Oyster survival differences in high-quality reefs from Skidaway Island, GA from July to October 2019

Website: https://www.bco-dmo.org/dataset/892464
Data Type: Other Field Results
Version: 1
Version Date: 2023-03-23

Project
» Collaborative Research: Keystone chemicals: Identifying general and universal molecules of fear (Identifying molecules of fear)

Contributors	Affiliation	Role
Smee, Delbert Lee	Dauphin Island Sea Lab (DISL)	Principal Investigator
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Abstract
This dataset contains the survivorship of oysters planted in high-quality reefs to determine how induced defenses and habitat structural complexity influence basal prey survival. Oysters (a basal prey) induced to grow stronger shells were planted with control oysters along transects spanning the center of the reefs to outside the reefs. Oysters were left in the field for two days before individual oyster survival was assessed. Predators often produce nonconsumptive effects (NCEs) in their prey in the form of behavioral or morphological changes. Such changes often have larger or equal consequences for population dynamics as the predator directly consumes individual prey. However, it is not well understood how predators feeding across multiple trophic levels cause cascading NCEs that interact across prey trophic levels or how the prey survival benefits from these interactions change across contexts. These data help demonstrate how NCEs can influence population dynamics across space and quantify the strength of these context-dependent interactions. Data were collected by Drs. Benjamin Belgrad, Lee Smee, and Marc Weissburg from the Dauphin Island Sea Lab and Georgia Institute of Technology.

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Coverage

Spatial Extent: **N**:31.967152 **E**:-81.012706 **S**:31.962855 **W**:-81.01434
Temporal Extent: 2020-07 - 2020-10

Methods & Sampling

Oysters (*Crassostrea virginica*) were cultured as spat-on-shell at the Auburn University Shellfish Laboratory

(AUSL) on Dauphin Island, AL starting in late May 2019 using standard techniques (Congrove et al. 2009). Oyster larvae were settled onto sun-bleached oyster shells to create spat-on-shell. After 3 days, when oyster spat were approximately 1.0 millimeters, they were exposed to either exudate from predatory blue crabs or empty cage controls in four flow-through holding tanks (length = 2.4 meters, width = 0.9 meters, water depth = 0.4 meters) supplied with unfiltered seawater pumped directly from the Gulf of Mexico. The number of spat per shell varied from approximately 5 – 40 and we elected to not alter the initial density to mimic natural settlement during the induction period. Oysters were suspended above the tank bottom in oyster aquaculture baskets (64 x 23 x 14 centimeters with 140 spat-covered per shell basket) to prevent sediment buildup from suffocating oysters. Seven oyster baskets were present in each tank (28 total).

Spat were exposed to blue crab predator cues by holding four live caged adult blue crabs (*Callinectes sapidus*) in two of the tanks (8 crabs total), whereas the remaining two tanks contained empty cages (control) to mimic conditions where oysters regularly experience predator cues or are limited in their exposure from cues. Water volumes and crab densities were informed from established procedures (Belgrad et al. 2021). Crabs in each tank were held in four separate cages (32 x 23 x 14 centimeters) to prevent crabs from consuming the experimental oysters or each other. Every crab was fed one adult oyster daily (approximately 5.0 centimeters in length) to maximize predator cue intensity as experimental oysters would be exposed to exudates from predators and damaged conspecifics. This ensured that oysters were exposed to the most natural set of cues indicative of a predation event, which produces a strong response in oysters (Scherer et al. 2016). Crabs were replaced during the experiment as needed due to mortality. Experimental oyster baskets were rotated around the crab cages daily to reduce differences in oyster growth due to proximity to predator cues, and no differences among cages were found. The induction period was 2 months.

