Results
Version: 1
Version Date: 2023-11-09

Project
» RAPID: Collaborative Research: Disentangling the effects of heat stress versus bleaching phenotype on coral performance (Mcap pairs time series)

Contributors	Affiliation	Role
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Abstract
Increasingly frequent marine heatwaves are devastating coral reefs. Corals that survive these extreme events must rapidly recover if they are to withstand subsequent events, and long-term survival in the face of rising ocean temperatures may hinge on recovery capacity and acclimatory gains in heat tolerance over an individual's lifespan. To better understand coral recovery trajectories in the face of successive marine heatwaves, we monitored the responses of bleaching-susceptible and bleaching-resistant individuals of two dominant coral species in Hawai'i, Montipora capitata and Porites compressa, over a decade that included three marine heatwaves. This dataset includes the temperature data from the standardized short-term (18 hour) heat stress assay.

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Coverage

Spatial Extent: **Lat**:21.4509 **Lon**:-157.7954
Temporal Extent: 2022-09-01 - 2022-09-05

Dataset Description

This dataset and other data from this study will be published in the results paper "Divergent bleaching and recovery trajectories in reef-building corals following a decade of successive marine heatwaves." (see pre-print Brown, et al. (2023), doi: 10.1101/2023.07.16.549193).

All BCO-DMO datasets related to this publication can be found on the page https://www.bco-dmo.org/related-resource/915300.

See Related Datasets section for "Short-term heat stress assay: photochemical yield data" from the same short-term (18 hour) heat stress assay.

Methods & Sampling

Sampling Location: patch reef 13 in Kāne'ohe Bay, O'ahu, Hawai'i (21.4509, -157.7954)

The following methods describe how this dataset was produced along with the related dataset "Short-term heat stress assay: photochemical yield data" (https://www.bco-dmo.org/dataset/914723)

Acute heat stress experiment

Ten individual colonies of each phenotype per species were sampled on September 1, 2022. Four fragments were collected from each individual colony (i.e., genetic clones) by hand using bone cutters, totalling 160 fragments. Following collection, corals were transported to the Hawai'i Institute of Marine Biology (HIMB) and placed in outdoor, flow-through seawater tanks under ambient temperatures (mean ± SD; 28.2 ± 0.1°C, n=2 tanks) until experimentation. Coral thermal tolerance experiments were initiated 72 hours after collection. The experimental heat stress assay followed the standardized temperature profile used to measure heat tolerance in corals (e.g., MMM, MMM+3°C, MMM+6°C, and MMM+9°C) (Voolstra, et al., 2020). The experiment began on September 4 2022 at 13:00 with a 3-hour ramp to respective treatment temperatures (27.5°C, 30.5°C, 33.5°C, 36.5°C), a 3-hour hold, and a 1-hour ramp down to MMM temperature (27.5°C). A fragment from each coral colony was suspended using fishing line and randomly placed into each treatment, so that all genotypes across species were present in each treatment. Temperatures were controlled using a custom computer controlled system (Raspberry Pi). Temperatures were constantly monitored and manipulated by responding to probe measurements in real time, and recorded using cross-calibrated temperature loggers (accuracy: ± 0.47°C at 25°C; resolution: ± 0.10°C at 25°C HOBO UA-001-64, Onset Computer Corporation). Experiments were performed outdoors under natural photosynthetically active radiation (PAR), which ranged between 515–580 µmol m-2 sec-1 at midday (~12:00; Licor cosine sensor). At the end of the ramp and 1 h after sunset (~19:30), corals were assessed for dark-adapted photochemical yield (Fv/Fm) using a Diving-PAM (Walz GmbH) 5-mm diameter fiber-optic probe at a standardized distance (5 mm) above the coral tissue after F0 stabilized. Three random spots (2–3 cm apart across the front and back of the nubbin) were measured on each fragment to obtain average measures of Fv/Fm. All readings with F0 values that were less than 110 were removed to avoid any false detections (Marzonie et al., 2022). The following morning at 07:00 corals were photographed with a color standard (WDKK Waterproof Color Chart, DGK Color Tools) to assess coral color, a proxy for bleaching severity. Bleaching severity was determined visually (e.g., 0, 20, 40, 60, 80, 100% white) (Evensen, et al.., 2022) using the six gray standards as a reference (e.g., black= 0% bleached, white = 100% bleached) from two photographs (front and back of the fragment) to obtain an average color score (Brown et al., 2023 Fig. S4).

