Molar Ratios from an adult Eastern oyster ocean acidification exposure experiment at the Northeastern University Marine Science Center in 2017

Website: https://www.bco-dmo.org/dataset/888911
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
Lotterhos, Katie	Northeastern University	Principal Investigator
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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 molar ratio data that were processed using R, using the graphical interface RStudio and then converted to molar ratios to calcium.

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Coverage

Spatial Extent: **Lat**:42.751636 **Lon**:-70.837023
Temporal Extent: 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.

Elemental analysis
Extrapallial fluid, seawater, and shell samples 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 leached in the same manner as those for shell samples. The samples were acidified with ultra-pure nitric acid (Fisher TraceMetal Grade Nitric Acid UN2031). Shell samples were also acidified with ultra-pure nitric acid for analysis.

Extrapallial fluid, seawater, and shell samples were analyzed for a suite of 57 elements (including Ca) by ActLabs, Ontario, Canada. In addition to the common suite of elements, liquid samples were analyzed for Si and shell samples were analyzed for S, P, Au, B, and Re. Liquid samples were analyzed using the ActLabs ICPMS method. Shell samples were analyzed using the ActLabs ICPMS Ultratrace 4 method: https://actlabs.com/geochemistry/exploration-geochemistry/4-acid-near-total-digestion/

This dataset represents molar ratio data that were processed using R (v. 4.0.3; R Core Team 2020) using the graphical interface RStudio (v. 1.0.1073) and then converted to molar ratios to calcium. For each sample type (EPF, seawater, shell), 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.

Data Processing Description

Molar ratio data were processed using R (v. 4.0.3; R Core Team 2020) and the graphical interface RStudio (v. 1.0.1073).

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Data Files

File
traceelements_molarratios.csv filename: traceelements_molarratios.csv (Comma Separated Values (.csv), 99.63 KB) MD5:58667fba22938afc2943e66f7f2f63f7 Primary data file for dataset 888911, 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

References

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]

IsRelatedTo

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]

McNally, E., Lotterhos, K., Ries, J. B. (2023) **Seawater concentration data from an 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.888887.1 [view at BCO-DMO]

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Parameters

Parameter	Description	Units
SampleType	type of sample EPF= extrapallial fluid, seawater, or shell	unitless
Species	Species that the sample was taken from. C_virginica is Crassostrea virginica	unitless
SampleID	Unique identifier for the sample	unitless
TankID	Unique identifier for the tank	unitless
ShellType	sample shell type; M = mantle R = repair AM = above mud UM = under mud	unitless
Ag_Ca	molar ratio of silver to calcium	unitless
Al_Ca	molar ratio of aluminum to calcium	unitless
As_Ca	molar ratio of arsenic to calcium	unitless
Au_Ca	molar ratio of gold to calcium	unitless
B_Ca	molar ratio of boron to calcium	unitless
Ba_Ca	molar ratio of barium to calcium	unitless
Be_Ca	molar ratio of beryllium to calcium	unitless
Bi_Ca	molar ratio of bismuth to calcium	unitless
Ca_Ca	molar ratio of calcium to calcium	unitless
Cd_Ca	molar ratio of cadmium to calcium	unitless
Ce_Ca	molar ratio of cerium to calcium	unitless
Co_Ca	molar ratio of cobalt to calcium	unitless
Cr_Ca	molar ratio of chromium to calcium	unitless
Cs_Ca	molar ratio of cesium to calcium	unitless
Cu_Ca	molar ratio of copper to calcium	unitless
Dy_Ca	molar ratio of dysrosium to calcium	unitless
Er_Ca	molar ratio of erbium to calcium	unitless
Eu_Ca	molar ratio of europium to calcium	unitless
Fe_Ca	molar ratio of iron to calcium	unitless
Ga_Ca	molar ratio of gallium to calcium	unitless
Gd_Ca	molar ration of gadolinium to calcium	unitless
Ge_Ca	molar ratio of germanium to calcium	unitless
Hf_Ca	molar ratio of hafnium to calcium	unitless

Hg_Ca	molar ratio of mercury to calcium	unitless
Ho_Ca	molar ratio of holmium to calcium	unitless
In_Ca	molar ratio of indium to calcium	unitless
K_Ca	molar ratio of potassium to calcium	unitless
La_Ca	molar ratio of lanthanum to calcium	unitless
Li_Ca	molar ratio of lithium to calcium	unitless
Lu_Ca	molar ratio of lutetium to calcium	unitless
Mg_Ca	molar ratio of magnesium to calcium	unitless
Mn_Ca	molar ratio of manganese to calcium	unitless
Mo_Ca	molar ratio of molybdenum to calcium	unitless
Na_Ca	molar ratio of sodium to calcium	unitless
Nb_Ca	molar ratio of niobium to calcium	unitless
Nd_Ca	molar ratio of neodymium to calcium	unitless
Ni_Ca	molar ratio of nickel to calcium	unitless
P_Ca	molar ratio of phosphorous to calcium	unitless
Pb_Ca	molar ratio of lead to calcium	unitless
Pr_Ca	molar ratio of praseodymium to calcium	unitless
Rb_Ca	molar ratio of rubidium to calcium	unitless
Re_Ca	molar ratio of rhenium to calcium	unitless
S_Ca	molar ratio of sulfur to calcium	unitless
Sb_Ca	molar ratio of antimony to calcium	unitless
Sc_Ca	molar ratio of scandium to calcium	unitless
Se_Ca	molar ratio of selenium to calcium	unitless
Si_Ca	molar ratio of silicon to calcium	unitless
Sm_Ca	molar ratio of samarium to calcium	unitless
Sn_Ca	molar ratio of tin to calcium	unitless
Sr_Ca	molar ratio of strontium to calcium	unitless
Ta_Ca	molar ratio of tantalum to calcium	unitless
Tb_Ca	molar ratio of terbium to calcium	unitless
Te_Ca	molar ratio of thorium to calcium	unitless
Th_Ca	molar ratio of titanium to calcium	unitless
Ti_Ca	molar ratio of thulium to calcium	unitless
Tl_Ca	molar ratio of vanadium to calcium	unitless
Tm_Ca	molar ratio of tungsten to calcium	unitless
U_Ca	molar ratio of uranium to calcium	unitless
V_Ca	molar ratio of tellerium to calcium	unitless
W_Ca	molar ratio of thallium to calcium	unitless
Y_Ca	molar ratio of yttrium to calcium	unitless
Yb_Ca	molar ratio of ytterbium to calcium	unitless
Zn_Ca	molar ratio of zinc to calcium	unitless
Zr_Ca	molar ratio of zirconium to calcium	unitless

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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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