Physiological observations of Euphausia pacifica after a ten-day acclimation to dissolved oxygen (DO) and pH conditions in two separate laboratory experiments.

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Data Type: experimental
Version: 1
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Project
» Consequences of hypoxia on food web linkages in a pelagic marine ecosystem (PelagicHypoxia)

Contributors	Affiliation	Role
Keister, Julie E.	University of Washington (UW)	Principal Investigator
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Abstract
Physiological observations of Euphausia pacifica after a ten-day acclimation to dissolved oxygen (DO) and pH conditions in two separate laboratory experiments. Krill was sampled in the Puget Sound, WA, USA aboard R/V Clifford Barnes during cruises CB1073 and CB1078 in 2017.

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Coverage

Spatial Extent: **Lat**:48.01 **Lon**:-122.29

Dataset Description

Experiments done at:

- Friday Harbor Laboratories Ocean Acidification Environmental Laboratory
- NOAA Northwest Fisheries Science Center Mukilteo Research Station

Methods & Sampling

Krill for both experiments were collected from surface waters (upper 50 m) at approximately 48.01, -122.29 using a 60-cm diameter Bongo frame equipped with black 335-µm mesh nets and non-filtering cod ends towed for <10 min. The contents of each cod end were immediately diluted in coolers of seawater and sorted to remove healthy euphausiids. For the pH experiment krill were collected on 23 July 2017 between 23:00-00:30,

stored in 1-4 L containers at a concentration of 5 ind L-1, sealed with all air removed to eliminate splashing, and transported in coolers to the University of Washington Friday Harbor Laboratories (FHL) where they were sorted for healthy female *E. pacifica* (obvious ovary) and put in in experimental chambers between 06:00-08:00 on 24 July 2017. For the DO experiment krill were collected on 20 Sept 2017 between 20:00 and 21:15, krill were transported in coolers to the NOAA Mukilteo Research Station within an hour, sorted for healthy female *E. pacifica* (obvious ovary), and immediately put in experimental chambers. Krill were kept chilled (10-14 °C) at all times and were gently transferred using broad spoons to prevent damage. During experiments krill were fed Shellfish Diet 1800 (Reed Mariculture) twice per day and newly hatched *Artemia salina* (San Francisco Bay Brand) nauplii once per day. All physiological measurements were taken after 10 days of acclimation; individuals were flash frozen in liquid nitrogen after oxygen consumption was measured.

Experimental acclimation to pH was conducted at the FHL Ocean Acidification Environmental Laboratory, using a flow-through system with pH controlled by CO2 bubbling. Target pH levels were 8.0, 7.5, and 7.2: three flow-through systems were used, one per pH treatment. Within each system, conditioned seawater was delivered to eight flow-through boxes that each contained two 500-mL mesh-sided experimental chambers with one individual krill per chamber, for a total of 16 individuals per system. Experimental systems were kept covered in black plastic to reduce light. Temperature was set to 12 °C and oxygen was maintained at ambient levels through bubbling, but not monitored.

Acclimation of krill to different oxygen levels in the laboratory was done at the NOAA Mukilteo Research Station in flow-through experimental systems with independent temperature, pH, and oxygen control. Target dissolved oxygen levels were 3, 5, and 9 mg DO L-1: nine systems were used, three per DO treatment, with krill held individually in a mix of both 250- and 500-mL flow-through containers within the experimental systems. Temperature was maintained at 12 °C and pH at ~7.82; temperature, pH, and dissolved oxygen were monitored continuously.

Data Processing Description

System indicates the system that generated controlled seawater conditions and represents the experimental replicates. Many individual krill were held within one experimental system. For the pH experiment 3 systems were used, only one per treatment condition (104A, 104B, 105A); for the DO experiment nine systems were used with three per treatment condition (M1, M2, M3, M4, M5, M9, M10, M11, M12). System names match the continuously recorded observations of seawater conditions: temperature and pH were monitored during the pH experiment (temperature was not logged in system 104A); DO, pH, and temperature were monitored during the oxygen experiment.

Krill were measured for total length (from behind the eye to the end of the telson) at 6X using a calibrated eyepiece reticle then flash frozen individually in liquid nitrogen. Total length was converted to dry weight (DW) using a published length-weight regression (Feinberg et al. 2007).

Protein content was determined according to the bicinchoninic acid (BCA) method (Smith et al. 1985) using a Pierce BCA Protein Assay Kit (Thermo Scientific).

ETS activity was assayed using the method of Owens and King (1975), as modified by Gómez et al. (1996), and adapted for a 96-well plate. Assays and blanks were measured in triplicate at 25 °C, calculated according to Packard and Christensen (2004), and corrected to *in situ* temperatures (depth integrated) using the Arrhenius equation with an activation energy of 15 kcal mol-1 (Packard et al. 1975) and standardized to protein specific activity, spETS.

