# Water quality of experiment measuring phenotypic responses of Eastern oyster in response to variable length OA exposure conducted in summer 2017 with oysters sampled in Plum Island.

**Website**: https://www.bco-dmo.org/dataset/887456
**Data Type**: experimental
**Version**: 1
**Version Date**: 2023-01-19

**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 |
| Ries, Justin B. | Northeastern University | Principal Investigator |
| Cameron, Louise | Northeastern University | Scientist |
| Downey-Wall, Alan | Northeastern University | Scientist |
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**Abstract**
These data water quality readings for oysters exposed to ocean acidification at multiple timepoints over an 80 day period. The experiment was conducted in the summer of 2017 at the Northeastern University's Marine Science Center. The data was collected as part of a larger study aimed at assessing the molecular response of adult Eastern oyster (C. virginica) to OA exposure over time. Specifically, the aim of this work was to investigate the association of these molecular responses with oysters' capacity to regulate internal chemistry and calcification.

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## Coverage

**Spatial Extent**: **N**:42.751636 **E**:-70.813498 **S**:42.681764 **W**:-70.855022
**Temporal Extent**: 2017 - 2017

## Dataset Description

**Data have not been made public due to unanswered questions and data quality issues. Final review by the data submitter was not received after it was imported into the BCO-DMO data system.**

**Reason: the submitter did  not provide enough metadata descriptions, context and details about data relations.**

The data was collected as part of a larger study aimed at assessing the molecular response of adult Eastern oyster (*C. virginica*) to OA exposure over time. Specifically, the aim of this work was to investigate the association of these molecular responses with oysters' capacity to regulate internal chemistry and calcification. Please see the linked Dryad and Github respository for additional information about associated molecular data.

This data was collected by Alan Downey-Wall and other members of the Lotterhos and Ries Lab at Northeastern University.

#### Methods & Sampling

These data water quality readings for oysters exposed to ocean acidification at multiple timepoints over an 80 day period. The experiment was conducted in the summer of 2017 at the Northeastern University's Marine Science Center with a flow-through seawater system that draws water from Broad Sound in Nahant, Massachusetts (42.416884, −70.907564) using oysters collected from Plum Island Sound, Massachusetts, USA (Site 1, 42.751636, −70.837023; Site 2, 42.725186, −70.855022; Site 3, 42.681764, −70.813498) in late April.

**Water Chemistry:** Temperature, pH, and salinity of all tanks were measured three times per week (M,W, and F) for the duration of the experiment. Seawater pH was measured with an Accumet solid state pH electrode (precision = 1 mV) calibrated with pH 7.01 and pH 10.01 NBS buffers (for calibration slope) and Dickson seawater Certified Reference Material (for calibration intercept). Complete carbonate chemistry was determined for each tank every 2 weeks. In brief, seawater samples were collected every 2 weeks in 250 ml borosilicate ground-glass stoppered bottles sealed with vacuum grease from each tank and immediately poisoned with 100 µl saturated HgCl2 solution, then refrigerated until analysis of dissolved inorganic carbon (DIC) and total alkalinity (TA) was performed. DIC, TA, salinity, and temperature were used to calculate calcite saturation state, pH, CO2−3, HCO−3, aqueous CO2, and pCO2 of each sample using CO2SYS version 2.1 (Pierrot et al., 2011).

#### Data Processing Description

Link to data processing: https://github.com/epigeneticstoocean/AE17_Cvirginica_MolecularResponse

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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) - Scrips https://github.com/epigeneticstoocean/AE17_Cvirginica_MolecularResponse
*Software*

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*

Pierrot, D. E. Lewis,and D. W. R. Wallace. 2006. MS Excel Program Developed for CO2 System Calculations. ORNL/CDIAC-105a. Carbon Dioxide Information Analysis Center, Oak Ridge National Laboratory, U.S. Department of Energy, Oak Ridge, Tennessee. doi: 10.3334/CDIAC/otg.CO2SYS_XLS_CDIAC105a.
*Software*

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## Related Datasets

**IsRelatedTo**

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Downey-Wall, A. (2020). *Data from: Ocean acidification induces subtle shifts in gene expression and DNA methylation in mantle tissue of the Eastern oyster (Crassostrea virginica)* (Version 3) [Data set]. Dryad. https://doi.org/10.5061/DRYAD.8CZ8W9GNK https://doi.org//10.5061/dryad.8cz8w9gnk

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]
*Relationship Description: Dataset is part of same experiment.*

