Larval mussel shell composition under high and low pH and O2 from SIO, UCSD from 2012 and 2013 (OA_Proxies project)

Website: https://www.bco-dmo.org/dataset/521670
Data Type: experimental
Version: 1
Version Date: 2014-08-07

Project
» Development of geochemical proxies to evaluate larval pH-exposure history (OA_Proxies)

Program
» Science, Engineering and Education for Sustainability NSF-Wide Investment (SEES): Ocean Acidification (formerly CRI-OA) (SEES-OA)

Contributors	Affiliation	Role
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Abstract
Larval mussel shell composition under high and low pH and O2 from SIO, UCSD from 2012 and 2013.

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Coverage

Spatial Extent: **N**:34.4128 **E**:-117.203 **S**:32.725 **W**:-119.842
Temporal Extent: 2012-05-05 - 2013-01-23

Dataset Description

Larval mussel shell composition under high and low pH and O2 from SIO, UCSD from 2012 and 2013.

Methods & Sampling

Mussel larvae were obtained and cultured as described in Frieder et al. 2014, EST. At the end of each experiment, the larvae were frozen then cleaned from organic material using trace-metal-clean techniques in a clean room (described in Frieder et al. 2014, EST).

Once clean and mounted, larvae were individually analyzed for a combination of elements (Mg, Cu, Zn, Sr, Ba,

Pb, U with respect to Ca) at UC Santa Barbara using a New Wave research UP-213 laser ablation unit coupled with a Thermo Element 2 single-collector inductively coupled plasma mass spectrometer operating in low resolution mode.

As described in the supplemental material for Frieder et al. 2014 (EST) "three standards were used to ensure proper calibration of the instrument: a solution-based dissolved CaCO3 reference material (OTO, [Spex certified primary standard solutions]), and two solid standards, NIST 612 and USGS MACS3 CaCO3 standard. All reference materials, both solution- and solid-based, were analyzed at the beginning and the end of each run; mounting medium[, solution standards] and instrument blanks were run multiple times during a sequence. For ablations, laser settings were a single, 30-µm-long by 80-µm-wide line at 40% power, 10 Hz, and 8 µm s-1 scanning speed. These settings usually consumed the entire larval shell. The tape used to mount the shells had less than 5% of the average shell value for each element."

Data Processing Description

All isotope data were originally measured by the mass spec as intensities (counts per second or cps) relative to cps of 48Ca to control for differences in amount of material analyzed per sample. Detection limits were determined by running blanks where no sample material was being analyzed to measure any background levels of the element ratios. For each sequence run, the cps measurements of background blanks were averaged separately for each elemental ratio. The detection limit for each elemental ratio was set to three standard deviations above the average intensity of the blanks. Any sample measurement above the detection limit was determined to be a legitimate sample reading as it was significantly above the background levels. Any sample measurements falling below the detection limit were not used for further analysis.

For those samples with elemental counts above the detection limit, each isotope ratio intensity was compared to the known concentrations of each element in the OTO solution standard and altered for machine drift (measured by comparing the solution standards run throughout the sequence) to determine the element ratios in units of mmol/mol Ca. These mmol/mol or µmol/mol ratios are what we consider to be the "raw" values presented in this mussel geochemistry dataset. All the listed samples were those used in the various statistical analyses.

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Data Files

File
mussel_shell_comp.csv (Comma Separated Values (.csv), 71.23 KB) MD5:7857264654a9e8bcfb8440bbda5b0c16 Primary data file for dataset ID 521670

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Related Publications

Bockmon, E. E., Frieder, C. A., Navarro, M. O., White-Kershek, L. A., & Dickson, A. G. (2013). Technical Note: Controlled experimental aquarium system for multi-stressor investigation of carbonate chemistry, oxygen saturation, and temperature. Biogeosciences, 10(9), 5967–5975. doi:10.5194/bg-10-5967-2013
Methods

Frieder, C. A., Gonzalez, J. P., & Levin, L. A. (2014). Uranium in Larval Shells As a Barometer of Molluscan Ocean Acidification Exposure. Environmental Science & Technology, 48(11), 6401–6408. doi:10.1021/es500514j
Results

