Dataset 3: Field measurements of periostracum cover of mussels from focal population collected at Marshall Gulch Beach, CA in July and August 2022

Website: https://www.bco-dmo.org/dataset/935484
Data Type: Other Field Results
Version: 1
Version Date: 2024-08-19

Project
» Invertebrate calcification and behavior in seawater of decoupled carbonate chemistry (OA decoupling)

Contributors	Affiliation	Role
Gaylord, Brian	University of California-Davis (UC Davis-BML)	Principal Investigator
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Abstract
These data build off of experimental incubations described in Dataset 1 and 2. To contextualize laboratory incubations, we measured periostracum cover of live California mussels from multiple microhabitats (relative tidal height and degree of sun exposure) in our focal sample population. This dataset represents periostracum cover measurements of California Mussels conducted at Marshall Gulch Beach, CA in July and August 2022. Dataset 1: Lab incubations of mussels (Mytilus californianus) in 2022 to examine the influence of periostracum cover and pH on external shell dissolution collected at Marshall Gulch Beach, CA from August 2021 to March 2022 (see BCO-DMO related dataset) Dataset 2: Lab incubations of mussels in 2022 to examine the influence of simulated abrasion of periostracum on external shell dissolution collected at Marshall Gulch Beach, CA from August 2021 to March 2022 (see BCO-DMO related dataset)

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Coverage

Location: Marshall Gulch, California
Spatial Extent: **Lat**:38.369738 **Lon**:-123.073921
Temporal Extent: 2022-07-17 - 2022-08-18

Methods & Sampling

To provide ecological context for the laboratory dissolution experiments, we also measured the percent cover of periostracum of living California mussels in the field, focusing on mussels inhabiting different microhabitats within the intertidal zone. We sampled mussels across two tidal heights and three levels of sun exposure on 17 July and 18 August 2022 from the same population where we had collected mussels for the laboratory trials (Marshall Gulch Beach, California). We sampled from the topmost layer of mussels within a 20 cm x 20 cm quadrat positioned within the center of each of 8 mussel beds at each tidal height (characterized as ‘high’ or low’, -0.3 – +0 m sea level height (SLH) and +0.3 - +1 m SLH), haphazardly choosing the first 20 adult individuals within a pre-selected size range (n = 113 mussels total, 54 mm + 4 mm SD). We characterized sun exposure based on the cardinal direction of the mussel bed orientation, which included mussels oriented 200°

– 240° SW (termed ‘intense’), 30° – 70° NE (termed ‘average’), and 300° – 340° NW (termed ‘shade’). We photographed both valves of each mussel, ensuring a scale bar was visible in the field of view for use in ImageJ, and averaged the coverage of periostracum across the two valves as the metric of percent cover for a given individual.

Data Processing Description

Data analysis:

We performed computations with R statistical software, RStudio version 2023.06.2. We used a two-way ANOVA to compare average periostracum cover in adult mussels collected from the field at two relative tidal heights and three levels of sun exposure. We omitted the interaction term between the treatments after confirming it failed to explain significant variability in the model. Using tidal height and sun exposure as categorical predictors to explain periostracum cover, we then ran a TukeyHSD test (95% confidence) to identify which microhabitat types differed from one another via post-hoc, pairwise comparisons.

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Related Datasets

IsRelatedTo

Gaylord, B. (2024) **Dataset 1: Lab incubations of mussels (Mytilus californianus) in 2022 to examine the influence of periostracum cover and pH on external shell dissolution collected at Marshall Gulch Beach, CA from August 2021 to March 2022.** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2024-08-19 http://lod.bco-dmo.org/id/dataset/935476 [view at BCO-DMO]
Relationship Description: Mussels from the same population as Dataset 2 & Dataset 3 examining the influence of periostracum cover and pH on external shell dissolution

