Thermal tolerance (ED50) data used to compare previously published regional (Florida Reef Tract, Coral Sea, Red Sea) coral thermal tolerance with Heron Island, Great Barrier Reef values measured in 2022

Website: https://www.bco-dmo.org/dataset/926911
Data Type: Synthesis, experimental, Other Field Results
Version: 1
Version Date: 2024-05-07

Project
» Influence of environmental pH variability and thermal sensitivity on the resilience of reef-building corals to acidification stress (Coral Resilience)

Contributors	Affiliation	Role
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Abstract
Variable temperature regimes that expose corals to sub-lethal heat stress have been recognized as a mechanism to increase coral thermal tolerance and lessen coral bleaching. However, there is a need to better understand which thermal regimes maximize coral stress hardening. Here, standardized thermal stress assays were used to determine the relative thermal tolerance of three divergent genera of corals (Acropora, Pocillopora, Porites) originating from six reef sites representing an increasing gradient of annual mean diel temperature fluctuations of 1–3°C day-1. Bleaching severity and dark-acclimated photochemical yield (i.e., Fv/Fm) were quantified following exposure to five temperature treatments ranging from 23.0 to 36.3°C (see Related Datasets). This data set contains the comparison of thermal tolerance across studies.

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Coverage

Location: Heron Island Research Station, Heron Island, southern Great Barrier Reef (23 27°S, 151 55°E)
Spatial Extent: **Lat**:-23.27 **Lon**:151.55
Temporal Extent: 2022-09-15 - 2022-10-30

Dataset Description

See the "Related Datasets" section for other closely related data that was also part of the study published in Brown et al., 2024.

Dataset "Short-term heat stress assay Heron Island - physiological data" contains a supplemental file ed50.csv

which contains Photochemical yield and color score data from the Heron Island short term heat assay which was used to determine effective dose 50 (ED50, thermal tolerance). The Heron Island ED50 values are included in this thermal tolerance comparison dataset.

Methods & Sampling

Three published studies using the standardized experimental approach (i.e., (Evensen et al. 2023)) were identified to compare coral thermal thresholds across reef systems and spatial scales: 1. Florida Reef Tract in the Caribbean (~300 km) (Cunning et al. 2021), 2. Coral Sea in eastern Australia (~860 km) (Marzonie et al. 2022), and 3. Red Sea (~900 km) (Evensen et al. 2022). Reported values of coral thermal tolerance (i.e., Fv/Fm ED50) were compiled by nursery/reef/site. To compare regional (Florida Reef Tract, Coral Sea, Red Sea) coral thermal tolerance with local (Heron Island), the range of coral thermal tolerance was calculated for each species by computing the difference between the site with the greatest thermal tolerance and the site with the lowest thermal tolerance.

Organism Genera (Genus, Lifesciences Identifier [LSID]):
Pocillopora, urn:lsid:marinespecies.org:taxname:206938
Porites, urn:lsid:marinespecies.org:taxname:206485
Acropora, urn:lsid:marinespecies.org:taxname:205469
* see supplemental file species_list.csv for supplemental information and LSIDs for all species names in the data table for this dataset.

Data Processing Description

For more detailed information on analysis and results, please see: Brown, et al. (2024).

BCO-DMO Processing Description

* submitted file "ed50 comparison across studies.csv" was imported into the BCO-DMO data system for this dataset. No changes were made to the table.
** Missing data values are displayed differently based on the file format you download. They are blank in csv files, "NaN" in MatLab files, etc.

Problem Description

N/A

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Related Publications

Cunning, R., Parker, K. E., Johnson-Sapp, K., Karp, R. F., Wen, A. D., Williamson, O. M., Bartels, E., D'Alessandro, M., Gilliam, D. S., Hanson, G., Levy, J., Lirman, D., Maxwell, K., Million, W. C., Moulding, A. L., Moura, A., Muller, E. M., Nedimyer, K., Reckenbeil, B., … Baker, A. C. (2021). Census of heat tolerance among Florida's threatened staghorn corals finds resilient individuals throughout existing nursery populations. Proceedings of the Royal Society B: Biological Sciences, 288(1961). https://doi.org/10.1098/rspb.2021.1613
Methods

Evensen, N. R., Parker, K. E., Oliver, T. A., Palumbi, S. R., Logan, C. A., Ryan, J. S., Klepac, C. N., Perna, G., Warner, M. E., Voolstra, C. R., & Barshis, D. J. (2023). The Coral Bleaching Automated Stress System (CBASS): A low-cost, portable system for standardized empirical assessments of coral thermal limits. Limnology and Oceanography: Methods, 21(7), 421–434. Portico. https://doi.org/10.1002/lom3.10555
Methods

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

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Related Datasets

IsRelatedTo

Brown, K., Barott, K. (2024) **Photochemical yield and color score data from short-term heat stress assays performed with with corals collected from sites around Heron Island, southern Great Barrier Reef in Sept and Oct of.** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2024-05-07 http://lod.bco-dmo.org/id/dataset/926887 [view at BCO-DMO]
Relationship Description: These datasets were part of the same study published in Brown et al., 2024.