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## Parameters

| Parameter | Description | Units |
|---|---|---|
| Timepoint | Unique timepoint category | unitless |
| date | Triweekly water chemistry sample date in ISO format (YYY-MM-DD), UTC time | unitless |
| PCO2 | pCO2 treatment (categorical) | uatm |
| Shelf | Shelf in experimental array (1-6) | unitless |
| Tank | Tank ID for each shelf in experimental array (1-3) | unitless |
| TankID | Unique tank ID across experiment (1-18) | unitless |
| Experimental_Cat | Experimental window (day 9 or day 80) | unitless |
| Exp_Temp | Experimental target temperature (catergorical) | unitless |
| Sal_Corr | Tank salinity | psu |
| Temperature | Tank temperatue | Degrees Celsius (°C) |
| pH_scaleFree | Tank pH (scale free) | pH |
| pH_NBS | Tank pH (NBS) | pH |
| pH_SW | Tank pH (Seawater) | pH |
| pH_Total | Tank pH (Total) | pH |
| CarbChem_date | Biweekly carbonate chemistry sample date in ISO format (YYY-MM-DD), UTC time | Date |
| Calc_corr_CT | Total DIC | uM |
| Calc_corr_AT | Alkalinity | µmol/kg-SW |
| Calc_pH_out | Calculated pH (Generated by CO2Sys) | mol/kg |
| Calc_fCO2_out | Calculated fCO2 (Generated by CO2Sys) | uatm |
| Calc_pCO2_out | Calculated pCO2 (Generated by CO2Sys) | uatm |
| Calc_HCO3_out | Calculated HCO3 (Generated by CO2Sys) | µmol/kg-SW |
| Calc_CO3_out | Calculated CO3 (Generated by CO2Sys) | µmol/kg-SW |
| Calc_CO2_out | Calculated CO2 (Generated by CO2Sys) | µmol/kg-SW |
| Calc_B_Alk_out | Calculated B_Alk (Generated by CO2Sys) | µmol/kg-SW |
| Calc_OH_out | Calculated OH (Generated by CO2Sys) | µmol/kg-SW |
| Calc_P_Alk_out | Calculated P_Alk (Generated by CO2Sys) | µmol/kg-SW |
| Calc_Si_Alk_out | Calculated Si_Alk (Generated by CO2Sys) | µmol/kg-SW |
| Calc_Revelle_out | Calculated Revelle (Generated by CO2Sys) | µmol/kg-SW |
| Calc_Ca_out | Calculated Ca (Generated by CO2Sys) | µmol/kg-SW |
| Calc_Ar_out | Calculated Ar (Generated by CO2Sys) | µmol/kg-SW |
| Calc_CO2_dry_out | Calculated CO2_dry (Generated by CO2Sys) | ppm |

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## Instruments

| | |
|---|---|
| **Dataset-specific Instrument Name** | Aqua Euro USA Model MC-1/4HP aquarium chiller |
| **Generic Instrument Name** | Aquarium chiller |
| **Generic Instrument Description** | Immersible or in-line liquid cooling device, usually with temperature control. |

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|---|---|
| **Dataset-specific Instrument Name** | VINDTA 3C coupled alkalinity gram titration and coulometric DIC analyzer system |
| **Generic Instrument Name** | Automatic titrator |
| **Generic Instrument Description** | Instruments that incrementally add quantified aliquots of a reagent to a sample until the end-point of a chemical reaction is reached. |

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|---|---|
| **Dataset-specific Instrument Name** | YSI 3200 conductivity probe (precision = 0.1 ppt) |
| **Generic Instrument Name** | Conductivity Meter |
| **Generic Instrument Description** | Conductivity Meter - An electrical conductivity meter (EC meter) measures the electrical conductivity in a solution. Commonly used in hydroponics, aquaculture and freshwater systems to monitor the amount of nutrients, salts or impurities in the water. |

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|---|---|
| **Dataset-specific Instrument Name** | Accumet solid state pH electrode (precision = 1mV) |
| **Generic Instrument Name** | pH Sensor |
| **Generic Instrument Description** | An instrument that measures the hydrogen ion activity in solutions. The overall concentration of hydrogen ions is inversely related to its pH. The pH scale ranges from 0 to 14 and indicates whether acidic (more H+) or basic (less H+). |

| | |
|---|---|
| **Dataset-specific Instrument Name** | Orion 91'10DJWP Double Junction micro-pH probe+ |
| **Generic Instrument Name** | pH Sensor |
| **Generic Instrument Description** | An instrument that measures the hydrogen ion activity in solutions. The overall concentration of hydrogen ions is inversely related to its pH. The pH scale ranges from 0 to 14 and indicates whether acidic (more H+) or basic (less H+). |

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|---|---|
| **Dataset-specific Instrument Name** | Bottom-loading scale (Cole Parmer Symmetry S-PT 413E, precision = 0.001 g) |
| **Generic Instrument Name** | scale |
| **Generic Instrument Description** | An instrument used to measure weight or mass. |

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|---|---|
| **Dataset-specific Instrument Name** | NIST-standardized glass thermometer (precision = 0.1 °C) |
| **Generic Instrument Name** | Thermometer |
| **Generic Instrument Description** | A device designed to measure temperature. |

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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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