Effect of phenotypic variation on dogwhelk morphology during an eco-evolutionary field experiment

Website: https://www.bco-dmo.org/dataset/918546
Data Type: Other Field Results, experimental
Version: 1
Version Date: 2024-01-26

Project
» Coastal mosaics of local adaptation and the eco-evolutionary dynamics of a marine predator-prey interaction (Coastal Adaptation)

Contributors	Affiliation	Role
Sanford, Eric	University of California-Davis (UC Davis-BML)	Principal Investigator
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Abstract
Although there is a growing body of work indicating that ecological and evolutionary processes can have reciprocal feedbacks on one another, few studies have tested these feedbacks in natural field settings at the community level. We tested the ecological consequences of selection on intra-population variation in dogwhelk drilling. We reared juvenile dogwhelks (Nucella canaliculata) on four early-life diet treatments (thin-shelled Mytilus trossulus, two treatments of M. californianus from two populations known to differ in adult shell thickness, and acorn barnacles) and then outplanted the dogwhelks to field cages to quantify the community effects of variation in drilling phenotype on mussel bed succession over a year. Changes in Nucella canaliculata morphology (change in length) were determined over the course of the experiment.

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Coverage

Location: Bodega Marine Reserve, California
Spatial Extent: **Lat**:38.323515 **Lon**:-123.078133
Temporal Extent: 2021-07-20 - 2022-08-29

Methods & Sampling

Dogwhelks (*Nucella canaliculata*) were reared in the lab from hatching on four early-life diet treatments (thin-shelled *Mytilus trossulus*, two treatments of *M. californianus* from two populations known to differ in adult shell thickness, and acorn barnacles). Adult dogwhelks were outplanted to field cages in July of 2021. The tidal height of each cage was measured relative to Mean Lower Low Water (MLLW) using a rotary laser level (DeWalt DW071). Five dogwhelks from the same family (i.e., dogwhelks from the same egg capsule cluster) and early-life diet treatment were placed in each of the cages. Prior to the outplant, the length of dogwhelks was measured with digital calipers, the sex was determined with visual inspection, and the snails were individually marked with small tags (Floy Tags). Cages were checked every 8 weeks for the next year. If a

dogwhelk was dead, it was replaced with another dogwhelk from the same family by diet treatment. At the end of the experiment, the length of the snails was remeasured.

BCO-DMO Processing Description

- Imported original file "Effect of phenotypic variation on dogwhelk morphology during eco-evolutionary field experiment.xlsx" into the BCO-DMO system.
- Flagged "NA" as a missing data value (missing data are empty/blank in the final CSV file).
- Added columns for site Latitude and Longitude.
- Renamed fields/columns to comply with BCO-DMO naming conventions.
- Rounded the "Plot_Tidal_Height" to 5 decimal places.
- Saved the final file as "918546_v1_dogwhelk_morphology.csv".

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Data Files

File	
918546_v1_dogwhelk_morphology.csv	(Comma Separated Values (.csv), 32.68 KB) MD5:0c173ce1d31dc4ff3c6f0f5b25ced02f
Primary data file for dataset ID 918546, version 1	

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Related Datasets

IsRelatedTo

Longman, E. K., Sanford, E. (2024) **Effects of early-life diet on Nucella canaliculata drilling phenotype quantified in the laboratory after rearing on different prey treatments.** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2024-01-24 doi:10.26008/1912/bco-dmo.918460.1 [view at BCO-DMO]
Relationship Description: These datasets result from the same overarching project, in which Dogwhelks were raised on one of 4 diets for 3 months. A portion of the surviving dogwhelks were scored in the laboratory and another portion were outplanted to field cages for a year.

Longman, E. K., Sanford, E. (2024) **Effects of early-life diet on mortality of juvenile Nucella canaliculata quantified in the laboratory after 3 months on experimental diets.** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2024-01-24 doi:10.26008/1912/bco-dmo.918401.1 [view at BCO-DMO]
Relationship Description: These datasets result from the same overarching project, in which Dogwhelks were raised on one of 4 diets for 3 months. A portion of the surviving dogwhelks were scored in the laboratory and another portion were outplanted to field cages for a year.

Longman, E. K., Sanford, E. (2024) **Effects of intra-population variation in dogwhelk drilling on the abundance and size of Mytilus californianus mussels.** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2024-01-25 doi:10.26008/1912/bco-dmo.918582.1 [view at BCO-DMO]
Relationship Description: These datasets result from the same overarching project, in which Dogwhelks were raised on one of 4 diets for 3 months. A portion of the surviving dogwhelks were scored in the laboratory and another portion were outplanted to field cages for a year.

Longman, E. K., Sanford, E. (2024) **Percent cover measure of mussel bed succession on rocky shores due to intra-population variation in dogwhelk drilling.** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2024-01-24 doi:10.26008/1912/bco-dmo.918518.1 [view at BCO-DMO]
Relationship Description: These datasets result from the same overarching project, in which Dogwhelks were raised on one of 4 diets for 3 months. A portion of the surviving dogwhelks were scored in the laboratory and

another portion were outplanted to field cages for a year.

Longman, E. K., Sanford, E. (2024) **Shell thickness of mussel recruits quantified in two species, Mytilus trossulus and Mytilus californianus.** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2024-01-24 doi:10.26008/1912/bco-dmo.918420.1 [view at BCO-DMO]
Relationship Description: These datasets result from the same overarching project, in which Dogwhelks were raised on one of 4 diets for 3 months. A portion of the surviving dogwhelks were scored in the laboratory and another portion were outplanted to field cages for a year.

