Juvenile growth of Olympia oysters outplanted to the field in Tomales Bay after being reared as larvae in the lab at Bodega Marine Lab in September 2010

Website: https://www.bco-dmo.org/dataset/658364
Data Type: experimental, Other Field Results
Version: 27 Sept 2016
Version Date: 2016-09-27

Project
» Bodega Ocean Acidification Research (BOAR)

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Dataset Description

Juvenile growth of Olympia oysters outplanted to the field after being reared as larvae in the lab.

Related datasets:
juvenile survival
percent settlement
size at settlement
water chemistry

Methods & Sampling

Detailed methodology and results are described in following publication:
Hettinger, A., E. Sanford, T.M. Hill, E.A. Lenz, A.D. Russell, and B. Gaylord. 2013. Larval carry-over effects from ocean acidification persist in the natural environment. Global Change Biology 19: 3317-3326. doi:10.1111/gcb.12307

Briefly (excerpted from above):
Larval culturing:
Adult Olympia oysters (n = 105) were collected in September 2010 from Tomales Bay, California (38° 06' 57.01"N, 122° 51' 14.39" W) and transported to Bodega Marine Laboratory (BML). Adults were cleaned of epiphytes and distributed evenly among three 100 L cylinders. Adults were fed microalgal food to encourage larval release. After 72 h, larvae were released in one of the cylinders, and subsets of these

individuals were distributed by pipette among 4.5 L glass jars (n = 1000/jar) used for culturing. Larvae were reared through their entire planktonic duration in a culturing facility at BML. The target seawater pCO2 concentration in larval treatment cultures was 1000 uatm. The accompanying control seawater pCO2 target was 400 uatm. After filling culture jars with carboy water, pCO2 concentrations were maintained in the jar seawater by pumping the same CO2 gas mixtures into sealed air spaces above the free surfaces of the seawater in the culture jars ("headspaces") shared by 6 replicate jars per pCO2 concentration. There were three headspaces for each pCO2 concentration, and 6 jars associated with each headspace (n = 2 pCO2 concentrations x 3 headspaces x 6 replicate jars = 36 jars).

On day 11 of the experiment, prior to the commencement of settlement and metamorphosis, larvae were transferred into new glass "substrate" jars. The surface of each new jar base was abraded with sandpaper to encourage larval settlement. The underside of each new jar base was scored to facilitate separation into four tiles after larvae had metamorphosed into benthic juveniles. These tiles were suitable for outplanting juvenile oysters to the field.

Seawater chemistry:
Seawater pH(NBS) and temperature were quantified using a potentiometric pH/temperature meter (Accumet Excel XL60), salinity was determined using a YSI 6600V2 multi-parameter instrument, and total alkalinity (TA, umol per kg of seawater) was measured using automated Gran titration with duplicates (Metrohm 809). A subset of samples was analyzed for dissolved inorganic carbon (DIC, umol per kg of seawater) at the University of Georgia's infrared CO2 analysis facility (Cai & Wang, 1998). Both TA and DIC measurements were standardized using certified reference material from A. Dickson at Scripps Institute of Oceanography (La Jolla, California). Calcite and aragonite saturation states (Ωcalcite, Ωaragonite) and seawater pCO2 were calculated using the carbonate system analysis software, CO2SYS (Lewis & Wallace, 1998).

Metamorphosis and field outplants:
Settlement of larvae and metamorphosis into benthic juveniles was assessed daily starting at day 11 when larvae were transferred into substrate jars. Each jar base was divided into four 50 cm2 tiles for outplanting. Tiles from a given pCO2 concentration with similar juvenile densities were arranged into four groups, each composed of six replicate tiles. The four groups were then randomly assigned to one of the two field sites and one of the two shore levels. The overall design was: n = 2 larval pCO2 concentrations x 2 sites x shore levels x 6 tiles = 48 tiles. Tiles were outplanted to the field on the same day as settlement (day 14 post larval release).

A shoreline region half-way along the Tomales Bay estuary was selected for the two replicate field sites (38° 09' 01.01"N, 122° 53' 19.19"W). The replicate sites were 40 m apart in the alongshore direction, and were similar in substrate type, solar exposure, and bottom slope. At each replicate site, six PVC 'T' stakes, placed 0.5 m apart and each holding two tiles, were driven into the substrate such that the tiles were situated at either 0 or 0.3 m above MLLW (i.e., 'low' and 'mid' shore levels, respectively). Tiles deployed on four of the six stakes per site and shore level were outfitted with temperature loggers (iButton, Maxim, Sunnyvale, CA, USA). A YSI 6600V2 multi-parameter instrument was used to measure temperature, salinity, and pH(NBS) at each of the outplant sites approximately weekly up to day 52 postsettlement, and then monthly up to day 127 postsettlement.

Juvenile survival on each tile was calculated as the percentage of initial juveniles that were alive on each sampling date (day 6, 13, 27, 127 postsettlement). Each tile was examined for live juvenile oysters under a dissecting microscope (Leica M125 with DC290 camera) at BML. Juvenile growth rates were estimated from photographs of juveniles randomly sampled on each tile using a random number table to select squares on the gridded tile. Juvenile growth rates were calculated on days 6, 13, and 27 postsettlement as the change in the total projected area of the shell between the sample date and when the larvae metamorphosed, divided by the intervening number of days (mm2 per day). Thus, these growth rates represent the average growth rate over the full benthic life stage to the age examined, not an age-specific growth rate characteristic of the period between assay dates.

