Body size measurements collected for Acartia hudsonica during multigenerational exposure to ocean warming (OW), ocean acidification (OA), and combined ocean warming and acidification (OWA)

Website: https://www.bco-dmo.org/dataset/924236
Data Type: Cruise Results, experimental
Version: 1
Version Date: 2024-04-03

Project
» Collaborative Research: Response of marine copepods to warming temperature and ocean acidification (Copepod Response to Warming Temp and OA)

Contributors	Affiliation	Role
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Abstract
These data include body size measurements collected for Acartia hudsonica during multigenerational exposure to ocean warming (OW), ocean acidification (OA), and combined ocean warming and acidification (OWA) including a benign ambient condition temperature and CO2 control (AM). These data were collected every second generation between F0 and F4 for all treatments and at F11 for AM and OWA. Data were collected on C1 juveniles (C1), adult males (C6M), and adult females (C6F). Individual copepods were stained with non-acid lugol's solution, isolated in a drop of filtered seawater, and photographed using a Lumenera Infinity5-5 camera (Teledyne Lumenera, Ottawa, ON, CAN) attached to an inverted microscope (Olympus IX70, Olympus, Waltham, MA, USA) after the water droplet had been removed. Body size was measured as prosome length at C1 and C6 stages using Image-J (https://imagej.nih.gov/). The experimental environmental conditions were: 1) Ambient control (AM): 13˚C, 400 µatm CO2, pH = 8.2; 2) Ocean Acidification (OA): 13˚C, 1000 µatm CO2, pH = 7.85; 3) Ocean Warming (OW): 15°C, 400 µatm CO2, pH = 8.2; 4) Combined warming and acidification (OWA): 15°C, 1000 µatm CO2, pH = 7.85.

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Coverage

Location: University of Connecticut, Avery Point campus
Spatial Extent: **Lat**:41.3 **Lon**:-72
Temporal Extent: 2017-07-02 - 2018-08-15

Methods & Sampling

Three hundred copepods were collected in April of 2018 from eastern Long Island Sound, Connecticut, USA (41.3°N, 72.0°W) and raised for one year (~12 generations) (14 degrees Celsius (°C), 400 microatmospheres (µatm) CO2, 30 ‰ salinity, 12:12 hours light:dark) as stock cultures to limit maternal effects (Falconer, 1989, *Introduction to Quantitative Genetics*). Three resulting stock cultures with >2,000 individuals each were combined and then split evenly into three groups for each of the four treatments. Groups were acclimatized within a generation to temperature (15°C or 13°C, 1°C per day) and pCO2 (1000 µatm, 100 µatm per day, OA treatments only). Groups seeded the F0 individuals for 7-10 days yielding ~15,000 eggs per treatment. Resulting F0 eggs and nauplii were combined for each treatment, redistributed among three replicate cultures, and returned to their respective experimental conditions. The experimental environmental conditions were: 1) Ambient control (AM): 13°C, 400 µatm CO2, pH = 8.2; 2) Ocean Acidification (OA): 13°C, 1000 µatm CO2, pH = 7.85; 3) Ocean Warming (OW): 15°C, 400 µatm CO2, pH = 8.2; 4) Combined warming and acidification (OWA): 15°C, 1000 µatm CO2, pH = 7.85. Copepods were fed equal proportions of the live phytoplankters *Tetraselmis* sp., *Rhodomonas* sp., and T*halassiosira weissflogii* every 48-72 hours to achieve food-replete conditions (≥600 micrograms (µg) Carbon per liter (L)) (Feinberg and Dam, 1998. *Marine Ecology Progress Series*), deliberately raised under ambient conditions to avoid confounding effects of possible food quality changes.