AARS was measured following the method of Yebra and Hernadez-León (2004), modified by Yebra et al. (2011), and adapted for a 96-well plate (Yebra et al. 2017). All activities were corrected to *in situ* temperatures with the Arrhenius equation using an activation energy of 8.57 kcal mol-1 (Yebra et al. 2005) and standardized to protein specific activity, spAARS. spAARS_1 was measured with the NADH Blank and calculated as described by Mclaskey et al. (2020). For each sample, assays and NADH Blanks were measured in triplicate.

Oxygen consumption of individual krill was measured at 12 °C by closed-cell respirometry in 22-mL vials containing optical oxygen sensors (PSt7 PreSens) and a 12-mm magnetic stir bar separated from the animal by 200-µm mesh. Measurements were taken every 15 minutes for 2 hours. Krill were kept in filtered seawater to clear their guts for ~1 hr prior to respirometry.

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Data Files

File
krill_physio_experiments.csv (Comma Separated Values (.csv), 9.60 KB) MD5:18448f1ac18c537640b163a848e4f97e Primary data file for dataset ID 840572

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Related Publications

Feinberg, L., Shaw, C., & Peterson, W. (2007). Long-term laboratory observations of Euphausia pacifica fecundity: comparison of two geographic regions. Marine Ecology Progress Series, 341, 141–152. doi:10.3354/meps341141
Methods

Gómez, M., Torres, S., & Hernández-León, S. (1996). Modification of the electron transport system (ETS) method for routine measurements of respiratory rates of zooplankton. South African Journal of Marine Science, 17(1), 15–20. doi:10.2989/025776196784158446
https://doi.org/https://doi.org/10.2989/025776196784158446
Methods

McLaskey, A. K., Keister, J. E., & Yebra, L. (2020). Individual growth rate (IGR) and aminoacyl-tRNA synthetases (AARS) activity as individual-based indicators of growth rate of North Pacific krill, Euphausia pacifica. Journal of Experimental Marine Biology and Ecology, 527, 151360. doi:10.1016/j.jembe.2020.151360
Methods

Owens, T. G., & King, F. D. (1975). The measurement of respiratory electron-transport-system activity in marine zooplankton. Marine Biology, 30(1), 27–36. doi:10.1007/bf00393750
https://doi.org/10.1007/BF00393750
Methods

Packard, T. T., & Christensen, J. P. (2004). Respiration and vertical carbon flux in the Gulf of Maine water column. Journal of Marine Research, 62(1), 93–115. doi:10.1357/002224004607446636
Methods

Packard, T. T., Devol, A. H., & King, F. D. (1975). The effect of temperature on the respiratory electron transport system in marine plankton. Deep Sea Research and Oceanographic Abstracts, 22(4), 237–249. doi:10.1016/0011-7471(75)90029-7
Methods

Smith, P. K., Krohn, R. I., Hermanson, G. T., Mallia, A. K., Gartner, F. H., Provenzano, M. D., … Klenk, D. C. (1985). Measurement of protein using bicinchoninic acid. Analytical Biochemistry, 150(1), 76–85. doi:10.1016/0003-2697(85)90442-7
Methods

Yebra, L. (2004). Aminoacyl-tRNA synthetases activity as a growth index in zooplankton. Journal of Plankton Research, 26(3), 351–356. doi:10.1093/plankt/fbh028
Methods

Yebra, L., Berdalet, E., Almeda, R., Pérez, V., Calbet, A., & Saiz, E. (2011). Protein and nucleic acid metabolism as proxies for growth and fitness of Oithona davisae (Copepoda, Cyclopoida) early developmental stages. Journal of Experimental Marine Biology and Ecology, 406(1-2), 87–94. doi:10.1016/j.jembe.2011.06.019
Methods

Yebra, L., Harris, R. P., & Smith, T. (2005). Comparison of five methods for estimating growth of Calanus helgolandicus later developmental stages (CV–CVI). Marine Biology, 147(6), 1367–1375. doi:10.1007/s00227-005-0039-9
Methods

Yebra, L., Kobari, T., Sastri, A. R., Gusmão, F., & Hernández-León, S. (2017). Advances in Biochemical Indices of Zooplankton Production. Advances in Marine Biology, 157–240. doi:10.1016/bs.amb.2016.09.001
Methods

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Related Datasets

IsRelatedTo

McLaskey, A. K., Keister, J. E. (2021) **Seawater conditions monitored and recorded during two separate laboratory experiments in 2017 to acclimate krill to dissolved oxygen (DO) or pH conditions.** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2021-03-02 doi:10.26008/1912/bco-dmo.842922.1 [view at BCO-DMO]
Relationship Description: Krill physiology observations during the pH and dissolved oxygen experiment.

