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

Website: https://www.bco-dmo.org/dataset/935480
Data Type: Other Field Results, experimental
Version: 1
Version Date: 2024-08-19

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

Contributors	Affiliation	Role
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Abstract
These data build off of experimental incubations described in Dataset 1. Given that the periostracum can be eroded over time, we were interested in whether the abrasion of the periostracum by sand of differing coarseness might separately influence dissolution rates under corrosive seawater conditions. Therefore, we conducted incubations of abraded California mussel valves (in addition to unsanded control valves) and measured dissolution rates as a function of sand paper grit coarseness (pH = 7.4). This dataset represents shell dissolution data of California Mussels from lab experiments conducted at the Bodega Marine Laboratory, University of California, Davis in 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)

Table of Contents

Coverage

Location: Marshall Gulch, California
Spatial Extent: **Lat**:38.369738 **Lon**:-123.073921
Temporal Extent: 2021-08-01 - 2022-08-22

Methods & Sampling

We performed dissolution assays to explore how the coarseness of sand grit used to simulate abrasive removal of the periostracum might modify rates of dissolution of underlying shell. As in the first set of trials, individual California mussel valves were placed into individual incubation bottles, and shell loss was determined using the alkalinity anomaly method based on measured increases in seawater TA described above. Seawater conditions were modified following methods of chemical addition (described above) and reduced seawater pH (pH = 7.4) without changing seawater TA. Mussels were collected and sacrificed in a similar way to Dataset 1; following sacrifice, the interior surface of the mussel valves were coated with silicone to prevent interior shell

dissolution signal.

Mussel valve preparation: To prepare mussel valves for the incubation, shell periostracum was abraded using sanding sponges (Gator brand) of two levels of grit coarseness (P50-60: coarse (n = 11), and P120-150: fine (n = 12)). We included control mussel valves (15% of daily sample size), collected with no periostracum cover, to compare dissolution rates between abraded and periostracum that was removed naturally in the field.

Data Processing Description

Data analysis: We performed computations with R statistical software, RStudio version 2023.06.2. We performed carbonate system calculations using the package *seacarb*. To understand whether abrasion from sand of differing coarseness might influence dissolution, we computed the difference between dissolution rates of mussel valves in abrasion treatments, and those of unsanded control (collected with < 5% periostracum cover) valves exposed to similar low-pH conditions. We then used a Welch's independent sample t-test to determine whether differences in average dissolution existed between the sanding treatments. Assumptions of normality and homogeneity of variances were assessed visually using QQ-plots.

[table of contents | back to top]

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 3: Field measurements of periostracum cover of mussels from focal population collected at Marshall Gulch Beach, CA in July and August 2022.** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2024-08-19 http://lod.bco-dmo.org/id/dataset/935484 [view at BCO-DMO]
Relationship Description: Mussels from the same population as Dataset 1 & Dataset 2 with field measurements of periostracum cover of mussels

[table of contents | back to top]

Parameters

Parameter	Description	Units
INDEX	Shell ID: identification number of individual mussel valve	unitless
lat	latitude, South is negative	deicmal degrees
lon	longitude, West is negative	decimal degrees

date	Date of starting incubation	unitless
time_in	Date and time of incubation start	unitless
date_out	Date of end of incubation	unitless
time_out	Date and time of incubation end	unitless
medium	description	unitless
sanding	Sanding treatment: Sand grit coarseness applied to shell to abrade periostracum (X). Coarse or Fine	unitless
ph_spec_0	Initial pH of seawater (total scale) measured by spectrophotometer using m-cresol dye calibration	unitless
temp_0	Initial seawater temperature	Degrees Celsius (°C)
sal_0	Initial seawater salinity	unitless
peri_percent	Periostracum cover: percent cover of intact periostracum over mussel valve	percentage (%)
shell_A	Mussel valve area measurement (ImageJ)	milimeters squared (mm^2)
shell_L	Longest measured length of valve (ImageJ)	milimeter (mm)
shell_W	Widest measured width of mussel valve (ImageJ)	milimeter (mm)
incub_day	Length of incubation in days	day
incub_hr	Length of incubation in hours	hour
incub_min	Length of incubation in minutes	minute
alk_t0	Initial alkalinity: measured alkalinity of seawater prior to incubation	micromole per kg (umol/kg)
alk_t1	Final alkalinity: measured alkalinity of seawater after completion of incubation	micromole per kg (umol/kg)

alk_t0_t1	Alkalinity change: change in alkalinity from initial measurement to final measurement (negative value indicates an increase in alkalinity)	micromole per kg (umol/kg)
alk_t0_t1_norm	Alkalinity change per hour: measured change in alkalinity normalized per hour of incubation	micromole per kg per hour (umol kg-1 hr-1)
diss	Dissoluton rate: inverse of alkalinity change measurement	micromole per kg per hour (umol kg-1 hr-1)
diss_diff	Normalized difference in Dissolution rate: dissolution rate normalized to individual shell area measurements and subtracted from control valve dissolution rates	micromole per kg per hr per milimeter squared (umol kg-1 hr-1 mm-2)

[table of contents | back to top]

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.

[table of contents | back to top]

Funding

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

[table of contents | back to top]