Taxonomic Identifiers:
Montipora capitata, LSID (urn:lsid:marinespecies.org:taxname:287697)
Porites compressa, LSID (urn:lsid:marinespecies.org:taxname:207236)

Data Processing Description

See results publication Brown, et al. (2023) for more detailed information on analysis and results.

BCO-DMO Processing Description

* Table within file "Short-term heat stress temperature data.csv " was imported into the BCO-DMO data system with values "NA" as missing data values.
** Missing data values are displayed differently based on the file format you download. They are blank in csv files, "NaN" in MatLab files, etc.

* Column names adjusted to conform to BCO-DMO naming conventions designed to support broad re-use by a variety of research tools and scripting languages. [Only numbers, letters, and underscores. Can not start with a number]
* First column in the data table was un-named column of row numbers. This was removed from the imported dataset.
* DateTime converted to ISO 8601 format in UTC using the DateTime provided in Pacific/Hawaii UTC-10 time.

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Data Files

File
914715_v1_sths-temperature.csv (Comma Separated Values (.csv), 102.96 KB) MD5:adeccca0618c3c786b6a0f304dbc8c76
Primary data file for dataset ID 914715, version 1

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Related Publications

Brown, K. T., Lenz, E. A., Glass, B. H., Kruse, E., McClintock, R., Drury, C., Nelson, C. E., Putnam, H. M., & Barott, K. L. (2023). Divergent recovery trajectories in reef-building corals following a decade of successive marine heatwaves. bioRxiv preprint. https://doi.org/10.1101/2023.07.16.549193
Results

Evensen, N. R., Voolstra, C. R., Fine, M., Perna, G., Buitrago-López, C., Cárdenas, A., Banc-Prandi, G., Rowe, K., & Barshis, D. J. (2022). Empirically derived thermal thresholds of four coral species along the Red Sea using a portable and standardized experimental approach. Coral Reefs, 41(2), 239–252. https://doi.org/10.1007/s00338-022-02233-y
Methods

Marzonie, M. R., Bay, L. K., Bourne, D. G., Hoey, A. S., Matthews, S., Nielsen, J. J. V., & Harrison, H. B. (2022). The effects of marine heatwaves on acute heat tolerance in corals. Global Change Biology, 29(2), 404–416. Portico. https://doi.org/10.1111/gcb.16473
Methods

Voolstra, C. R., Buitrago-López, C., Perna, G., Cárdenas, A., Hume, B. C. C., Rädecker, N., & Barshis, D. J. (2020). Standardized short-term acute heat stress assays resolve historical differences in coral thermotolerance across microhabitat reef sites. Global Change Biology, 26(8), 4328-4343. Portico. https://doi.org/10.1111/gcb.15148
Methods

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Related Datasets

IsRelatedTo

Barott, K., Putnam, H., Brown, K. T. (2023) **Photochemical yield and bleaching severity data from a standardized short-term (18 hour) heat stress assay of Montipora capitata and Porites compressa collected at a patch reef in Kane'ohe Bay, O'ahu, Hawai'i in September of 2022.** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2023-11-09 doi:10.26008/1912/bco-dmo.914723.1 [view at BCO-DMO]
Relationship Description: Data from the same short-term (18 hour) heat stress assay.

