Seawater concentration data from an ocean acidification exposure experiment on adult Eastern oysters from Plum Island Sound in 2017

Website: https://www.bco-dmo.org/dataset/888887
Data Type: Other Field Results
Version: 1
Version Date: 2023-02-02

Project
» Collaborative Research: Does ocean acidification induce a methylation response that affects the fitness of the next generation in oysters? (Epigenetics to Ocean)

Contributors	Affiliation	Role
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Abstract
Trace, minor, and major element data from adult Eastern oyster ocean acidification exposure experiments were conducted at the Ries Lab at the Northeastern University Marine Science Center on samples from Plum Island Sound in 2017. This dataset represents the phenotypic and molecular responses in the extrapallial fluid in the adult eastern oyster (Crassostrea virginica) exposed to experimental ocean acidification (OA) over 80 days.

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Coverage

Spatial Extent: **Lat**:42.751636 **Lon**:-70.837023
Temporal Extent: 2017-04 - 2017-04

Methods & Sampling

In this study, we examined the phenotypic and molecular responses in the extrapallial fluid in the adult eastern oyster (*Crassostrea virginica*) exposed to experimental ocean acidification (OA) over 80 days. The collection and culturing of *C. virginica* specimens are detailed in Downey-Wall, A.M., L.P. Cameron, B.M. Ford, E.M. McNally, Y.R. Venkataraman, S.B. Roberts, J.B. Ries, and K.E. Lotterhos. 2020. Ocean acidification induces subtle shifts in gene expression and DNA methylation in the mantle tissue of the Eastern oyster (*Crassostrea virginica*). Frontiers in Marine Science doi: 10.3389/fmars.2020.566419.

Extrapallial fluid (EPF) was extracted as described in Downey-Wall et al. (2020). Extrapallial fluid was extracted by inserting a sterile 5 milliliter (mL) syringe with a flexible 18-gauge polypropylene tip into the EPF cavity through the luer-lock port. The EPF was stored in 2 mL polypropylene microcentrifuge tubes with screw caps (Fisherbrand Catalog No. 02-682-558) and refrigerated at 6 degrees celsius until further analysis.

Since all tanks received water from the same header source, seawater from a subset of six tanks (2 treatment-1) was sampled for elemental analysis. Seawater samples were collected in 50-milliliter (mL) polypropylene centrifuge tubes outside of an oyster sampling timepoint near the halfway point of the experimental exposure (day 63).

Elemental analysis
Extrapallial fluid and seawater were analyzed for trace and minor elements by inductively coupled plasma mass spectrometry (ICPMS). Liquid samples (i.e., EPF, seawater) were diluted to less than 0.05 percent total dissolved solid content with ultra-pure deionized water in 15 mL polypropylene centrifuge tubes and acidified with ultra-pure nitric acid (Fisher TraceMetal Grade Nitric Acid UN2031).

Extrapallial fluid and seawater was analyzed for a suite of 57 elements (including Ca) by ActLabs, Ontario, Canada. Liquid samples were analyzed using the ActLabs ICPMS method.

Data Processing Description

Concentration data are data received from ActLabs:
https://actlabs.com/geochemistry/exploration-geochemistry/4-acid-near-total-digestion/

Concentration data were negative-corrected (i.e., for intercept correction of the calibration) by adding the lowest negative value along with a de minimis constant (0.000001) to each sample for each element that exhibited negative concentration values. Extrapallial fluid and seawater samples were then dilution-corrected. Extrapallial fluid and seawater data were converted to molarity and element-to-calcium ratios were calculated. Values were identified as outliers if the E/Ca ratio deviated by more than 103 from the mean E/Ca ratio for that element. This approach to identifying outliers removes those caused by sampling or equipment error but is more conservative than Tukey's method to identify and remove outliers.

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Data Files

File
seawater_concentration.csv (Comma Separated Values (.csv), 64.96 KB) MD5:aec1bf95bbcb50082c51904b4b2a5209 Primary data file for dataset 888887, version 1.

