

# 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)

**Website:** <https://www.bco-dmo.org/dataset/924126>

**Data Type:** Other Field Results, experimental

**Version:** 1

**Version Date:** 2024-04-02

## Project

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

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## Abstract

These data include 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) including a benign ambient condition temperature and CO<sub>2</sub> control (AM). These data were collected every second generation between F0 and F4 for all treatments and at F11 for AM and OWA. Data was collected as the number of eggs produced and hatched offspring per female per treatment at each generation.

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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) CO<sub>2</sub>, 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 pCO<sub>2</sub> (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 CO<sub>2</sub>, pH = 8.2; 2) Ocean Acidification (OA): 13°C, 1000 µatm CO<sub>2</sub>, pH = 7.85; 3) Ocean Warming (OW): 15°C, 400 µatm CO<sub>2</sub>, pH = 8.2; 4) Combined warming and acidification (OWA): 15°C, 1000 µatm CO<sub>2</sub>, pH = 7.85. Copepods were fed equal proportions of the live phytoplankters *Tetraselmis* sp., *Rhodomonas* sp., and *Thalassiosira 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.

For each replicate culture within a treatment, 12 pairs of newly developed adult males and females were placed into 25 milliliter (mL) Petri dishes housed in the plexiglass enclosure described above for 96 hours (N= 108 per treatment for F0 to F4). Adults were transferred to a new dish after 48 hours. For food limitation experiments in F11, the 12 pairs were split equally among the three food concentrations. Adults in food limitation experiments laid eggs for 72 hours and were transferred to a new dish daily to maintain food concentration during the experiment. After the egg-laying period, adults were checked for survival and removed from the Petri dishes. Eggs were left in the dishes for an additional 72 hours to hatch and then preserved with non-acid Lugol's solution. Dishes with dead males were used for EPR, but not HS, since fertilization could not be assumed. Dishes with dead females were discarded. We independently evaluated survival in additional assays, thus the measurements for this assay were only used to estimate the number of offspring produced for live copepods. EPR was calculated as the number of eggs produced per female per day and HS was calculated as the proportion of live nauplii from produced eggs.

## Data Processing Description

All data were processed in R (v 4.0.2). Data analysis and visualization code can be accessed at: <https://zenodo.org/badge/latest/doi/505896789>.

## BCO-DMO Processing Description

- Imported original file "EPR\_HS\_data\_total\_w\_11.txt" into the BCO-DMO system.
- Renamed fields to comply with BCO-DMO naming conventions.
- Saved final file as "924126\_v1\_a\_hudsonica\_ep\_and\_hs.csv".

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## Data Files

File
<b>924126_v1_a_hudsonica_ep_and_hs.csv</b> (Comma Separated Values (.csv), 11.46 KB) MD5:90d97f80d9805723cc288c2a96996aab
Primary data file for dataset ID 924126, 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>

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) **Body size 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 2024-04-03 doi:10.26008/1912/bco-dmo.924236.1 [[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) **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) **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>

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## Parameters

Parameter	Description	Units
Generation	The corresponding generation when egg production and egg hatching success was measured	unitless
Number	The individual technical replicate	unitless
Treatment	Corresponding treatment evaluated	unitless
Temp	Target temperature for each treatment	degrees Celsius
pH	The target pH for each treatment	pH units
EPRtot	The rate of eggs produced	eggs per female per day
Hftot	The frequency of hatching success	nauplii per egg laid
Generation_c	A numeric column for the corresponding generation when egg production and egg hatching success was measured; equivalent to the "Generation" column	unitless
Rep	The biological culture replicate for each treatment	unitless

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## Instruments

<b>Dataset-specific Instrument Name</b>	Olympus SZH-ILLD Stereoscope
<b>Generic Instrument Name</b>	Microscope - Optical
<b>Generic Instrument Description</b>	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
<a href="#">NSF Division of Ocean Sciences (NSF OCE)</a>	<a href="#">OCE-1559075</a>
<a href="#">NSF Division of Ocean Sciences (NSF OCE)</a>	<a href="#">OCE-1559180</a>

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