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Parameters

Parameter	Description	Units
Date	Date of temperature recording. Time zone Pacific/Hawaii (UTC-10).	unitless
Time	Time of temperature recording (24hr). Time zone Pacific/Hawaii (UTC-10).	unitless
hour	Hour of the day (24h). Time zone Pacific/Hawaii (UTC-10).	hours
Temperature	Temperature	degrees celcius
Treatment	Treatment identifier (AMB=ambient; or 3C, 6C, 9C)	unitless
Date_Time	Date and Time (local). Time zone Pacific/Hawaii (UTC-10).	unitless
ISO_DateTime_UTC	Date and Time (UTC) in ISO 8601 format.	unitless

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Instruments

Dataset-specific Instrument Name	HOBO pendant logger
Generic Instrument Name	Onset HOBO Pendant Temperature/Light Data Logger
Dataset-specific Description	seawater temperature
Generic Instrument Description	The Onset HOBO (model numbers UA-002-64 or UA-001-64) is an in-situ instrument for wet or underwater applications. It supports light intensity, soil temperature, temperature, and water temperature. A two-channel logger with 10-bit resolution can record up to approximately 28,000 combined temperature and light measurements with 64K bytes memory. It has a polypropylene housing case. Uses an optical USB to transmit data. A solar radiation shield is used for measurement in sunlight. Temperature measurement range: -20 deg C to 70 deg C (temperature). Light measurement range: 0 to 320,000 lux. Temperature accuracy: +/- 0.53 deg C from 0 deg C to 50 deg C. Light accuracy: Designed for measurement of relative light levels. Water depth rating: 30 m.

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Project Information

RAPID: Collaborative Research: Disentangling the effects of heat stress versus bleaching phenotype on coral performance (Mcap pairs time series)

Coverage: Coral reefs of Kaneohe Bay, Oahu, Hawaii

NSF Award Abstract:
Coral bleaching has become increasingly common on reefs worldwide as rising sea surface temperatures associated with climate change disrupt the coral-algal symbiosis. This dramatic heat stress response turns the normally colorful corals bright white, and yet during these heat stress events not all corals undergo bleaching. This project focuses on assessing the effects of bleaching by comparing pairs of corals side-byside on the reef during an ongoing heat wave, where one has bleached and the other has not, despite experiencing the same

temperatures. These coral pairs have been monitored throughout three bleaching events in the past five years, providing a unique resource to address whether corals with consistently different bleaching susceptibilities have the capacity to acclimate in response to disturbances through epigenetic changes, or changes in gene expression not due to change in DNA bases. To address this, the project will characterize the impacts of bleaching or not bleaching on coral physiology, gene expression, and epigenetic patterns using coral pairs in their natural habitat during a marine heatwave. This project also provides research support for graduate student trainees, as well as data and materials for the research and training of undergraduate and high school students. This project will recruit underrepresented minority students from URI and UPenn area high schools and university undergraduates for work on computer analysis of images (benthic and colony photographs, brightfield and confocal micrographs) and sequencing data. It will also support the training of an undergraduate student at the University of Hawai'i in coral ecology and physiology, and the development of her senior thesis.

This project will investigate the effects of repeated heat stress events on the performance of Montipora capitata, a dominant reef builder throughout Hawai'i. It utilizes the timely context of paired colonies of M. capitata with bleached vs. unbleached histories that have been monitored through two past bleaching events in Hawai'i (2015 and 2019) and the currently ongoing 2020 event. This system allows for the unique opportunity to disentangle the consequences of heat stress versus bleaching on coral performance through time, an essential feature of reef resilience. The contrasting physiological and energetic processes these two phenotypes undergo during a heatwave are likely to result in alterations to the cellular environment within the animal that impacts epigenetic transcriptional regulation. These regulatory and energetic changes, if persistent over time, have the potential to alter coral fitness beyond the duration of the heatwave differentially between corals with contrasting bleaching phenotypes. Specifically, the project will: 1) quantify the effect of the 2020 heatwave on coral physiology during bleaching and recovery, 2) generate a corresponding archive of coral tissues and nucleic acids as a resource for future work characterizing how bleaching phenotype alters energetics and non-genetic inheritance, and 3) characterize how bleaching phenotype alters intra-generational inheritance of epigenetic marks (i.e., DNA methylation) and gene expression, and the duration of these marks and expression patterns following heat stress. This project represents an urgent assessment of an ideal system to test the legacy of coral bleaching phenotype on coral fitness. The results of this project will therefore lay the foundation for intra and cross-generational effects of bleaching vs. heat stress, which is essential for understanding coral resilience to climate change.

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-2102989
NSF Division of Ocean Sciences (NSF OCE)	OCE-2103067

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