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Related Publications

Downey-Wall, A. M., Cameron, L. P., Ford, B. M., McNally, E. M., Venkataraman, Y. R., Roberts, S. B., Ries, J. B., & Lotterhos, K. E. (2020). Ocean Acidification Induces Subtle Shifts in Gene Expression and DNA Methylation in Mantle Tissue of the Eastern Oyster (Crassostrea virginica). Frontiers in Marine Science, 7.
https://doi.org/10.3389/fmars.2020.566419
IsRelatedTo

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Related Datasets

IsRelatedTo

Downey-Wall, A., Lotterhos, K., Ries, J. B., Cameron, L. (2023) **Phenotypic responses of Eastern oyster in response to variable length OA exposure conducted in summer 2017 with oysters sampled in Plum Island.** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2023-01-20 http://lod.bco-dmo.org/id/dataset/887553 [view at BCO-DMO]

Lotterhos, K., Ries, J. B. (2023) **Molar Ratios from an adult Eastern oyster ocean acidification exposure experiment at the Northeastern University Marine Science Center in 2017.** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2023-02-02 doi:10.26008/1912/bco-dmo.888911.1 [view at BCO-DMO]

Lotterhos, K., Ries, J. B. (2023) **Shell Concentrations from an adult Eastern oyster ocean acidification exposure experiment on adult Eastern oysters from Plum Island Sound in 2017.** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2023-02-02 doi:10.26008/1912/bco-dmo.888902.1 [view at BCO-DMO]

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Parameters

Parameter	Description	Units
RunID	Unique identifier for the analysis run	unitless
SampleID	Unique identifier for the sample	unitless
Species	type of liquid sample either seawater or extrapallial fluid (EPF)	unitless
SampleType	Species that extrapallial fluid was sampled from	unitless
BivalveID	Bivalve identifier	unitless
SampleWt	weight of the sample	grams
DIWt	weight of the deionized water added to dilute the sample	grams
NitricWeight	weight of the nitric acid added to acidify the sample	grams
ActLabsNitric	weight of nitric acid added by ActLabs	grams
Ag_ugL	measured concentration of silver	micrograms per liter
Al_ugL	measured concentration of aluminum	micrograms per liter
As_ugL	measured concentration of arsenic	micrograms per liter
Ba_ugL	measured concentration of barium	micrograms per liter
Be_ugL	measured concentration of beryllium	micrograms per liter
Bi_ugL	measured concentration of bismuth	micrograms per liter
Ca_ugL	measured concentration of calcium	micrograms per liter
Cd_ugL	measured concentration of cadmium	micrograms per liter
Ce_ugL	measured concentration of Cerium	micrograms per liter
Co_ugL	measured concentration of cobalt	micrograms per liter
Cr_ugL	measured concentration of chromium	micrograms per liter
Cs_ugL	measured concentration of cesium	micrograms per liter
Cu_ugL	measured concentration of copper	micrograms per liter
Dy_ugL	measured concentration of dysprosium	micrograms per liter
Er_ugL	measured concentration of erbium	micrograms per liter

Eu_ugL	measured concentration of europium	micrograms per liter
Fe_ugL	measured concentration of iron	micrograms per liter
Ga_ugL	measured concentration of gallium	micrograms per liter
Gd_ugL	measured concentration of gadolinium	micrograms per liter
Ge_ugL	measured concentration of germanium	micrograms per liter
Hf_ugL	measured concentration of hafnium	micrograms per liter
Hg_ugL	measured concentration of mercury	micrograms per liter
Ho_ugL	measured concentration of holmium	micrograms per liter
In_ugL	measured concentration of indium	micrograms per liter
K_ugL	measured concentration of potassium	micrograms per liter
La_ugL	measured concentration of lanthanum	micrograms per liter
Li_ugL	measured concentration of lithium	micrograms per liter
Lu_ugL	measured concentration of lutetium	micrograms per liter
Mg_ugL	measured concentration of magnesium	micrograms per liter
Mn_ugL	measured concentration of manganese	micrograms per liter
Mo_ugL	measured concentration of molybdenum	micrograms per liter
Na_ugL	measured concentration of sodium	micrograms per liter
Nb_ugL	measured concentration of niobium	micrograms per liter
Nd_ugL	measured concentration of neodymium	micrograms per liter
Ni_ugL	measured concentration of nickel	micrograms per liter
Pb_ugL	measured concentration of lead	micrograms per liter
Pr_ugL	measured concentration of praseodymium	micrograms per liter
Rb_ugL	measured concentration of rubidium	micrograms per liter
Sb_ugL	measured concentration of antimony	micrograms per liter
Sc_ugL	measured concentration of scandium	micrograms per liter
Se_ugL	measured concentration of selenium	micrograms per liter
Si_ugL	measured concentration of silicon	micrograms per liter
Sm_ugL	measured concentration of samarium	micrograms per liter
Sn_ugL	measured concentration of tin	micrograms per liter
Sr_ugL	measured concentration of strontium	micrograms per liter
Ta_ugL	measured concentration of tantalum	micrograms per liter
Tb_ugL	measured concentration of terbium	micrograms per liter
Te_ugL	measured concentration of tellurium	micrograms per liter
Th_ugL	measured concentration of thorium	micrograms per liter
Ti_ugL	measured concentration of titanium	micrograms per liter
Tl_ugL	measured concentration of thallium	micrograms per liter
Tm_ugL	measured concentration of thulium	micrograms per liter
U_ugL	measured concentration of uranium	micrograms per liter
V_ugL	measured concentration of vanadium	micrograms per liter
W_ugL	measured concentration of tungsten	micrograms per liter
Y_ugL	measured concentration of yttrium	micrograms per liter

