Growth of Antarctic krill (Euphausia superba) from an experiment at two temperatures and three pH levels, Feb-Mar. 2015

Website: https://www.bco-dmo.org/dataset/820462
Data Type: experimental
Version: 1
Version Date: 2020-08-10

Project
» Collaborative Research: Synergistic effects of Elevated Carbon Dioxide (CO2) and Temperature on the Metabolism, Growth, and Reproduction of Antarctic Krill (Euphausia superba) (OA Krill)

Contributors	Affiliation	Role
Saba, Grace	Rutgers University	Principal Investigator
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Abstract
Antarctic krill (Euphausia superba) growth data collected during an experiment where krill were allowed to molt once in ambient conditions then placed in individual bottles maintained at one of six target treatments: 1) Ambient temperature (0 degrees C) and ambient pH (8.00); 2) Ambient temperature (0 degrees C) and pH = 7.50; 3) Ambient temperature (0 degrees C) and pH = 7.10; 4) Elevated temperature (3 degrees C) and ambient pH (8.00); 5) Elevated temperature (3 degrees C) and pH = 7.50; 6) Elevated temperature (3 degrees C) and pH = 7.10. The bottles were incubated until the either the krill molted a second time or the experiment ended (after 26 days, Feb-March 2015).

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Coverage

Spatial Extent: **Lat**:-64.7741 **Lon**:-64.0526
Temporal Extent: 2015-02-09 - 2015-03-05

Dataset Description

Antarctic krill (Euphausia superba) growth data collected during an experiment where krill were allowed to molt once in ambient conditions then placed in individual bottles maintained at one of six target treatments: 1) Ambient temperature (0 degrees C) and ambient pH (8.00); 2) Ambient temperature (0 degrees C) and pH = 7.50; 3) Ambient temperature (0 degrees C) and pH = 7.10; 4) Elevated temperature (3 degrees C) and ambient pH (8.00); 5) Elevated temperature (3 degrees C) and pH = 7.50; 6) Elevated temperature (3 degrees C) and pH = 7.10. The bottles were incubated until the either the krill molted a second time or the experiment ended (after 26 days).

Methods & Sampling

Sampling and analytical procedures:

Capture and husbandry: Antarctic krill (Euphausia superba) were captured during the austral summer of 2014/2015. Krill were collected by net tow (2 m diameter, 1000 m mesh, non-filtering cod end) off the R/V Laurence M. Gould near the Western Antarctic Peninsula and transported directly to the Palmer Station biological laboratory. One to two thousand krill were housed in one 4'w x 3'h circular holding tank and two 5’ x 2’ x 1’ rectangular tanks provided with aeration and flow-through seawater. Water was non-filtered and individuals were able to feed on plankton ad libitum throughout the season.

Experimental treatments: Six experimental treatments were targeted in this study: 1) Ambient temperature (0 degrees C) and ambient pH (8.00); 2) Ambient temperature (0 degrees C) and pH = 7.50; 3) Ambient temperature (0 degrees C) and pH = 7.10; 4) Elevated temperature (3 degrees C) and ambient pH (8.00); 5) Elevated temperature (3 degrees C) and pH = 7.50; 6) Elevated temperature (3 degrees C) and pH = 7.10. Temperature treatments were obtained using two separate recirculating systems. Three 800 L cylindrical polycarbonate carboys were attached to temperature controlled chillers (Delta Star) and inline pumps. The carboys were filled with non-filtered seawater acquired from the Palmer Station intake line, placed in a flow-through water bath, and maintained at 0 degrees C. Three other 800 L carboys were set up without a chiller and placed in an environmental chamber at 3 degrees C. The systems were replaced with new water daily and allowed to acclimate to temperature for a minimum of 24 hours before the start of a trial or water change. High CO2 conditions were obtained using a peristaltic pump to inject straight CO2 into the propeller of a pump submerged in seawater. Treated water was then gently siphoned with minimal disturbance into treatment bottles.

Krill were picked and placed in individual 4 L wide-mouth polycarbonate bottles with airtight lids (n = 26 per experimental treatment). Bottles were filled with ambient seawater. Bottles were immediately closed and placed in environmental chambers at ambient temperature (0 degrees C). Every 24-48 hours, 80% of the water was siphoned out of each bottle and replaced with new ambient seawater to minimize excretory and respiratory effect. Bottles were checked for molts twice per day. If a molt was observed, the molt was removed for processing (measured for krill uropod and total length), and the krill was placed in another individual 4 L wide-mouth polycarbonate bottle containing one of the six pre-acclimated treatment waters as described above to begin the second phase of the experiment. The bottle was then immediately closed and placed in environmental chambers at either 0 or 3 degrees C. This process was repeated for all the krill after each molted for the first time, enabling the experiment to continue with a total of 26 krill per treatment. Water changes every 24-48 hours with either ambient seawater (for krill awaiting first molt) or with pre-acclimated treatment water (for krill awaiting second molt) and twice daily checks for molts continued for the duration of the experiment. If a second molt was observed, that bottle was pulled from the experiment and the molt and live krill processed. The experiment ended on March 7 due to the end of the Palmer Station field season, and a majority of the krill did not molt a second time. However, the remaining krill were processed for uropod and total length and wet weight.