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Parameters

Parameter	Description	Units
Block	Block number. Plots were in a block design such that 5 plots were near each other. Each block contained snails from the same family or egg capsule cluster, with each cage randomly assigned to contain snails from one of the four early-life diet treatments, plus a reference cage with no dogwhelks. Blocks were numbered sequentially.	unitless
Plot_Number	Unique identifier for each plot.	unitless
Plot_Tidal_Height	Plot tidal height relative to Mean Lower Low Water (MLLW).	meters (m)
Family	Families (dogwhelks from the same egg capsules cluster were considered to be full or half siblings and classified as a family) were given a unique identifier.	unitless
Site_Latitude	Latitude of the Bodega Marine Reserve field site.	decimal degrees
Site_Longitude	Longitude of the Bodega Marine Reserve field site (negative values = West).	decimal degrees
Treatment	Nucella canaliculata early-life diet treatment. Four treatments were used in this study: (1) a control diet of thin-shelled M. trossulus, (2) M. californianus from Soberanes Point, (3) M. californianus from Bodega Marine Reserve, and (4) acorn barnacles (Chthamalus dalli).	unitless
Family_x_Treatment	Each family by early-life diet treatment was given a unique identifier.	unitless
Snail_ID	Each snail was given a unique identifier that represented the family by diet treatment.	unitless
Snail_Tag	Small tags were affixed to the dogwhelks for easy identification in the field.	unitless
Sex	Dogwhelk sex: male (M) or female (F).	unitless
Length_initial	Initial dogwhelk length prior to snail outplant.	millimeters (mm)
Length_final	Final dogwhelk length at the end of the year-long outplant.	millimeters (mm)
Length_change	Change in dogwhelk length over the course of the year-long field outplant experiment.	millimeters (mm)
Dead_vs_Replaced_vs_Never_found	D, NF, or R. Cages were checked every 8 weeks during each check as many dogwhelks as possible were located. Dead dogwhelks (D) were recorded and subsequently replaced (R) with another snail from the same family by diet treatment. At the end of the experiment, it was also noted if a snail was never found (NF).	unitless
Date_dead_or_replaced	Date on which a dead dogwhelk was found or the date that a replacement dogwhelk was placed in the experimental cages.	unitless

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Instruments

Dataset-specific Instrument Name	Floy Tags
Generic Instrument Name	labeling tag
Dataset-specific Description	Floy Tags, Seattle, Washington, USA: Small individual numbered tags were affixed to each dogwhelk
Generic Instrument Description	Passive devices attached to captured organisms to specifically identify them when recaptured after release.

Dataset-specific Instrument Name	Rotary laser level
Generic Instrument Name	Levels and staffs
Dataset-specific Description	DeWalt DW071: Rotary laser level used to measure plot tidal heights relative to Mean Lower Low Water (MLLW)
Generic Instrument Description	Optical instruments and graduated poles used in surveying to determine the elevation of a location relative to a datum level.

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Project Information

Coastal mosaics of local adaptation and the eco-evolutionary dynamics of a marine predator-prey interaction (Coastal Adaptation)

Coverage: Northeast Pacific coast; California and Oregon, USA

NSF Award Abstract:
Historically, ecologists regarded evolution as a process that typically acts slowly over very long time scales. However, recent studies suggest that evolution might also shape the way species interact over much shorter timespans, ranging from weeks to years. Are these sorts of rapid feedbacks between evolution and ecology important in marine ecosystems? This project will address this question along the Pacific coast of the United States by studying predatory snails (Channeled Dogwhelks) that feed on California Mussels, an important habitat-forming species on rocky intertidal shores. Prior research shows that some dogwhelk populations are composed of an assortment of individuals that differ genetically in how effectively they can drill through mussel shells. This project will test whether short-term changes in the environment can impose rapid natural selection that favors some of these drilling variants over others, altering the effects that a dogwhelk population has on the surrounding mussel bed. At the same time, this project will examine whether regional differences in mussel shell thickness have influenced the evolution of drilling ability among dogwhelk populations distributed along >900 kilometers of the California and Oregon coasts. Overall, this study seeks to understand the dynamic feedbacks between evolution and ecology that might influence marine communities in the face of changing ocean conditions. This project will train diverse undergraduate and graduate students and will provide the foundation for a significant public outreach component, including the production of accessible video documentaries.

This project seeks to advance our understanding of eco-evolutionary dynamics in the sea by investigating links among oceanographic variation, natural selection, species interactions, and community succession. This project will use the interaction between the Channeled Dogwhelk (*Nucella canaliculata*) and the California Mussel (*Mytilus californianus*) as a model system to address two central objectives. (1) The research team will explore how spatial mosaics of selection drive adaptive differentiation among populations of consumers. Newly collected and archived mussels will be analyzed to characterize variation in shell thickness along the coasts of California and Oregon, and to evaluate whether this spatial mosaic has been consistent or variable over the past two decades. Laboratory experiments will test whether dogwhelk populations distributed across this mosaic have diverged in the thickness of shell that they can drill successfully. (2) The research team will examine whether temporal variation in selection on consumer phenotypes shapes predator-prey interactions, with cascading effects on ecological dynamics. In particular, the project will test whether short-term variation in

prey recruitment and shell thickness can impose rapid selection on the frequency of drilling phenotypes within a dogwhelk population. A field experiment will also test whether selection on these predator phenotypes in turn alters the trajectory of mussel bed succession.

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.

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Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-1851462

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