Gaylord, B. (2024) **Dataset 2: Lab incubations of mussels in 2022 to examine the influence of simulated abrasion of periostracum on external shell dissolution collected at Marshall Gulch Beach, CA from August 2021 to March 2022.** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2024-08-19 http://lod.bco-dmo.org/id/dataset/935480 [view at BCO-DMO]
Relationship Description: Mussels from the same population as Dataset 1 and Dataset 3 examining the influence of simulated abrasion of periostracum on external shell dissolution

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Parameters

Parameter	Description	Units
ID	Shell ID: identification number of individual mussel valve	unitless
species	Mussel species	unitless
AphiaID	Unique identifier for the listed taxon in the Aphia database.	unitless
LSID	Life Science Identifier (LSID) for the listed taxon.	unitless
lat	latitude, South is negative	deicmal degrees
lon	longitude, West is negative	decimal degrees
date_start	collection start date	unitless
date_end	collection end date	unitless
light	Microhabitat: sun exposure based on the cardinal direction of the mussel bed orientation, which included mussels oriented 200° – 240° SW (termed 'intense'), 30° – 70° NE (termed 'average'), and 300° – 340° NW (termed 'shade'): N (shady), M (average), or F (intense)	unitless
height	Microhabitat: tidal height: tidal height characterized as 'high' (HT) or low' (LT) based on measured sea level height (-0.3 – +0 m sea level height (SLH) and +0.3 - +1 m SLH)	unitless
peri_percent	Periostracum cover: percent cover of intact periostracum over mussel valve	percentage (%)
shell_L_avg	Valve length: average value between longest measured length of both mussel valves (ImageJ)	milimeter (mm)
shell_A_avg	Shell area: average mussel valve area measurement between both mussel valves (ImageJ)	milimeters squared (mm^2)

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Project Information

Invertebrate calcification and behavior in seawater of decoupled carbonate chemistry (OA decoupling)

Coverage: California coast, USA

NSF Award Abstract:
This research is exploring the capacity of coastal organisms to cope with alterations in seawater chemistry driven by both freshwater inputs and absorption of carbon dioxide into the world's oceans (ocean acidification). The project focuses on calcification responses and behavioral impairments of shoreline animals under altered seawater chemistry, and forefronts a common mussel species (the California mussel), and a common snail (the black turban snail), each abundant on rocky shores along the west coast of North America. The target species operate as exemplar organisms for characterizing the responses of marine invertebrates more generally. Methods involve experimental decoupling of multiple components of the carbonate system of seawater to isolate drivers that are difficult to separate otherwise. Broader impacts include transfer of scientific information to policy-makers, including legislators, as well as training and skill-set development of future generations of scientists and citizens. One Ph.D. student is supported, as are UC Davis undergraduates conducting mentored research. The project also provides research internships for undergraduates from a local community college (Santa Rosa Junior College), many of whom are from underrepresented groups. The latter project component substantially bolsters an ongoing program at Bodega Marine Laboratory that includes efforts in diversity, equity, and inclusion. Data and interpretations from the project are feeding into an existing educational program that links to local K-12 schools and reaches ~10,000 members of the public each year.

Overall, the research of the project is dissecting drivers of calcification and behavioral disruption in key shoreline invertebrates, across present-day and future carbonate system conditions appropriate to coastal marine environments. Efforts are exploring the extent to which calcification depends on one versus multiple parameters of the seawater carbonate system. In particular, existing conceptual models emphasize the importance of calcium carbonate saturation state (Ω) and/or the ratio of bicarbonate to hydrogen ion concentrations ([HCO3-]/[H+]), and the project is examining these mechanisms as well as the possibility that more than one driver acts simultaneously. It is doing so both in bivalves and in gastropods to test for generality across mollusks. The project is additionally examining whether pH is the only carbonate system factor contributing to known patterns of behavioral impairment in marine invertebrates. Leading explanations for debilitating behaviors induced by ocean acidification involve altered ion channel function, but discussion in the literature continues, and studies that explicitly decouple the carbonate system are necessary.

This award reflects NSF's statutory mission and has been deemed worthy of support through evaluation using the Foundation's intellectual merit and broader impacts review criteria.

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Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-2129942

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