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Parameters

Parameter	Description	Units
Type	Experiment type: pH or DO experiment	unitless
System	The system that generated controlled seawater conditions and represents the experimental replicates. Many individual krill were held within one experimental system. For the pH experiment 3 systems were used, only one per treatment condition (104A, 104B, 105A); for the DO experiment nine systems were used with three per treatment condition (M1, M2, M3, M4, M5, M9, M10, M11, M12)	unitless
Treatment	Target treatments: DO experiment target treatments were 9.0, 5.0, 3.0 mg DO L-1. For the pH experiment target treatments were pH 8.0, 7.5, and 7.2	unitess
Total_Length	Measured total length of individual krill	millimeters (mm)
Dry_Weight	Dry weight calculated from total length.	milligrams (mg)
Protein	Protein content per individual	milligrams (mg)
spETS_activity	Protein specific Electron Transport System (ETS) activity	umol O2 h-1 mg protein-1
spAARS_activity	Protein specific aminoacyl-tRNA synthetase (AARS) activity	nmol PPi h-1 mg protein-1
spAARS_1_activity	Protein specific aminoacyl-tRNA synthetase (AARS) activity calculated with NADH blank correction described in McLaskey et al. 2020	nmol PPi h-1 mg protein-1
Respiration_rate	Individual oxygen consumption measured by respirometry	umol O2 hr-1 ind-1
Krill_Sampling_Location_Latitude	Latitude of krill sampling location, south is negative	decimal degrees
Krill_Sampling_Location_Longitude	Longitude of krill sampling location, west is negative	decimal degrees
Krill_Sampling_Date	Date of krill sampling in ISO format (yyy-mm-dd), timezone is Pacific Daylight Time.	unitless

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Instruments

Dataset-specific Instrument Name	PreSens Microx 4 with PSt7
Generic Instrument Name	Oxygen Sensor
Dataset-specific Description	PreSens Microx 4 with PSt7 optical oxygen sensors.
Generic Instrument Description	An electronic device that measures the proportion of oxygen (O2) in the gas or liquid being analyzed

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Deployments

CB1073

Website	https://www.bco-dmo.org/deployment/841303
Platform	R/V Clifford A. Barnes
Start Date	2017-06-23
End Date	2017-07-01

CB1078

Website	https://www.bco-dmo.org/deployment/841305
Platform	R/V Clifford A. Barnes
Start Date	2017-08-25
End Date	2017-09-02

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Project Information

Consequences of hypoxia on food web linkages in a pelagic marine ecosystem (PelagicHypoxia)

Coverage: Puget Sound, WA (47 N, 123 W)

Description from NSF award abstract:
Low dissolved oxygen (hypoxia) is one of the most pronounced, pervasive, and significant disturbances in marine ecosystems. Yet, our understanding of the ecological impacts of hypoxia on pelagic food webs is incomplete because of our limited knowledge of how organism responses to hypoxia affect critical ecosystem processes. In pelagic food webs, distribution shifts of mesozooplankton and their predators may affect predator-prey overlap and dictate energy flow up food webs. Similarly, hypoxia may induce shifts in zooplankton community composition towards species that impede energy flow to planktivorous fish. However, compensatory responses by species and communities might negate these effects, maintaining trophic coupling and sustaining productivity of upper trophic level species. The PIs propose to answer the question "Does hypoxia affect energy flow from mesozooplankton to pelagic fish?" They approach this question with a nested framework of hypotheses that considers two sets of processes alternatively responsible for either changes or maintenance of pelagic ecosystem energy flows. They will conduct their study in the Hood Canal, WA. Unlike most hypoxia-impacted estuaries, hypoxic regions of Hood Canal are in close proximity to sites that are not affected. This makes it logistically easier to conduct a comparative study and reduces the number of potential confounding factors when comparing areas that are far apart.

Improved understanding of how hypoxia impacts marine ecosystems will benefit the practical application of

ecosystem-based management (EBM) in coastal and estuarine ecosystems. Effective application of EBM requires that the impacts of human activities are well understood and that ecological effects can be tracked using indicators. This project will contribute to both of these needs. The PIs will share their findings on local and national levels with Federal, State, Tribal, and County biologists. To increase exposure of science to underrepresented groups, the PIs also will provide Native American youth with opportunities to participate in field collections and laboratory processing through summer internships. The PIs will collaborate with the NSF-funded Pacific Northwest Louis Stokes Alliance for Minority Participation and tribes from the Hood Canal region to recruit and mentor students for potential careers in marine science. This project will support several undergraduate researchers, two Ph.D. students, a post-doc, and two early-career scientists.

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Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-1154648

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