Growth of Antarctic krill (Euphausia superba) from a 1-month experiment at ambient conditions, ambient temperature and elevated pCO2, or elevated temperature and elevated pCO2, Jan-Feb. 2015

Website: https://www.bco-dmo.org/dataset/820424
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 a 1-month experiment in Jan-Feb. 2015 where krill were maintained at either ambient conditions, ambient temperature and elevated pCO2, elevated temperature and ambient pCO2, or elevated temperature and elevated pCO2.

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Coverage

Spatial Extent: **Lat**:-64.7741 **Lon**:-64.0526
Temporal Extent: 2015-01-13 - 2015-02-05

Dataset Description

Antarctic krill (Euphausia superba) growth data collected during a 1-month experiment in Jan-Feb. 2015 where krill were maintained at either ambient conditions, ambient temperature and elevated pCO2, elevated temperature and ambient pCO2, or elevated temperature and elevated pCO2.

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: Four experimental treatments were targeted in this study, (1) ambient temperature (0 degrees C) and ambient pCO2/pH (400ppm/8.10), (2) ambient temperature (0 degrees C) and elevated pCO2 (800ppm)/reduced pH (7.7), (3) elevated temperature (3 degrees C) and ambient pCO2 (400ppm/8.10), and (4) elevated temperature (3 degrees C) and elevated pCO2 (800ppm)/reduced pH (7.7). Temperature treatments were obtained using two separate recirculating systems. Two 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. Two 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 of comparable size (31-38 mm) were picked and placed in individual 4 L wide-mouth polycarbonate bottles with airtight lids (n = 30 per experimental treatment). Bottles were filled with one of the four pre-acclimated treatment waters as described above. Bottles were immediately closed and placed in environmental chambers at either 0 or 3 degrees C. Every 24-48 hours, 80% of the water was siphoned out of each experimental bottle and replaced with pre-acclimated water from the 800 L carboys to minimize excretory and respiratory effect of the animals on treatment conditions. During the 23-day experiment, bottles were checked for molts twice per day. If a molt was observed, that bottle was pulled from the experiment and the molt and live krill processed. The experiment ended after the last krill molted.

Analyses: Once a krill molted, 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.

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	
2015_krill_growth1.csv	(Comma Separated Values (.csv), 9.66 KB) MD5:27571f36e18bb0e539315696d7b6f262
Primary data file for dataset ID 820424	

Carbonate chemistry data from the 2015-1 Antarctic krill growth experiments

filename: 2015-1_carbonate.csv (Comma Separated Values (.csv), 1.22 KB)
MD5:d2e6104403d5cd9d5ceff82206ca8a0b

Temperature, pCO2, salinity, pH, total alkalinity in sample bottles for 2015-1 growth experiments.

BCO-DMO Processing Notes:

- carbonate data submitted in Excel file "2015_AntarcticKrill_GrowthExperiment_1.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'

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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)	degrees Celsius
Treatment_pCO2	pCO2 treatment; either Ambient or Elevated (target = 800 ppm)	unitless
Spec_pH_Expt_start	pH determined spectrophotometrically from subsamples of seawater from each bottle at the start of the experiment	unitless
Expt_Start_Date	Date experiment was begun; formatted as yyyy-mm-dd	unitless
Molt_Date	Date krill molted in bottle; bottle pulled from experiment on this date; formatted as yyyy-mm-dd	unitless
Duration_days	Length of time between start of experiment and time of molt;	days
Molt_uropod_length	Krill uropod length determined from the molt	millimeters
Total_krill_length_pre_molt	Krill length determined from the molt	millimeters
Live_krill_uropod_length_post_molt	Krill uropod length determined from the live krill after it molted	millimeters
Live_krill_total_length_post_molt	Krill length determined from the live krill after it molted	millimeters
Krill_wet_wt	Wet weight determined from the live krill after it molted	milligrams
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	Metrohm 888 Titrando
Generic Instrument Name	Automatic 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	Instruments that incrementally add quantified aliquots of a reagent to a sample until the end-point of a chemical reaction is reached.

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.

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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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