Body size was measured as prosome length at C1 and C6 stages using Image-J (https://imagej.nih.gov/ij/) for individuals grown in 250-milliliter (mL) beakers alongside survivorship experiments. Ten individuals per replicate and treatment (i.e. 10 C1, 10 males, and 10 females) were preserved in non-acid Lugol's solution each generation for life-history trait measurements. Individuals were isolated in a drop of filtered seawater and photographed using a Lumenera Infinity5-5 camera (Teledyne Lumenera, Ottawa, ON, CAN) attached to an inverted microscope (Olympus IX70, Olympus, Waltham, MA, USA) after the water droplet had been removed. Full methods on replication can be found in deMayo, et al. 2023.

Data Processing Description

All data were collected using Image-J (https://imagej.nih.gov/ij/) and processed with R (v4.0.2). Data analysis and visualization code can be accessed at: https://zenodo.org/badge/latestdoi/505896789.

BCO-DMO Processing Description

- Imported original file "Body_size_data_MS_complete.txt" into the BCO-DMO system.
- Saved final file as "924236_v1_a_hudsonica_body_size.csv".

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Data Files

File	
924236_v1_a_hudsonica_body_size.csv	(Comma Separated Values (.csv), 22.28 KB) MD5:7f084ea91c35bf8276d6330440e703d8
Primary data file for dataset ID 924236, version 1	

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Related Publications

R Core Team (2020). R: A language and environment for statistical computing. R v4.0.2. R Foundation for Statistical Computing, Vienna, Austria. URL https://www.R-project.org/
Software

Schneider, C. A., Rasband, W. S., ... (n.d.). ImageJ. US National Institutes of Health, Bethesda, MD, USA. Available from https://imagej.nih.gov/ij/
Software

deMayo, J. A., Brennan, R. S., Pespeni, M. H., Finiguerra, M., Norton, L., Park, G., Baumann, H., & Dam, H. G. (2023). Simultaneous warming and acidification limit population fitness and reveal phenotype costs for a marine copepod. Proceedings of the Royal Society B: Biological Sciences, 290(2006). https://doi.org/10.1098/rspb.2023.1033
Results

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Related Datasets

IsRelatedTo

Dam, H. G., Baumann, H., Finiguerra, M., Pespeni, M., Brennan, R. (2024) **Development (i.e. maturation) time measurements for Acartia hudsonica during multigenerational exposure to ocean warming (OW), ocean acidification (OA), and combined ocean warming and acidification (OWA).** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2024-04-03 doi:10.26008/1912/bco-dmo.924206.1 [view at BCO-DMO]
Relationship Description: These datasets result from the same set of experiments.

Dam, H. G., Baumann, H., Finiguerra, M., Pespeni, M., Brennan, R. (2024) **Egg production rate (EPR) and egg hatching success (HS) data for Acartia tonsa during multigenerational exposure to ocean warming (OW), ocean acidification (OA), and combined ocean warming and acidification (OWA).** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2024-04-02 doi:10.26008/1912/bco-dmo.924126.1 [view at BCO-DMO]
Relationship Description: These datasets result from the same set of experiments.

Dam, H. G., Baumann, H., Finiguerra, M., Pespeni, M., Brennan, R. (2024) **Population fitness measurements collected for Acartia hudsonica during multigenerational exposure to ocean warming (OW), ocean acidification (OA), and combined ocean warming and acidification (OWA).** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2024-03-29 doi:10.26008/1912/bco-dmo.923960.1 [view at BCO-DMO]
Relationship Description: These datasets result from the same set of experiments.

Dam, H. G., Baumann, H., Finiguerra, M., Pespeni, M., Brennan, R. (2024) **Population fitness measurements collected for Acartia tonsa during multigenerational exposure to ocean warming (OW), ocean acidification (OA), and combined ocean warming and acidification (OWA).** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2024-03-28 doi:10.26008/1912/bco-dmo.923908.1 [view at BCO-DMO]
Relationship Description: These datasets result from the same set of experiments.

Dam, H. G., Baumann, H., Finiguerra, M., Pespeni, M., Brennan, R. (2024) **Survivorship measurements collected for Acartia hudsonica during multigenerational exposure to ocean warming (OW), ocean acidification (OA), and combined ocean warming and acidification (OWA).** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2024-04-01 doi:10.26008/1912/bco-dmo.924088.1 [view at BCO-DMO]
Relationship Description: These datasets result from the same set of experiments.

