Effects of early-life diet on Nucella canaliculata drilling phenotype quantified in the laboratory after rearing on different prey treatments

Website: https://www.bco-dmo.org/dataset/918460
Data Type: experimental, Other Field Results
Version: 1
Version Date: 2024-01-24

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: Bodega Marine Laboratory (UC Davis-BML)	Principal Investigator
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Abstract
The growing field of eco-evolutionary dynamics has highlighted the importance of reciprocal feedbacks between evolutionary and ecological processes. We tested whether selection could act on existing within-population variation in a predatory trait in the marine dogwhelk, Nucella canaliculata. We reared newly hatched dogwhelks on four prey treatments (thin-shelled Mytilus trossulus, two treatments of M. californianus from two populations known to differ in adult shell thickness, and acorn barnacles). To quantify dogwhelk phenotype, we tested the surviving adult dogwhelks on their ability to drill mid-sized (5-7cm long) M. californianus. We found evidence that dogwhelk phenotype varied among the early-life diet treatments.

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Coverage

Location: Bodega Marine Reserve and Soberanes Point, California; and Bob Creek, Oregon
Spatial Extent: **N**:38.3235 **E**:-121.929 **S**:36.4476 **W**:-123.078
Temporal Extent: 2021-06-07 - 2022-02-17

Methods & Sampling

Adult dogwhelks were scored for their ability to drill mid-sized (5 to 7 centimeters long) *Mytilus californianus* mussels during a 100-day laboratory experiment. 12 adult dogwhelks from 18 Bodega Marine Reserve families (dogwhelks that hatched from the same egg capsule cluster were considered a 'family' of snails) and from 4 Soberanes Point families were scored. Dogwhelks were held in individual containers with flowing seawater. Checks were performed routinely every 3 weeks to assess dogwhelk drilling. If a mussel was drilled, it was recorded and replaced with another mussel. Two metrics for dogwhelk drilling were quantified – a binary trait if

a dogwhelk was able to drill at least one mussel during the course of the experiment, and the total number of mussels drilled per snail. The experiment was performed in two rounds due to space limitations.

BCO-DMO Processing Description

- Imported original file "Effects of early-life diet on Nucella canaliculata drilling phenotype.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.
- Saved the final file as "918460_v1_Nucella_canaliculata_drilling_phenotype.csv".

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Data Files

File	
918460_v1_nucella_canaliculata_drilling_phenotype.csv	(Comma Separated Values (.csv), 77.79 KB) MD5:dda0e210c01540f54c1b3401ebe826b2
Primary data file for dataset ID 918460, version 1	

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Related Datasets

IsRelatedTo

Longman, E. K., Sanford, E. (2024) **Effect of phenotypic variation on dogwhelk morphology during an eco-evolutionary field experiment.** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2024-01-26 doi:10.26008/1912/bco-dmo.918546.1 [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
Container	Container number.	unitless
Round	Either 1 or 2. The laboratory experiment occurred in two rounds due to space limitations.	unitless
Population	Population that the dogwhelk egg capsule cluster was collected from: Bodega Marine Reserve (BMR) or Soberanes Point (SBR).	unitless
Site_Latitude	Latitude of the dogwhelk collection site.	decimal degrees
Site_Longitude	Longitude of the dogwhelk collection site (negative values = West).	decimal degrees
Family	Code/number to identify the family. Families (dogwhelks from the same egg capsules cluster were considered to be full or half siblings and classified as a family) from each population were numbered.	unitless
Treatment	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 diet treatment was given a unique identifier.	unitless
Snail	Each snail was given a unique identifier based on its family, early-life diet treatment and recplicate.	unitless
Drilled_Binary	Either 1 or 0. Measure of dogwhelk phenotype - if a dogwhelk drilled a complete drill hole through the shell of one *Mytilus californianus* mussel over the course of the 100-day experiment.	unitless
Total_Drilled	Measure of dogwhelk phenotype - the total number of *Mytilus californianus* mussels drilled per dogwhelk.	unitless

Check_1	The number of mussels drilled by each dogwhelk recorded on the first experimental check (week 3). Drilled mussels were removed and replaced with a new 5-7cm *Mytilus californianus* mussel.	unitless
Check_2	The number of mussels drilled by each dogwhelk recorded on the second experimental check (week 6). Drilled mussels were removed and replaced with a new 5-7cm *Mytilus californianus* mussel.	unitless
Check_3	The number of mussels drilled by each dogwhelk recorded on the third experimental check (week 9). Drilled mussels were removed and replaced with a new 5-7cm *Mytilus californianus* mussel.	unitless
Check_4	The number of mussels drilled by each dogwhelk recorded on the fourth experimental check (week 12). Drilled mussels were removed and replaced with a new 5-7cm *Mytilus californianus* mussel.	unitless
Check_5	The number of mussels drilled by each dogwhelk recorded on the fifth experimental check (week 15). Drilled mussels were removed and replaced with a new 5-7cm *Mytilus californianus* mussel.	unitless
Dead	Data on if a dogwhelk died during the course of the laboratory scoring experiment.	unitless

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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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