Analyses: Upon the first molting event for each krill, the molt was gently removed from the bottle. The molt was measured for uropod and total length (mm) with digital calipers (Fowler).

Once a krill molted a second time, both the krill and molt were gently removed from the bottle. Both the molt and krill were measured for uropod and total length (mm) with digital calipers (Fowler), and the krill wet weight (mg) was measured. At the end of the experiment, the remaining krill that did not molt a second time were processed for uropod and total length (mm) and wet weight (mg).

pH was measured in each experimental bottle at the start of the experiment. Salinity, pH, and total alkalinity were measured during water changes. The water changes occurred every 24-48 hours, but we were unable to collect salinity, pH, and total alkalinity samples at every water change due to time constraints. Salinity was measured with a bench top conductivity meter (YSI 3100) calibrated daily with a conductivity standard (50,000 uS/cm; Ricca Chemical Company). pH was determined spectrophotometrically using the indicator dye thymol blue (Dickson et al. 2007; Zhang and Byrne 1996). Total alkalinity was determined on 100 ml subsamples with an open-cell, potentiometric titration of seawater (Metrohm 888 Titrando) with 0.1 M HCl following the potential of a pH electrode (Dickson et al. 2007). Tiamo software (version 2.3) was used to process the alkalinity data. Measurements of pH and TA were quality controlled using certified reference materials (CRMs) obtained from Andrew Dickson at UCSD Scripps Institute of Oceanography

Data Processing Description

BCO-DMO Processing Notes:
- data submitted in Excel file "2015_AntarcticKrill_GrowthExperiment_1.xlsx" sheet "Sheet1" extracted to csv
- removed carbonate table to server separately
- added conventional header with dataset name, PI name, version date
- modified parameter names to conform with BCO-DMO naming conventions
- converted dates to ISO format (yyyy-mm-dd)
- replaced ND with nd for 'no data'

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Data Files

File	
Carbonate chemistry data from the 2015-2 Antarctic krill growth experiments filename: 2015-2_carbonate.csv	(Comma Separated Values (.csv), 2.33 KB) MD5:e4b59751a6c0a3629c21e42f02579cd5
Temperature, salinity, pH, total alkalinity in sample bottles for 2015-2 growth experiments. BCO-DMO Processing Notes: - carbonate data submitted in Excel file "2015_AntarcticKrill_GrowthExperiment_2.xlsx" sheet "Sheet1" extracted to csv - changed date format to ISO format (yyyy-mm-dd) - modified parameter names to conform with BCO-DMO naming conventions - replaced NA with nd for 'no data'	
2015_krill_growth2.csv Primary data file for dataset ID 820462	(Comma Separated Values (.csv), 17.92 KB) MD5:406be120d7c8626ab4f71dc17a4a8c07

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Related Publications

Dickson, A.G., Sabine, C.L. and Christian, J.R. (Eds.) 2007. Guide to best practices for ocean CO2 measurements. PICES Special Publication 3, 191 pp. ISBN: 1-897176-07-4. URL: https://www.nodc.noaa.gov/ocads/oceans/Handbook_2007.html https://hdl.handle.net/11329/249
Methods

Zhang, H., & Byrne, R. H. (1996). Spectrophotometric pH measurements of surface seawater at in-situ conditions: absorbance and protonation behavior of thymol blue. Marine Chemistry, 52(1), 17–25. doi:10.1016/0304-4203(95)00076-3
Methods

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Parameters

Parameter	Description	Units
Bottle_Krill	bottle number	unitless
Treatment_temp	Temperature treatment; either Ambient (0 degrees C) or Elevated (3 degrees C)	unitless

Treatment_Target_pH	Targeted pH treatment; either 8.00; 7.50; or 7.10	unitless
Expt_Start_Date	Date experiment was begun; ISO formatted as yyyy-mm-dd	unitless
First_Molt_Date	Date krill molted in bottle at ambient conditions; krill transferred to bottle under experimental treatments experiment on this date; ISO formatted as yyyy-mm-dd	unitless
Duration_to_first_molt	Length of time between start of experiment and time of first molt	days
First_molt_uropod_length	Krill uropod length determined from the first molt	mm
Total_krill_length_pre_molt	Krill length determined from the first molt	mm
Second_Molt_Date	Date krill molted for second time; under treatment conditions; bottle pulled from experiment on this date; ISO formatted as yyyy-mm-dd	unitless
Duration_between_first_and_second_molt	Length of time between first and second molts	days
Second_molt_uropod_length	Krill uropod length determined from the second molt	mm
Total_krill_length_after_first_molt	Krill length determined from the second molt	mm
Live_krill_uropod_length	Krill uropod length determined from the live krill after either it molted a second time or at the end of the experiment; whichever came first	mm
Live_krill_total_length	Krill length determined from the live krill after either it molted a second time or at the end of the experiment; whichever came first	mm
Krill_wet_weight	Wet weight determined from the live krill after either it molted a second time or at the end of the experiment; whichever came first	mg
Notes	comments on experiment	unitless

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Instruments

Dataset-specific Instrument Name	Delta Star chiller
Generic Instrument Name	Aquarium chiller
Dataset-specific Description	Used to cool water to ambient temperature.
Generic Instrument Description	Immersible or in-line liquid cooling device, usually with temperature control.