Yb_ugL	measured concentration of ytterbium	micrograms per liter
Zn_ugL	measured concentration of zinc	micrograms per liter
Zr_ugL	measured concentration of zirconium	micrograms per liter

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Instruments

Dataset-specific Instrument Name	Shiyang-III dental drill
Generic Instrument Name	Drill
Generic Instrument Description	A drill is a tool used for making round holes or driving fasteners. There are many types of drills: some are powered manually, and others use electricity (electric drill) or compressed air as the motive power. Drills with a percussive action (hammer drills) are mostly used in hard materials such as masonry (brick, concrete, and stone) or rock. Some types of hand-held drills are also used to drive screws and other fasteners.

Dataset-specific Instrument Name	
Generic Instrument Name	Inductively Coupled Plasma Mass Spectrometer
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.

Dataset-specific Instrument Name	Mettler Toledo scale
Generic Instrument Name	scale
Dataset-specific Description	Mettler Toledo scale (precision = 0.001g)
Generic Instrument Description	An instrument used to measure weight or mass.

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Project Information

Collaborative Research: Does ocean acidification induce a methylation response that affects the fitness of the next generation in oysters? (Epigenetics to Ocean)

Coverage: Coastal Massachusetts near Nahant: 42°25'06"N 70°54'14"W

NSF Award Abstract:
Marine ecosystems worldwide are threatened by ocean acidification, a process caused by the unprecedented rate at which carbon dioxide is increasing in the atmosphere. Since ocean change is predicted to be rapid, extreme, and widespread, marine species may face an "adapt-or-die" scenario. However, modifications to the DNA sequence may be induced in response to a stress like ocean acidification and then inherited. Such

"epigenetic" modifications may hold the key to population viability under global climate change, but they have been understudied. The aim of this research is to characterize the role of DNA methylation, a heritable epigenetic system, in the response of Eastern oysters (Crassostrea virginica) to ocean acidification. The intellectual merit lies in the integrative approach, which will characterize the role of DNA methylation in the intergenerational response of oysters to ocean acidification. These interdisciplinary data, spanning from molecular to organismal levels, will provide insight into mechanisms that underlie the capacity of marine invertebrates to respond to ocean acidification and lay the foundation for future transgenerational studies. Ocean acidification currently threatens marine species worldwide and has already caused significant losses in aquaculture, especially in Crassostrea species. This research has broader impacts for breeding, aquaculture, and the economy. Under the investigators' "Epigenetics to Ocean" (E2O) training program, the investigators will build STEM talent in bioinformatics and biogeochemistry, expose girls in low-income school districts to careers in genomics, and advance the field through open science and reproducibility.

This research will specifically test if intermittent exposure to low pH induces a methylation response with downstream beneficial effects for biomineralization. These methylation states could be inherited and confer a fitness advantage to larvae that possess them. Phase 1 of the project will use an exposure experiment to determine the degree to which DNA methylation is altered and regulates the response to OA. Data from this experiment will be used to test the hypotheses that (i) DNA methylation, induced in the tissue of shell formation (i.e., mantle tissue), is correlated with changes in transcription and regulation of pallial fluid pH (calcifying fluid pH, measured by microelectrode), and (ii) that methylation changes induced in the mantle tissue are also induced in the germline --indicating that such changes are potentially heritable. Phase 2 of the project will use a pair-mated cross experiment to test the hypothesis that parental exposure to OA alters larval traits (calcification rate, shell structure, and polymorph mineralogy). Larvae will be generated from parents exposed to OA or control seawater, and then raised under control or OA conditions. Results will be used to (i) characterize inheritance of induced methylation states, (ii) estimate the variance in larval traits explained by genotype, non-genetic maternal/paternal effects, adult OA exposure, larval OA exposure, and parental methylome, and (iii) test the hypothesis that adult exposure alters the heritability (a quantity that predicts evolutionary response) of larval traits. Since the effects of epigenetic phenomena on estimates of heritability are highly debated, the results would advance understanding of this important issue. Because the investigators could discover that DNA methylation is a mechanism for heritable plastic responses to OA, knowledge of this mechanism would significantly improve and potentially transform predictive models for how organisms respond to global change.

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Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-1635423

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