Frieder, C. A., Gonzalez, J. P., Bockmon, E. E., Navarro, M. O., & Levin, L. A. (2014). Can variable pH and low oxygen moderate ocean acidification outcomes for mussel larvae? Global Change Biology, 20(3), 754–764. doi:10.1111/gcb.12485
Results

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Related Datasets

IsReferencedBy

Levin, L. A. (2020) **Experimental seawater chemical properties for larval mussel shell study from SIO, UCSD from 2012-2013 (OA_Proxies project).** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2014-08-14 doi:10.26008/1912/bco-dmo.522939.1 [view at BCO-DMO]

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Parameters

Parameter	Description	Units
species	experimental organism taxonomic species name	unitless
sample	sample identification	unitless
replicate	replicate code	unitless
treatment	High pH= ; low pH= ; high O2= ; low O2 =	unitless
Mg_Ca	Mg:Ca ratio	millimoles/mole
Cu_Ca	Cu:Ca ratio	millimoles/mole
Zn_Ca	Zn:Ca ratio	millimoles/mole
Sr_Ca	Sr:Ca ratio	millimoles/mole
Ba_Ca	Ba:Ca ratio	micromoles/mole
Pb_Ca	Pb:Ca ratio	micromoles/mole
U_Ca	U:Ca ratio	micromoles/mole

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Instruments

Dataset-specific Instrument Name	ICP Mass Spec
Generic Instrument Name	Inductively Coupled Plasma Mass Spectrometer
Dataset-specific Description	LA-ICP-MS (Laser Ablation Inductively Coupled Plasma Mass Spectrometry): Thermo Element 2 single-collector ICP-MS operating in low-resolution mode with a New Wave Research UP-213 laser ablation unit (at the University of California Santa Barbara).
Generic Instrument Description	An ICP Mass Spec is an instrument that passes nebulized samples into an inductively-coupled gas plasma (8-10000 K) where they are atomized and ionized. Ions of specific mass-to-charge ratios are quantified in a quadrupole mass spectrometer.

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Deployments

Levin_mussels

Website	https://www.bco-dmo.org/deployment/523534
Platform	SIO Levin
Start Date	2012-11-22
End Date	2013-01-23
Description	Study of larval mussel shell trace elements. Adult M. californianus were collected from the Scripps Institution of Oceanography pier in southern California, U.S.A. (32.867° N 117.257° W), and adult M. galloprovincialis were collected from San Diego Bay, California, U.S.A. (32.725° N 117.203° W). Laser ablation was performed at UCSB (34.412824, -119.841964).

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Project Information

Development of geochemical proxies to evaluate larval pH-exposure history (OA_Proxies)

Coverage: Southern California, 32 N 117 W

This research is funded as part of NSF CRI Ocean Acidification Category 2. The investigators will develop a new interdisciplinary partnership between connectivity ecology (Levin at SIO), metal isotope geochemistry (Anbar and Gordon at ASU), and paleoclimatology (Herrmann at ASU/LSU) to identify new proxies for ocean acidification that can be used to assess pH exposures in living organisms and, potentially to interpret the geologic record. The investigators hypothesize that the isotopic composition of larval calcium carbonates reflects changes in seawater chemistry driven by ocean acidification and, in some instances, with associated decline in oxygen levels. The large extent to which these two parameters vary in concert in the modern and past ocean (and thus have joint influence), and the extent to which they may be uncoupled by anthropogenic CO2 inputs, merits considerable attention. Thus, the integration of pH and oxygen in proxy development would be an important advance.

The focus of this project is on proxy development to determine pH exposure history for living organisms in their larval state, and will center on calcium, boron, and uranium isotopes as well as multi-elemental fingerprints. For this project, the investigators will target open coast, front bay and backbay mytilid mussel species, each living naturally under a different pH regime, and statoliths of encapsulated market squid larvae from the open shelf. Larvae with known pH, oxygen and temperature exposure histories will be obtained from (1) laboratory larval rearing experiments that manipulate pH and oxygen and (2) in situ out planting of lab-spawned larvae in larval homes onto existing moorings where pH, T and oxygen are being monitored. Analyses will employ SIMS (for del 11B), multicollector (for del 44Ca, del 238 U), and laser ablation ICP-MS (targeting B, Cu, U, Pb, Mo, and a suite of additional pH- and redox-sensitive trace elements). Multivariate statistical tools will define ability to detect pH-induced signatures and to determine species or taxon-specific vital effects. The investigators are exploring proxies for invertebrate larvae that are untested in the context of acidification geochemistry. Targeting larvae is critical as many marine organisms produce larval carbonate structures and these stages may be most affected by ocean acidification. The retention of larval shell and statoliths after recruitment may ultimately allow us to test the importance of larval pH and O2 exposure to survival and population persistence. An ability to assess past exposures through geochemical proxies will provide information about relative pH tolerances and ecosystem-level change in response to changes in the ocean's carbonate chemistry.