Dataset-specific Instrument Name	Fowler digital calipers
Generic Instrument Name	calipers
Dataset-specific Description	Used to measure krill uropod and total lengths.
Generic Instrument Description	A caliper (or "pair of calipers") is a device used to measure the distance between two opposite sides of an object. Many types of calipers permit reading out a measurement on a ruled scale, a dial, or a digital display.

Dataset-specific Instrument Name	YSI 3100 Conductivity Instrument
Generic Instrument Name	Conductivity Meter
Dataset-specific Description	Used to measure salinity in seawater.
Generic Instrument Description	Conductivity Meter - An electrical conductivity meter (EC meter) measures the electrical conductivity in a solution. Commonly used in hydroponics, aquaculture and freshwater systems to monitor the amount of nutrients, salts or impurities in the water.

Dataset-specific Instrument Name	
Generic Instrument Name	Plankton Net
Dataset-specific Description	Net with 2 m diameter, 1000 m mesh, non-filtering cod end. Used to collected krill for experimental analyses.
Generic Instrument Description	A Plankton Net is a generic term for a sampling net that is used to collect plankton. It is used only when detailed instrument documentation is not available.

Dataset-specific Instrument Name	Shimadzu spectrophotometer
Generic Instrument Name	Spectrophotometer
Dataset-specific Description	Used to measure pH in seawater.
Generic Instrument Description	An instrument used to measure the relative absorption of electromagnetic radiation of different wavelengths in the near infra-red, visible and ultraviolet wavebands by samples.

Dataset-specific Instrument Name	Metrohm 888 Titrando
Generic Instrument Name	Titrator
Dataset-specific Description	Instrument used for open-cell titrations to determine total alkalinity in seawater. Used to measure total alkalinity in seawater.
Generic Instrument Description	Titrators are instruments that incrementally add quantified aliquots of a reagent to a sample until the end-point of a chemical reaction is reached.

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Project Information

Collaborative Research: Synergistic effects of Elevated Carbon Dioxide (CO2) and Temperature on the Metabolism, Growth, and Reproduction of Antarctic Krill (Euphausia superba) (OA Krill)

Website: http://coseenow.net/project-parka/

Coverage: Palmer Station, Antarctica

NSF Award Abstract:
Climate change projections for this century suggest that the Southern Ocean will be the first region to be affected by seawater chemistry changes associated with enhanced carbon dioxide (CO2). Additionally, regions of the Southern Ocean are warming faster than any other locations on the planet. Ocean acidification and warming may act synergistically to impair the performance of different organisms by simultaneously increasing metabolic needs and reducing oxygen transport. However, no studies have measured krill acid-base regulation, metabolism, growth, or reproduction in the context of ocean acidification or synergistic ?greenhouse? conditions of elevated CO2 and temperature. In the present project, the investigators will conduct both short and prolonged exposure experiments at Palmer Station, Antarctica to determine the responses of Euphausia superba to elevated CO2 and temperature. The investigators will test hypotheses related to acid-base compensation and acclimation of various life stages of krill to elevated CO2 and temperature. Furthermore, they will determine these impacts on feeding, respiration, metabolism, growth, and reproduction.

The Antarctic krill, Euphausia superba, is a key species in Antarctic food webs as they are a primary food source for many of the top predators in the Southern Ocean including baleen whales, seals, penguins, and other sea birds. This project will determine the responses of Antarctic krill exposed to elevated CO2 and temperature and whether or not krill have the capacity to fully compensate under future ocean conditions. The proposed field effort will be complemented by an extensive broader impact effort focused on bringing marine science to both rural and urban high school students in the Midwest (Kansas). The core educational objectives of this proposal are to 1) instruct students about potential careers in marine science, 2) engage students and promote their interest in the scientific process, critical thinking, and applications of science, mathematics, and technology, and 3) and increase student and teacher awareness and understanding of the oceans and global climate change, with special focus on the Western Antarctic Peninsula region. Finally, this project will engage undergraduate and graduate students in the production, analysis, presentation and publication of datasets.

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Funding

Funding Source	Award
NSF Office of Polar Programs (formerly NSF PLR) (NSF OPP)	OPP-1641198
NSF Office of Polar Programs (formerly NSF PLR) (NSF OPP)	OPP-1246293

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