Jamesdemayo, & Dam-Lab. (2023). *dam-lab/hudsonica_transgenerational_MS: Data and code for manuscript: Limited copepod adaptation to combined warming and acidification reveals cost of producing adaptive phenotypes* (Version 3.3) [Computer software]. Zenodo. https://doi.org/10.5281/ZENODO.6678641 https://doi.org/10.5281/zenodo.6678641

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Parameters

Parameter	Description	Units
Generation	The generation where the body size was measured	unitless
Treatment	The treatment experienced by the copepods (1=AM, 2=OA, 3=OW, or 4=OWA)	unitless
Replicate	The biological replicate	unitless
Stage	The life stage for the copepod. C1 = CI stage, C6M = adult male, C6F = adult female	unitless
Number	The technical replicate of the sample	unitless
Length	The measured length of the copepod	millimeters (mm)

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Instruments

Dataset-specific Instrument Name	Lumenera Infinity5-5 camera (Teledyne Lumenera, Ottawa, ON, CAN)
Generic Instrument Name	Camera
Generic Instrument Description	All types of photographic equipment including stills, video, film and digital systems.

Dataset-specific Instrument Name	Olympus SZH-ILLD Stereoscope
Generic Instrument Name	Microscope - Optical
Generic Instrument Description	Instruments that generate enlarged images of samples using the phenomena of reflection and absorption of visible light. Includes conventional and inverted instruments. Also called a "light microscope".

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Project Information

Collaborative Research: Response of marine copepods to warming temperature and ocean acidification (Copepod Response to Warming Temp and OA)

Coverage: North western Atlantic ocean; Gulf of Maine, coastal and estuarine habitats

NSF Award Abstract:
Over time, our oceans are becoming both warmer and higher dissolved carbon dioxide. The latter condition is called ocean acidification. The consequences of these simultaneous changes for populations of marine organisms are not well understood. For this project, the investigators will conduct a series of laboratory experiments to determine how two closely-related, common species of Acartia copepods will respond to the interactive effects of warming and acidification and also how well these species can adapt over multiple generations to changing ocean conditions. Since these copepods are key species in coastal food webs, results will have important implications for understanding and predicting how marine ecosystems may respond to future climate change. The investigators will share results from the research through traditional print media, case studies, and video mini lectures. The goal will be for educators of all levels to easily access material on climate change and ocean acidification to include in teaching curricula, in alignment with recommendations for universal design for learning. The project is a collaborative effort between an established professor at the University of Connecticut and an early-career female scientist at the University of Vermont. It will provide training and opportunities for collaborative, interdisciplinary research for two postdoctoral investigators, two graduate students and an undergraduate student.

The project's main goals are: 1) to test the simultaneous effects of temperature and carbon dioxide under current and future conditions on life history traits throughout the life cycle for two key copepod species, warm-adapted Acartia tonsa and cold-adapted Acartia hudsonica; 2) to test for adaptive capacity of both copepod species to a warmer and carbon-dioxide-enriched ocean; 3) to measure the genetic and maternally-induced changes across multiple generations of experimental selection in future conditions in both copepod species, and to identify the genes and pathways responding to selection. The investigators will use experiments encompassing current and projected temperature and carbon-dioxide conditions, will determine the roles of each variable and their interaction on traits that affect the fitness of both copepod species. They will also determine which life stages are most sensitive to individual or simultaneous stress conditions. Through multigenerational selection experiments, the investigators will identify and characterize the mechanisms of copepod evolutionary adaptation. Finally, they will measure genomic changes across the generations under all four experimental conditions to quantify the relative contributions of genetic and maternally-induced change in the physiological and life history traits of copepods in response to near-future climate conditions.

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Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-1559075
NSF Division of Ocean Sciences (NSF OCE)	OCE-1559180

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