Coral physiology data (chlorophyll a, symbiont densities) on four collected coral species from six sites in the Red Sea from 2018 to 2020

Website: https://www.bco-dmo.org/dataset/863786
Data Type: Other Field Results
Version: 1
Version Date: 2021-11-03

Project
» EAGER: Collaborative Research: Bleaching phenotypes of acute vs. chronic coral bleaching susceptibility and resilience: towards a standardized coral resilience diagnostic (EAGER-CBASS)

Contributors	Affiliation	Role
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Abstract
This dataset contains measurements of coral physiology (chlorophyll a and symbiont densities) following 18-hour acute thermal stress experiments, where temperatures were ramped up to 30, 33, 36, and 39 degrees Celsius. Four coral species (Acropora hemprichii, Pocillopora verrucosa, Porites lobata, and Stylophora pistillata) were sampled from six sites along the length of the Red Sea, down to Djibouti in the Gulf of Aden.

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Coverage

Spatial Extent: **N**:29.501771 **E**:40.962027 **S**:18.985395 **W**:34.917925
Temporal Extent: 2018-07-31 - 2018-08-21

Methods & Sampling

Data are from experiments performed across multiple sites in Israel, Saudi Arabia, and Djibouti. Multiple ramets from seven genets of *Acropora hemprichii, Pocillopora verrucosa, Porites lobata*, and *Stylophora pistillata* were collected from six sites along the Red Sea and used in an 18-hour acute thermal stress assay using the Coral Bleaching Automated Stress System (CBASS).

Corals were subjected to 18-hour acute thermal profiles with four peak target temperatures (30°C, 33°C, 36°C, and 39°C). Experimental tanks were ramped up from the 30 degrees Celsius control treatment to temperature treatments reaching 33°C, 36°C, and 36.5°C in the prolonged experiment at rates of 0.5 and 1.5

degrees C per day. Each temperature treatment contained two replicate tanks (A and B).

Chlorophyll a and symbiont densities as physiological response metrics were recorded and at the end of the experiments. A MicroDisTec homogenizer 125 (Thermo Fisher Scientific), SpectraMax Paradigm Multi-Mode Microplate Reader (Molecular Devices), and flow cytometer (BD LSRFortessa, BD Biosciences) were used.

'Chla_cm2' refers to chlorophyll a extracted from algal symbionts extracted in each ramet, normalized to the surface area of the ramet (µg per cm²). 'Sym_density' refers to symbiont densities measured in each ramet, normalized to the surface area of the ramet (cells per cm²).

Problems/Issues:
There are some missing data due to sample loss or mortality.

Data Processing Description

Data Processing:
Data were organized using Microsoft Excel and R statistical software (version 4.0.3).

Code used to analyze and plot data is available on GitHub: https://github.com/BarshisLab/Gradient-physiology.

BCO-DMO Processing:
- Adjusted field/parameter names to comply with BCO-DMO naming conventions;
- Added a conventional header with dataset name, PI names, version date;
- Converted Collection_Date to YYYY-MM-DD format.

Originally submitted GitHub repository https://github.com/BarshisLab/Gradient-physiology was forked to https://github.com/BCODMO/Gradient-physiology/tree/v1.0 for curation purposes and tagged with release 1.0, which corresponds with this dataset submission. The code is attached to this record as a Supplemental File. Note the original repository may have continued updates.

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Data Files

File
Red_Sea_Physio.csv (Comma Separated Values (.csv), 24.87 KB) MD5:e5384ff6d748c2f7d3d30809e4a6719a Primary data file for dataset ID 863786

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Supplemental Files

File
Gradient-physiology-1.0.zip (ZIP Archive (ZIP), 24.45 MB) MD5:23bd53d1798c0cce2c4822f0c7543bcb Code used to analyze and plot data; associated with BCO-DMO datasets 863771, 863786, 863800. These files are also available in the following GitHub repository: https://github.com/BCODMO/Gradient-physiology/releases/tag/v1.0

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Related Datasets

IsRelatedTo

Barshis, D. J., Voolstra, C. R., Evensen, N. R. (2021) **Coral physiology data (Fv/Fm) on four collected coral species from six sites in the Red Sea from 2018 to 2020.** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2021-11-03 doi:10.26008/1912/bco-dmo.863771.1 [view at BCO-DMO]

Barshis, D. J., Voolstra, C. R., Evensen, N. R. (2021) **Coral physiology data (visual bleaching) on four collected coral species from six sites in the Red Sea from 2018 to 2020.** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2021-11-03 doi:10.26008/1912/bco-dmo.863800.1 [view at BCO-DMO]

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Parameters

Parameter	Description	Units
Collection_Date	date of collection in format YYYY-MM-DD	unitless
Site_Latitude	latitude North	decimal degrees
Site_Longitude	longitude East (West is negative)	decimal degrees
Site	sampling site	unitless
Temperature	Temperature of tank	degrees Celsius
Species	species name	unitless
Genotype	genotype identifier	unitless
Replicate	replicate identifier (A or B)	unitless
Label	Sample identifier	unitless
Sym_Density	symbiont densities measured in each ramet, normalized to the surface area of the ramet	cells per square centimeter (cells per cm2)
Chla_cm2	chlorophyll a extracted from algal symbionts extracted in each ramet, normalized to the surface area of the ramet	micrograms per square centimeter (µg per cm2)

