Littorina obtusata shell length, shell thickness, and tissue mass measured during a field experiment conducted at 12 sites in the Gulf of Maine from April to August 2021

Website: https://www.bco-dmo.org/dataset/911221
Data Type: Other Field Results, experimental
Version: 1
Version Date: 2023-10-11

Project
» Local adaptation and the evolution of plasticity under predator invasion and warming seas: consequences for individuals, populations and communities (evolution of plasticity)

Contributors	Affiliation	Role
Trussell, Geoffrey C.	Northeastern University	Principal Investigator
Corbett, James J.	Northeastern University	Student
Rauch, Shannon	Woods Hole Oceanographic Institution (WHOI BCO-DMO)	BCO-DMO Data Manager

Abstract
This dataset includes measurements of shell length, shell thickness, and tissue mass from a field experiment that utilized 12 Littorina obtusata populations in the Gulf of Maine, with 6 in the northern Gulf and 6 in the southern Gulf.

Table of Contents

Coverage

Spatial Extent: **N**:44.8192 **E**:-66.9661 **S**:42.4215 **W**:-70.9076
Temporal Extent: 2021-04-28 - 2021-08-11

Methods & Sampling

To assess local and regional variation in shell thickness plasticity, we conducted a field experiment that utilized 12 *Littorina obtusata* populations in the Gulf of Main (GOM), with 6 in the northern Gulf and 6 in the southern Gulf. Hence, in addition to the 4 sites surveyed for crab abundance within each region (see Related Datasets), our experiment included two additional sites to increase site replication and power within each region. Juvenile *L. obtusata* (5-6 millimeters (mm) in length) were also collected from each population in late April, returned to the laboratory, and individually tagged with color-coded paint that was sealed with cyanoacrylate glue. Initial shell length and shell thickness were measured with digital calipers (Trussell 1996) and initial tissue mass was determined using a non-destructive weighing technique (see Palmer 1982). The initial measurements of shell length, shell thickness, and tissue mass were made on April 28th and April 29th, 2021.

In mid-May, 2021 snails were placed in replicate chambers and returned to their native sites in the mid-intertidal

zone (+1.5 meters Mean Low Water). In each chamber, we placed four snails (hereafter "response snails") in one of two paired chambers (10 x 10 x 7 centimeters (cm), length x width x height) that had mesh windows (mesh size = 3mm) to allow water flow and the transmission of risk cues. Each chamber also contained approximately 60 grams (g) of brown algae (*Ascophyllum nodosum*) to serve as food for response snails. The other chamber (the "stimulus chamber") was perforated with small holes on all sides which allowed response snails to be exposed to water-borne cues signaling either the presence (Crab, + C) or absence (No Crab, – NC) of predation risk. The 'Crab' treatment was created by placing a mature male green crab, *Carcinus maenas*, and 30 adult *L. obtusata* to serve as food for the crab in the stimulus chamber, whereas stimulus chambers for the 'No Crab' treatment received just 30 adult *L. obtusata*. These paired chambers were housed within a larger plastic chamber (14 x 14 x 16 cm) that also had mesh windows (mesh size = 3mm) to permit water flow. At each site, replicate chambers (n = 4 for each treatment) were anchored beneath the fucoid canopy and Tidbit loggers (Onset Computer Corp.) placed within a subset of chambers recorded seawater temperature at 5-minute intervals. The food supply for crabs was replaced approximately every 21 days while fucoid algae that served as food for the response snails was replaced at day 42. Replicate chambers remained in the field for 90 days before their return to the Northeastern University Marine Science Center (Nahant, Massachusetts) for final measurements of shell length, shell thickness, and tissue mass in response snails. The final measurements were made on August 10th and August 11th, 2021.

Data Processing Description

Data were first recorded manually on paper and then transferred to digital spreadsheets. Fidelity between paper and digital versions of the data were proofed by both Corbett and Trussell.