Brown, K., Barott, K. (2024) **Temperature data from short-term heat stress assays performed with with corals collected from sites around Heron Island, southern Great Barrier Reef in Sept and Oct of 2022.** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2024-05-07 http://lod.bco-dmo.org/id/dataset/926905 [view at BCO-DMO]
Relationship Description: These datasets were part of the same study published in Brown et al., 2024.

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Parameters

Parameter	Description	Units
Location	Geolocation of the study (Heron Island, Coral Sea, Florida, etc).	unitless
Genus	Coral genus	unitless
Species	Species name (includes cf.)	unitless
Reef	Reef Name or site code (see related publications for these studies for site code information). Heron island site include the full site name.	unitless
ed50	photochemical yield effective dose 50 [ed50m thermal tolerance]	degrees Celsius (degC)
Lower	95% lower confidence interval	degrees Celsius (degC)
Upper	95% upper confidence interval	degrees Celsius (degC)

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Instruments

Dataset-specific Instrument Name	temperature loggers (HOBO UA-001-64)
Generic Instrument Name	Onset HOBO Pendant Temperature/Light Data Logger
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

Influence of environmental pH variability and thermal sensitivity on the resilience of reef-building corals to acidification stress (Coral Resilience)

Coverage: Kaneohe Bay, Oahu, HI; Heron Island, Queensland, Australia

NSF Award Abstract:
Coral reefs are incredibly diverse ecosystems that provide food, tourism revenue, and shoreline protection for coastal communities. The ability of coral reefs to continue providing these services to society is currently threatened by climate change, which has led to increasing ocean temperatures and acidity that can lead to the death of corals, the animals that build the reef framework upon which so many species depend. This project examines how temperature and acidification stress work together to influence the future health and survival of corals. The scientists are carrying out the project in Hawaii where they have found individual corals with different sensitivities to temperature stress that are living on reefs with different environmental pH conditions. This project improves understanding of how an individual coral's history influences its response to multiple stressors and helps identify the conditions that are most likely to support resilient coral communities. The project will generate extensive biological and physicochemical data that will be made freely available. Furthermore, this project supports the education and training of undergraduate and high school students and one postdoctoral researcher in marine science and coral reef ecology. Hands-on activities for high school students are being developed into a free online educational resource.

This project compares coral responses to acidification stress in populations experiencing distinct pH dynamics (high diel variability vs. low diel variability) and with distinct thermal tolerances (historically bleaching sensitive vs. tolerant) to learn about how coral responses to these two factors differ between coral species and within populations. Experiments focus on the two dominant reef builders found at these stable and variable pH reefs: Montipora capitata and Porites compressa. Individuals of each species exhibiting different thermal sensitivities (i.e., bleached vs. pigmented) were tagged during the 2015 global coral bleaching event. This system tests the hypotheses that 1) corals living on reefs with larger diel pH fluctuations have greater resilience to acidification stress, 2) coral resilience to acidification is a plastic trait that can be promoted via acclimatization, and 3) thermally sensitive corals have reduced capacity to cope with pH stress, which is exacerbated at elevated temperatures. Coral cells isolated from colonies from each environmental and bleaching history are exposed to acute pH stress and examined for their ability to recover intracellular pH in vivo using confocal microscopy, and the expression level of proteins predicted to be involved in this recovery (e.g., proton transporters) is examined via Western blot and immunolocalization. Corals from each pH history are exposed to stable and variable seawater pH in a controlled aquarium setting to determine the level of plasticity of acidification resilience and to test for pH acclimatization in this system. Finally, corals with different levels of thermal sensitivity are exposed to thermal stress and recovery, and their ability to regulate pH is examined over time. The results of these experiments help identify reef conditions that promote coral resilience to ocean

acidification against the background of increasingly common thermal stress events, while advancing mechanistic understanding of coral physiology and symbiosis.

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-1923743

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