Oyster survival experiment
We conducted a field experiment on a healthy intertidal oyster reef to test whether our laboratory findings were consistent with effects in the field. Oyster spat-on-tile were taken from the above culturing work. Oysters were scraped to 10 spat per tile to standardize individual predation risk, and transported in aerated coolers filled with seawater to a large (more than 1 kilometer long x 10 meters wide x 1 meter high) healthy oyster reef at Skidaway Island, GA (31°57'52.2" N; 81°00'49.4" W) on August 11th, 2020. This reef is a contiguous set of approximately 10-100 meter live oyster patches separated by regions of mud and shell hash containing smaller oyster clusters. The site is located along the Wilmington River in upper Wassaw Sound, adjacent to the Skidaway Institute of Oceanography and bordered by a robust *Spartina alterniflora* zone. Mud crab densities within the oyster reef are roughly 30 square meters and resident mud crabs experience heavy predation by blue crabs, particularly in areas of bare substrate and shell hash (Hill and Weissburg 2013).

Sixty pairs of induced and control spat-covered tiles were zip tied to 60 pieces of 1.5 meter-long rebar. Rebar was set in 15 transects that ran perpendicular to the shoreline with over a 5-meter separation between each transect. Each transect contained 4 rebar poles planted in the following locations: the upper tidal zone of the reef, the lower tidal zone of the reef, the reef edge, and in the mud with at least a 1-meter distance from the reef. Poles typically were separated from each other by 1.5 meters (total transect length = 7 – 8 meters) and were planted so that the spat tiles rested just above the substrate. Individual survival of all oysters was checked 48 hours after planting (n = 1,200 spat total; 150 spat per treatment).

Data Processing Description

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Data Files

File	
oyster_survival_in_high_quality_reef-1.csv	(Comma Separated Values (.csv), 5.23 KB) MD5:6c65d6de391b5ecfbe1c3cc04bb0e3f3
Primary data file for dataset 892464, version 1.	

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Related Publications

Belgrad, B. A., Combs, E. M., Walton, W. C., & Smee, D. L. (2021). Use of predator cues to bolster oyster resilience for aquaculture and reef restoration. Aquaculture, 538, 736553. https://doi.org/10.1016/j.aquaculture.2021.736553
Methods

Belgrad, B. A., Smee, D. L., & Weissburg, M. J. (2023). Predator signaling of multiple prey on different trophic levels structures trophic cascades. Ecology, 104(6). Portico. https://doi.org/10.1002/ecy.4050
Results

Congrove, M. S., Wesson, J. A., & Allen Jr, S. K. (2009). A practical manual for remote setting in Virginia.
Methods

Hill, J. M., & Weissburg, M. J. (2012). Predator biomass determines the magnitude of non-consumptive effects (NCEs) in both laboratory and field environments. Oecologia, 172(1), 79–91. https://doi.org/10.1007/s00442-012-2488-4
Methods

Hill, J., & Weissburg, M. (2013). Habitat complexity and predator size mediate interactions between intraguild blue crab predators and mud crab prey in oyster reefs. Marine Ecology Progress Series, 488, 209–219. https://doi.org/10.3354/meps10386
Methods

Scherer, A. E., Lunt, J., Draper, A. M., & Smee, D. L. (2016). Phenotypic plasticity in oysters (Crassostrea virginica) mediated by chemical signals from predators and injured prey. Invertebrate Biology, 135(2), 97–107. Portico. https://doi.org/10.1111/ivb.12120
Methods

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Related Datasets

IsRelatedTo

Belgrad, B. A., Smee, D. L., Weissburg, M. (2023) **Morphological Characteristics of Oysters from Predator Experiments at the Dauphin Island Sea Lab, AL from July to October 2020.** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2023-03-30 doi:10.26008/1912/bco-dmo.892206.1 [view at BCO-DMO]

Belgrad, B. A., Smee, D. L., Weissburg, M. (2023) **Morphological Characteristics of Oysters from Predator Experiments at the Dauphin Island Sea Lab, AL, May-July 2019.** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2023-03-29 doi:10.26008/1912/bco-dmo.892096.1 [view at BCO-DMO]

Belgrad, B. A., Smee, D. L., Weissburg, M. (2023) **Oyster survival difference experiments in low quality reefs in Mobile Bay, AL in September 2019.** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2023-03-23 doi:10.26008/1912/bco-dmo.892475.1 [view at BCO-DMO]