NOTE: A series of laboratory experiments were run in which *Mytilus* spp. larvae (*Mytilus californianus* and *Mytilus galloprovincialis*) and *Doryteuthis opalescens* (market squid) embryos were reared under controlled temperature, pH and oxygen conditions. Experimental conditions are given in Table 1 (for mussel larvae) and Table 2 (for squid embryos). Geochemistry data in the form of Metal:Ca ratios for mussels has been uploaded to BCO-DMO as "Mussel shell trace element ratios" and squid statolith geochemistry data are available on request.

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Program Information

Science, Engineering and Education for Sustainability NSF-Wide Investment (SEES): Ocean Acidification (formerly CRI-OA) (SEES-OA)

Website: https://www.nsf.gov/funding/pgm_summ.jsp?pims_id=503477

Coverage: global

NSF Climate Research Investment (CRI) activities that were initiated in 2010 are now included under Science, Engineering and Education for Sustainability NSF-Wide Investment (SEES). SEES is a portfolio of activities that highlights NSF's unique role in helping society address the challenge(s) of achieving sustainability. Detailed information about the SEES program is available from NSF (https://www.nsf.gov/funding/pgm_summ.jsp?pims_id=504707).

In recognition of the need for basic research concerning the nature, extent and impact of ocean acidification on oceanic environments in the past, present and future, the goal of the SEES: OA program is to understand (a) the chemistry and physical chemistry of ocean acidification; (b) how ocean acidification interacts with processes at the organismal level; and (c) how the earth system history informs our understanding of the effects of ocean acidification on the present day and future ocean.

Solicitations issued under this program:
NSF 10-530, FY 2010-FY2011
NSF 12-500, FY 2012
NSF 12-600, FY 2013
NSF 13-586, FY 2014
NSF 13-586 was the final solicitation that will be released for this program.

PI Meetings:
1st U.S. Ocean Acidification PI Meeting(March 22-24, 2011, Woods Hole, MA)
2nd U.S. Ocean Acidification PI Meeting(Sept. 18-20, 2013, Washington, DC)
3rd U.S. Ocean Acidification PI Meeting (June 9-11, 2015, Woods Hole, MA – Tentative)

NSF media releases for the Ocean Acidification Program:

Press Release 10-186 NSF Awards Grants to Study Effects of Ocean Acidification

Discovery Blue Mussels "Hang On" Along Rocky Shores: For How Long?

Discovery nsf.gov - National Science Foundation (NSF) Discoveries - Trouble in Paradise: Ocean Acidification This Way Comes - US National Science Foundation (NSF)

Press Release 12-179 nsf.gov - National Science Foundation (NSF) News - Ocean Acidification: Finding New Answers Through National Science Foundation Research Grants - US National Science Foundation (NSF)

Press Release 13-102 World Oceans Month Brings Mixed News for Oysters

Press Release 13-108 nsf.gov - National Science Foundation (NSF) News - Natural Underwater Springs Show How Coral Reefs Respond to Ocean Acidification - US National Science Foundation (NSF)

Press Release 13-148 Ocean acidification: Making new discoveries through National Science Foundation research grants

Press Release 13-148 - Video nsf.gov - News - Video - NSF Ocean Sciences Division Director David Conover answers questions about ocean acidification. - US National Science Foundation (NSF)

Press Release 14-010 nsf.gov - National Science Foundation (NSF) News - Palau's coral reefs surprisingly resistant to ocean acidification - US National Science Foundation (NSF)

Press Release 14-116 nsf.gov - National Science Foundation (NSF) News - Ocean Acidification: NSF awards $11.4 million in new grants to study effects on marine ecosystems - US National Science Foundation (NSF)

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Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-1041062

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