BCO-DMO Processing Description

- Imported original file named "Data from Local and Regional Geographic Variation in Inducible Defenses.OutplantExperiment.xlsx" into the BCO-DMO system.
- Renamed fields/columns to comply with BCO-DMO naming conventions.
- Removed degrees symbols from LATITUDE and LONGITUDE columns.
- Made LONGITUDE values negative because they're in the Western hemisphere.
- Saved the final file as "911221_v1_outplant_experiment.csv".

[table of contents | back to top]

Data Files

File
911221_v1_outplant_experiment.csv (Comma Separated Values (.csv), 27.79 KB) MD5:ef645804d792caf024fed7b6a540c611 Primary data file for dataset ID 911221, version 1.

[table of contents | back to top]

Related Publications

Corbett, J.J., Trussell, G.C. (In press). Local and regional geographic variation in inducible defenses. Ecology.
Results

Palmer, A.R. (1982). Growth in marine gastropods. A non-destructive technique for independently measuring shell and body weight. Malacologia 23: 63-74.
Methods

Trussell, G. C. (1996). Phenotypic plasticity in an intertidal snail: The role of a common crab predator. Evolution, 50(1), 448–454. Portico. https://doi.org/10.1111/j.1558-5646.1996.tb04507.x
Methods

[table of contents | back to top]

Related Datasets

IsRelatedTo

Trussell, G. C., Corbett, J. J. (2023) **Green crab (Carcinus maenas) density at rocky intertidal sites determined at 8 sites in the Gulf of Maine from April 2019 to December 2021.** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2023-10-12 doi:10.26008/1912/bco-dmo.911365.1 [view at BCO-DMO]

Trussell, G. C., Corbett, J. J. (2023) **Seawater temperatures at high tide at study sites in the Gulf of Maine prior to, during, and after an outplant experiment that was conducted from April to August 2021.** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2023-10-12 doi:10.26008/1912/bco-dmo.911390.1 [view at BCO-DMO]

Trussell, G. C., Corbett, J. J. (2023) **Seawater temperatures at study sites in the Gulf of Maine prior to and during an outplant experiment that was conducted from April to August 2021.** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2023-10-12 doi:10.26008/1912/bco-dmo.911409.1 [view at BCO-DMO]

Trussell, G. C., Corbett, J. J. (2026) **Green crab (Carcinus maenas) density from intertidal surveys in the Gulf of Maine during 1973, 2003, 2017-2018 and 2021.** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2026-03-17 doi:10.26008/1912/bco-dmo.990378.1 [view at BCO-DMO]

Trussell, G. C., Corbett, J. J. (2026) **Latitudinal variation in the shell thickness and tissue mass of Littorina obtusata snails across 20 years as measured in samples collected from the Gulf of Maine from 1995-1997 and 2017-2018.** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2026-03-17 doi:10.26008/1912/bco-dmo.990839.1 [view at BCO-DMO]

IsSupplementTo

Trussell, G. C., Corbett, J. J. (2026) **Morphological data of Littorina obtusata populations from reciprocal transplant experiments in the Gulf of Maine conducted 20 years apart.** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2025-12-29 doi:10.26008/1912/bco-dmo.990830.1 [view at BCO-DMO]

[table of contents | back to top]

Parameters

Parameter	Description	Units
REGION	Region where the site is located (either 'NORTH' or 'SOUTH'). NORTH = Northern Gulf of Maine. SOUTH = Southern Gulf of Maine.	unitless
SITE	Name of the site.	unitless
LATITUDE	Latitude of the site. Positive values indicate North direction.	decimal degrees
LONGITUDE	Longitude of the site. Negative values indicate West direction.	decimal degrees
TREAT	Experimental treatment (either 'CRAB' or 'NO CRAB'). CRAB = The 'Crab' treatment was created by placing a mature male green crab, Carcinus maenas, and 30 adult L. obtusata to serve as food for the crab in the stimulus chamber. NO CRAB = stimulus chambers for the 'No Crab' treatment received just 30 adult L. obtusata	unitless
REPLICATE_MESOCOSM	Replicate mesocosm number.	unitless
Initial_Shell_Length_mm	Initial length of shell of Littorina obtusata; measured on April 28th or April 29th, 2021.	millimeters (mm)
Initial_Shell_Thickness_mm	Initial thickness of shell of Littorina obtusata; measured on April 28th or April 29th, 2021.	millimeters (mm)
Initial_Tissue_Mass_g	Initial tissue mass of Littorina obtusata; measured on April 28th or April 29th, 2021.	grams (g)
Final_Shell_Length_mm	Final length of shell of Littorina obtusata; measured on August 10th or August 11th, 2021.	millimeters (mm)
Final_Shell_Thickness_mm	Final thickness of shell of Littorina obtusata; measured on August 10th or August 11th, 2021.	millimeters (mm)
Final_Tissue_Mass_g	Final tissue mass of Littorina obtusata; measured on August 10th or August 11th, 2021.	grams (g)