Data Processing Description

BCO-DMO processing:
- modified parameter names to conform with BCO-DMO naming conventions;
- replaced spaces with underscores;
- 27 Sept 2016: replaced previous version with corrected version; previously, the target_pCO2 values were incorrect.

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Data Files

File
juvenile_growth.csv (Comma Separated Values (.csv), 1.59 KB) MD5:521ef2b7699b52783a6054c48e18848f Primary data file for dataset ID 658364

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Parameters

Parameter	Description	Units
day	Day post-settlement	unitless
site	Site	unitless
target_pCO2	Target larval pCO2	microatmospheres (uatm)
stake	Stake number; at each replicate site, six PVC 'T' stakes, each holding two tiles, were driven into the substrate.	unitless
tot_shell_area	Total shell area	square millimeter (mm^2)
growth_rate	Growth rate	square millimeters per day (mm^2/day)

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Instruments

Dataset-specific Instrument Name	DC290 camera
Generic Instrument Name	Camera
Dataset-specific Description	Each tile was examined for live juvenile oysters under a dissecting microscope (Leica M125 with DC290 camera) at BML.
Generic Instrument Description	All types of photographic equipment including stills, video, film and digital systems.

Dataset-specific Instrument Name	Leica M125
Generic Instrument Name	Microscope - Optical
Dataset-specific Description	Each tile was examined for live juvenile oysters under a dissecting microscope (Leica M125 with DC290 camera) at BML.
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".

Dataset-specific Instrument Name	YSI 6600V2
Generic Instrument Name	Multi Parameter Portable Meter
Dataset-specific Description	Salinity was determined using a YSI 6600V2 multi-parameter instrument. A YSI 6600V2 multi-parameter instrument was used to measure temperature, salinity, and pH(NBS) at each of the outplant sites.
Generic Instrument Description	An analytical instrument that can measure multiple parameters, such as pH, EC, TDS, DO and temperature with one device and is portable or hand-held.

Dataset-specific Instrument Name	Accumet Excel XL60
Generic Instrument Name	Water Temperature Sensor
Dataset-specific Description	Seawater pH(NBS) and temperature were quantified using a potentiometric pH/temperature meter (Accumet Excel XL60).
Generic Instrument Description	General term for an instrument that measures the temperature of the water with which it is in contact (thermometer).

Dataset-specific Instrument Name	iButton
Generic Instrument Name	Water Temperature Sensor
Dataset-specific Description	Tiles deployed on four of the six stakes per site and shore level were outfitted with temperature loggers (iButton, Maxim, Sunnyvale, CA, USA).
Generic Instrument Description	General term for an instrument that measures the temperature of the water with which it is in contact (thermometer).

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Deployments

BML_Gaylord

Website	https://www.bco-dmo.org/deployment/658395
Platform	lab Bodega Marine Laboratory
Start Date	2010-09-01
End Date	2011-06-30

Tomales_Bay_Gaylord

Website	https://www.bco-dmo.org/deployment/658398
Platform	lab Bodega Marine Laboratory
Start Date	2010-09-01
End Date	2010-09-30
Description	Locations in Tomales Bay where adult oysters were collected and where larval settlement was studied.

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Project Information

Bodega Ocean Acidification Research (BOAR)

Website: http://bml.ucdavis.edu/research/research-programs/climate-change/oceanacidification/

Coverage: Central California coast (northeast Pacific)

The absorption of human-produced CO2 into the world's oceans is decreasing seawater pH and causing marked declines in the saturation state for calcium carbonate, a major building block for shells, skeletons, and tests of many marine species. Such changes (collectively termed "ocean acidification") have the potential to devastate a broad array of organisms, both at the level of individuals and at population and ecosystem scales. Although awareness of these issues is rapidly growing, most of what is known is based on studies of coral reef organisms and plankton.

The proposed work will enhance understanding of impacts from ocean acidification by providing rigorous data on several new fronts applicable to temperate systems. The project will operate within one of the strongest upwelling centers of the eastern Pacific, where global trends in acidification are amplified by the presence of cold water characterized by already-high levels of aqueous CO2. Using an integrated, comparative approach that exploits the expertise of oceanographers, marine chemists, and biologists, the project will explicitly couple moored and shipboard measurements of seawater chemistry to controlled laboratory and field studies of biological responses.

Two vital foundation species (the California mussel, *Mytilus californianus*, and the Olympia oyster, *Ostrea conchaphila*) will be targeted. These two species play disproportionately important roles in open-coast and estuarine systems, respectively. Larvae (which are often the most vulnerable stages) of mussels and oysters will be cultured under elevated-CO2 conditions through the full pelagic period and into juvenile life. Growth and survivorship will be quantified, and water temperature and salinity will be varied to test for interactive effects of multiple factors. Intraspecific variation in response of larvae from different parental lineages will be examined. "Carry-over" effects that originate from exposure during the larval stage, but influence subsequent juvenile growth and survival, will be determined both in the laboratory and using field outplants. Because larval and juvenile stages play important roles as demographic age-structure bottlenecks, overall population consequences will be estimated through comparison of observed impacts on early life stages to other recognized sources of recruitment variation.

Data Status: Data will be reported from the BML offshore oceanographic moorings and from moorings within nearby Tomales Bay. The moorings will be outfitted with autonomously recording pH and pCO2 sensors, and these measurements will be supplemented with discrete water samples collected monthly along two associated

transects.

Live Data: For live-streaming data from Tomales Bay, visit http://www.ipacoa.org/Explorer and click on the icon in Tomales Bay.

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Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-0927255

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