Experimental grazing rates of sand dollar larvae (Dendraster excentricus) on algae (Dunaliella tertiolecta) under different ocean acidification conditions, July 2017

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Project
» RUI: Will climate change cause 'lazy larvae'? Effects of climate stressors on larval behavior and dispersal (Climate stressors on larvae)

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Abstract
Experimental grazing rates of sand dollar larvae (Dendraster excentricus) on algae (Dunaliella tertiolecta) under different ocean acidification conditions, July 2017.

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Coverage

Temporal Extent: 2017-07-07 - 2017-07-31

Dataset Description

Experimental grazing rates of sand dollar larvae (*Dendraster excentricus*) on algae (*Dunaliella tertiolecta)* under different ocean acidification conditions, July 2017.

Acquisition Description

Spawning and fertilization

We collected adult sand dollars (D. excentricus) from Semiahmoo Bay, WA, on July 7, 2017 and maintained them in 14°C continuous flowing seawater at the Shannon Point Marine Center. On July 12, 2017 we induced twelve individuals to spawn by injecting 1-mL of 0.5-M KCl into the coelom following methods outlined by Strathmann (1987). We then collected and mixed concentrated gametes of four males and four females for fertilization. We added five drops of sperm to 500-mL of filtered seawater and 5-mL of eggs. We placed the fertilized eggs in 12°C incubator and bubbled them with ambient pCO2 condition for 12-hrs before dividing the embryos into pCO2 treatment conditions before gastrulation. We then counted and transferred the larvae into jars with 1.5 L of nanopore filtered seawater at densities of 1-2 individuals mL-1.

Grazing experiment

To assess the interactive effects of temperature and pCO2 on Dunaliella excentricus feeding behavior, our experimental design had six treatments with four experimental jars (replicates) in each. The treatments combined three levels of CO2: 400 ppmv (ambient atmospheric level), 800 ppmv (moderate atmoshpheric level) and 1,500 ppmv (high atmospheric level), and two temperatures: 12°C (ambient temperature) and 17°C (high temperature). We fed Dunaliella tertiolecta at approximately 6,000 cells ml-1 to six-arm stage larvae to evaluate feeding rates at each treatment condition.

For each replicate, a corresponding 150-mL control bottle containing only D. tertiolecta was also prepared. Feeding rate was estimated as ingestion rate by measuring the algal concentration (cells ml-1) at the beginning (T0) and after 24 hours (Tf) in control bottles and experimental jars using a Sedgewick Rafter Chamber (Stumpp et al., 2011). Ingestion rate (cells ind-1 hr-1) was calculated as I = (Clearance rate) x (time-average algae concentration).

This dataset includes unprocessed data and simple data calculations accomplished with Excel.

Processing Description

BCO-DMO Processing Notes:
- added conventional header with dataset name, PI name, version date

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Related Publications

Strathmann, M. F. (2017). Reproduction and development of marine invertebrates of the northern Pacific coast: data and methods for the study of eggs, embryos, and larvae. University of Washington Press.

Stumpp, M., Dupont, S., Thorndyke, M. C., & Melzner, F. (2011). CO2 induced seawater acidification impacts sea urchin larval development II: Gene expression patterns in pluteus larvae. Comparative Biochemistry and Physiology Part A: Molecular & Integrative Physiology, 160(3), 320–330. doi:10.1016/j.cbpa.2011.06.023

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Parameters

Parameter	Description	Units
temp_c	Temperature treatment	degrees Celcius
pH	pCO2 treatment: low = 400ppm; medium = 800ppm; high = 1500ppm	unitless
jar_type	Type of treatment jar; a jar containing larval and algae or a control jar containing just algae	unitless
replicate	Replicate number of each treatment combination including temperature; pH; and jar type	unitless
count	The initial or final algae count to calculate algal cell concentration for the experiment	unitless
cells	Algae cell count using a Sedgewick-Rafter counting chamber	algae cells
squares	Number of squares counted within the Sedgewick-Rafter	squares
cell_concentration	Calculated concentration of algae cells within treatment jar from Sedgewick-Rafter counts. Cell concentration = (cells/squares)*1000	algae cells per milliliter (#/mL)

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Instruments

Dataset-specific Instrument Name	
Generic Instrument Name	Microscope-Optical
Dataset-specific Description	Used to count cells.
Generic Instrument Description	Instruments that generate enlarged images of samples using the phenomena of reflection and absorption of visible light. Includes conventional and inverted instruments. Also called a "light microscope".

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Project Information

RUI: Will climate change cause 'lazy larvae'? Effects of climate stressors on larval behavior and dispersal (Climate stressors on larvae)

Coverage: Coastal Pacific, USA

In the face of climate change, future distribution of animals will depend not only on whether they adjust to new conditions in their current habitat, but also on whether a species can spread to suitable locations in a changing habitat landscape. In the ocean, where most species have tiny drifting larval stages, dispersal between habitats is impacted by more than just ocean currents alone; the swimming behavior of larvae, the flow environment the larvae encounter, and the length of time the larvae spend in the water column all interact to impact the distance and direction of larval dispersal. The effects of climate change, especially ocean acidification, are already evident in shellfish species along the Pacific coast, where hatchery managers have noticed shellfish cultures with 'lazy larvae syndrome.' Under conditions of increased acidification, these 'lazy larvae' simply stop swimming; yet, larval swimming behavior is rarely incorporated into studies of ocean acidification. Furthermore, how ocean warming interacts with the effects of acidification on larvae and their swimming behaviors remains unexplored; indeed, warming could reverse 'lazy larvae syndrome.' This project uses a combination of manipulative laboratory experiments, computer modeling, and a real case study to examine

whether the impacts of ocean warming and acidification on individual larvae may affect the distribution and restoration of populations of native oysters in the Salish Sea. The project will tightly couple research with undergraduate education at Western Washington University, a primarily undergraduate university, by employing student researchers, incorporating materials into undergraduate courses, and pairing marine science student interns with art student interns to develop art projects aimed at communicating the effects of climate change to public audiences As studies of the effects of climate stress in the marine environment progress, impacts on individual-level performance must be placed in a larger ecological context. While future climate-induced circulation changes certainly will affect larval dispersal, the effects of climate-change stressors on individual larval traits alone may have equally important impacts, significantly altering larval transport and, ultimately, species distribution. This study will experimentally examine the relationship between combined climate stressors (warming and acidification) on planktonic larval duration, morphology, and swimming behavior; create models to generate testable hypotheses about the effects of these factors on larval dispersal that can be applied across systems; and, finally, use a bio-physically coupled larval transport model to examine whether climate-impacted larvae may affect the distribution and restoration of populations of native oysters in the Salish Sea.

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Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-1538626

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