Belgrad, B. A., Smee, D. L., Weissburg, M. (2023) **Oyster survival differences in mesocosm experiments at the Dauphin Island Sea Lab, AL between July and August 2019.** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2023-03-29 doi:10.26008/1912/bco-dmo.892425.1 [view at BCO-DMO]

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Parameters

Parameter	Description	Units
tile_ID	identification number of individual tile; each tile had 10 spat settled upon it	unitless
pole_ID	individual pole designation that tiles with 10 spat on them were attached to. Each pole contained an induced and control tile (20 spat total)	unitless
transect_ID	individual transect designation; each transect ran perpendicular to reef edge with four poles	unitless
reef_treatment	spat on poles were either planted within the reef (reef) or outside the reef (bare substrate)	unitless
pole_location	position of pole along transect; upper reef, lower reef, reef edge, bare substrate	unitless
induction_treatment	oyster tiles with spat were raised in the hatchery and either continuously exposed to predator cues (induced) or received no predator cues (not induced)	unitless
a48	number of spat alive on the tile after 48 hours in the field (originally 10 spat per tile)	unitless
d48	number of spat dead on the tile after 48 hours in the field (originally 10 spat per tile)	unitless

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Project Information

Collaborative Research: Keystone chemicals: Identifying general and universal molecules of fear (Identifying molecules of fear)

Coverage: Wassaw Sound, GA, US and Dauphin Island, AL

NSF Award Abstract:
Many prey species use chemicals released in predator urine to detect imminent danger and respond appropriately, but the identity of these 'molecules of fear' remains largely unknown. This proposal examines whether prey detect different estuarine predators using the same chemical or whether the identity of the chemical signals varies. Experiments focus on common and important estuarine prey, mud crabs and oysters, and their predators including fishes, crustaceans and marine snails. Bioactive molecules are being collected from predators and prey and characterized. The goal is to determine if there are predictive relationships between either the composition of prey flesh or the predator taxon and the signal molecule. Understanding the molecular nature of these cues can determine if there are general rules governing likely signal molecules. Once identified, investigators will have the ability to precisely manipulate or control these molecules in ecological or other types of studies. Oysters are critical to estuarine health, and they are important social, cultural and economic resources. Broader impacts of the project include training of undergraduate and graduate students from diverse backgrounds and working with aquaculture facilities and conservation managers to improve growth and survival of oysters. One response to predator cues involves creating stronger shells to deter predation. Determining the identity of cues used by oysters to detect predators can provide management

options to produce oysters that either grow faster or are more resistant to predators. Project personnel is working with oystermen to increase yields of farmed oysters by managing chemical cues.

For marine prey, waterborne chemical cues are important sources of information regarding the threat of predation, thus, modulating non-consumptive effects of predation in many systems. Often such cues are produced when the predators consume the flesh of that prey. In nearly all cases, the specific bioactive molecules responsible for modulating these interactions are unknown, raising the question whether there is a universal molecule of fear that prey respond to. Thus, the focus of the project is to determine the generality of fear-inducing metabolites released by predators and prey in estuarine food webs. The project combines metabolomics analysis of diet-derived urinary metabolites with bioassays to identify the bioactive molecules producing responses in two prey species from different taxonomic groups and trophic levels (oysters, mud crabs). Metabolites are sampled from three types of predators, fish, gastropods or crustaceans. This project aims to: 1) identify bioactive molecules produced by several common estuarine predators from different taxa; 2) compare cues from predators that induce defenses in prey vs. changes in prey behavior; and 3) contrast the identities and effects of predator-released cues with fear-inducing molecules from injured conspecifics. By identifying and contrasting the effects of waterborne molecules that induce prey responses from six predators and injured prey, this project is yielding insights into the mechanisms that mediate non-lethal predator effects, while addressing long-standing questions related to predator-prey interactions. In addition to the search of a universal molecule of fear, the experiments are exploring the role of complementary and distinct chemical information on the specificity of prey responses to different types of predators.

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-1948423
NSF Division of Ocean Sciences (NSF OCE)	OCE-1948441

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