[table of contents | back to top]

Instruments

Dataset-specific Instrument Name	Fowler UltraCal III digital calipers
Generic Instrument Name	calipers
Dataset-specific Description	Shell length and shell thickness was measured with digital calipers (Trussell 1996).
Generic Instrument Description	A caliper (or "pair of calipers") is a device used to measure the distance between two opposite sides of an object. Many types of calipers permit reading out a measurement on a ruled scale, a dial, or a digital display.

Dataset-specific Instrument Name	Mettler analytical balance
Generic Instrument Name	scale or balance
Dataset-specific Description	Tissue mass was determined using a non-destructive weighing technique (see Palmer 1982).
Generic Instrument Description	Devices that determine the mass or weight of a sample.

[table of contents | back to top]

Project Information

Local adaptation and the evolution of plasticity under predator invasion and warming seas: consequences for individuals, populations and communities (evolution of plasticity)

NSF Award Abstract:
Over the past two decades, the Gulf of Maine has experienced unprecedented warming that, among other things, has further enabled the invasive green crab to expand its range in rocky shore habitats. The adverse ecological impacts of this invasive predator have been documented worldwide. This study examines how geographic variation in the capacity of two common prey species to respond to the combination of this predator and warming ocean temperatures can shape prey feeding and performance and impact community structure and dynamics. Hence, this research enhances understanding of the evolution of phenotypes, their plasticity, and the nature of adaptation and its role in eco-evolutionary dynamics. More broadly, it informs understanding of how organisms and marine communities may respond to future environmental change. In addition, this project makes contributions to the STEM pipeline by providing middle and high school, undergraduate, and graduate students with cross-disciplinary training in evolutionary and community ecology. In collaboration with an institutional outreach program, the investigator is also developing web-based multimedia projects and teacher resource materials based on this research.

A central principle in ecology is that species residing in the middle of food chains must balance the benefits of eating with the risk of being eaten by their predators. Solving this foraging-predation risk trade-off often involves plasticity in prey traits with consequences for the evolution of adaptation and species interactions that drive community-level processes. Hence, the foraging-predation risk trade-off provides a powerful conceptual framework that links evolutionary and community ecology. Yet at the same time, other environmental stressors like temperature can shape this trade-off, adding complexity that makes it difficult to predict the capacity of organisms to adapt to environmental change and the consequences for communities. The investigator is conducting this study in rocky shore habitats of the Gulf of Maine (GOM) which have long been influenced by strong latitudinal temperature gradients and non-native species invasions. The overarching hypothesis is that predation risk and temperature are factors shaping geographic variation in plasticity and adaptation, with consequences for individuals, populations, and communities. First, the investigator is conducting field experiments to document geographic variation in the trait plasticity of two common prey species in the green crab's diet. Second, he is using reciprocal transplant experiments to examine trait

plasticity in response to risk and water temperature, generating data to compare with similar experiments conducted in the late 90s prior to recent ocean warming and expansion in range of green crabs. Third, he is conducting a laboratory common garden experiment to evaluate the effects of risk and water temperature on trait plasticity. Finally, he is using reciprocal transplant experiments in the field to understand the interactive effects of risk and water temperature on prey foraging rates and the abundance of a species that plays an important role in intertidal community structure and dynamics.

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-2017626

[table of contents | back to top]