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Instruments

Dataset-specific Instrument Name	CBASS
Generic Instrument Name	Coral Bleaching Automated Stress System
Generic Instrument Description	CBASS, which stands for "Coral Bleaching Automated Stress System", are portable, field-deployable experimental tanks used to apply rapid, acute heat stress challenges. This system is described in: 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

Dataset-specific Instrument Name	flow cytometer (BD LSRFortessa, BD Biosciences)
Generic Instrument Name	Flow Cytometer
Generic Instrument Description	Flow cytometers (FC or FCM) are automated instruments that quantitate properties of single cells, one cell at a time. They can measure cell size, cell granularity, the amounts of cell components such as total DNA, newly synthesized DNA, gene expression as the amount messenger RNA for a particular gene, amounts of specific surface receptors, amounts of intracellular proteins, or transient signalling events in living cells. (from: http://www.bio.umass.edu/micro/immunology/facs542/facswhat.htm)

Dataset-specific Instrument Name	MicroDisTec homogenizer 125 (Thermo Fisher Scientific)
Generic Instrument Name	Homogenizer
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	SpectraMax Paradigm Multi-Mode Microplate Reader (Molecular Devices)
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.

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Project Information

EAGER: Collaborative Research: Bleaching phenotypes of acute vs. chronic coral bleaching susceptibility and resilience: towards a standardized coral resilience diagnostic (EAGER-CBASS)

Coverage: Red Sea, Thuwal, Saudi Arabia, Eilat Israel

NSF Award Abstract:
The past few years have seen an unprecedented amount of coral bleaching across the globe. Global bleaching events in 2015-17, severely impacting iconic coral reefs in places such as the Great Barrier Reef, Micronesia,

Hawaiian Islands, and Caribbean, were the worst recorded in recent human history. When ocean temperatures rise, the symbiosis between reef-building corals and their photosynthetic algae deteriorates, many times resulting in widespread coral die-offs as corals can starve without their symbiotic partners to supply food. These widespread events can have drastic impacts on ocean health and biodiversity, as well as the communities that depend on reefs for fishing, tourism, and protection from storms. Importantly, some corals resist or recover from bleaching better than others. Such variability in coral response to ocean warming could be critical to reef survival in the future, yet the scientific community lacks any standardized diagnostics to rapidly assess bleaching tolerance limits. Here, we plan to: 1) develop a standardized, short-term exposure to assess bleaching limits (analogous to cardiac stress tests for humans), 2) design an experimental system capable of delivering a range of thermal treatments as an open-source, low-cost, highly-portable device that can be readily adapted for bleaching tests in a wide variety of coral habitats, and 3) disseminate the results, instructions, and technologies to the reef research and conservation community through a combination of hands-on workshops, online outreach materials, press releases, and open-access research publications. Widespread dissemination of project products will be achieved via hands-on demonstrations and workshops in key geographic areas (Middle East, Caribbean, and Indo-Pacific), with a focus on the assembly of the system and operation of the experimental assay using local corals. This project will train both graduate students and a postdoctoral researcher, and brings together a team of national and global researchers in a collaborative investigation to address the international problem of coral bleaching.

With each passing year, coral bleaching has shifted from an issue of serious sporadic concern to a critical widespread threat to reefs across the globe that is increasing in frequency and severity. However, during widespread bleaching events, some scattered corals and reef sections are able to survive better than others. Whether this is due to acclimatization or adaptation in thermal stress tolerance, this variability in response is critical to coral resilience to climate impacts. Currently, the scientific community lacks a standardized approach to rapidly assess coral thermal limits and identify resilient individuals or populations. Present day approaches range from observational surveys of natural bleaching and mortality, to multiple weeks of controlled chronic thermal exposure, to rapid, single or multi-day acute heat shocks. To what degree bleaching response varies across short-term versus longer-term experiments and how these responses compare to natural bleaching patterns is largely unknown. Using a group of coral species representative of a historical range of bleaching susceptibility (e.g., Acropora hemprichii, Pocillopora meandrina, and Porites lobata), research will address this important knowledge gap by experimental evaluation of the bleaching response to acute (0 - 2 day) versus chronic (>4 week) thermal stress. The overarching questions for this study are: how are the acute and chronic coral bleaching responses related, and can investigators predict ecologically relevant bleaching outcomes from the response to a short-term, acute heat-stress? To answer these questions, the research team will: 1) objectively compare acute versus chronic heat-stress exposures and synthesize a variety of response metrics based on core physiological measurements to develop a standardized, short-term thermal assay and diagnostic approach to rapidly assess bleaching, 2) operationalize an experimental system built around an open-source, cost-effective, easily transportable temperature control technology, and 3) distribute the results, experimental procedures, and temperature controlling technologies to the reef research and conservation communities. This project will produce an affordable experimental system and short-term diagnostic capable of determining coral thermal limits in just a few days in almost any location with reliable access to seawater and electricity or a portable generator. The research fills a critical knowledge gap through the development of a standardized set of diagnostic tools to assess coral thermal vulnerability before widespread bleaching events actually occur, so that proactive conservation and management strategies can be implemented ahead of widespread impacts to reef ecosystems.

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-1833201

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