Results of laboratory study examining effects of elevated concentrations of seawater carbon dioxide and altered salinity on rates of oxygen utilization by larval porcelain crabs (Petrolisthes cinctipes)

Website: https://www.bco-dmo.org/dataset/659950
Data Type: experimental
Version: 28 Sept 2016
Version Date: 2016-09-28

Project
» Bodega Ocean Acidification Research (BOAR)

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Dataset Description

Laboratory results concerning effects of elevated concentrations of seawater carbon dioxide and altered salinity on rates of oxygen utilization by larval porcelain crabs (*Petrolisthes cinctipes*). This dataset includes data on oxygen levels at fixed time points in the crab respirometry trials.

Related datasets:
oxygen drawdown
culturing system carbonate chemistry
salinity treatment carbonate chemistry

Methods & Sampling

In this study, the investigators determined how respiration by newly hatched larvae of the porcelain crab (*Petrolisthes cinctipes*) cultured under current (385 uatm) and future predicted (1000 uatm) levels of atmospheric pCO2 differed when exposed to low, normal, and high salinity conditions.

Detailed methodology and results are described in following publication:
Miller, S.H., S. Zarate, E.H. Smith, B. Gaylord, J.D. Hosfelt, and T.M. Hill. 2014. Effect of elevated *p*CO2 on metabolic responses of porcelain crab (*Petrolisthes cinctipes*) larvae exposed to subsequent salinity stress. PLoS One 9: e109167, doi:10.1371/journal.pone.0109167

Briefly (excerpted from above):
Fifty ovigerous Petrolisthes cinctipes were collected from Shell Beach (38 degrees 25.033' N, 123 degrees 06.350' W) and Twin Coves (38 degrees 27.490' N, 123 degrees 08.621' W), California. Crabs were held in individual mesh containers in flow-through seawater at Bodega Marine Laboratory for 2–14 days. Containers were checked daily for hatched larvae, and newly released individuals from multiple broods were transferred in mixed batches of 75 to replicate culture jars. These jars contained 0.45 um filtered seawater bubbled with prescribed pCO2 levels to maintain carbonate chemistry and water movement, and were held at a constant temperature and normal salinity. Not all females released larvae on the same night, which allowed culture start dates to be staggered and respirometry trials to be run on sequential days using larvae of the same age.

Larvae were cultured at 14 degrees C under two pCO2 conditions: 385 uatm (ambient) and 1000 uatm (elevated). Larvae were held at a density of 75 larvae per 3 L, and were fed newly hatched Artemia sp. nauplii at a density of 1 nauplius/ml. The water in each culture jar was changed every two days. During water changes, dead larvae and uneaten Artemia sp. were removed, and water exiting the jars was sampled for carbonate chemistry adhering to recommended practices. The investigators measured pH (total scale) using a glass electrode (Accumet Excel XL60; Thermo Fisher Scientific, Waltham, Massachusetts, USA) and repeated analysis of certified TRIS reference material (measured in millivolts; batch no. 8; A. Dickson, Scripps Institute of Oceanography). Total alkalinity (TA) was measured by autotitration (Metrohm 809; Metrohm, Herisau, Switzerland), using the same certified reference material. Dissolved inorganic carbon (DIC) samples were processed using coulometric titration at the Monterey Bay Aquarium Research Institute (MBARI).

Respirometry trials were conducted in seawater at ambient pCO2 using a dissolved oxygen meter (model 781b Strathkelvin Instruments Ltd., Glasgow, UK) with a Clark-type microcathode polarographic electrode with a 22 micron diameter platinum cathode and silver/silver chloride anode connected by a buffered potassium chloride electrolyte solution (model 1302). Data were transmitted via a data interface unit to a computer and the oxygen consumption rates were monitored using the Strathkelvin 949 Oxygen System (Version 2.2, Strathkelvin Instruments Ltd., Glasgow, UK).

The electrode was placed in a PVC holder with double O rings to seal the chamber. The holder and electrode were inserted into a test chamber (26.34 mm x 47.09 mm ID) holding 25 ml of test solution. The test chamber was maintained at a temperature of 14 degrees C. For each new trial, the electrode was calibrated using 2% sodium sulfite and air-saturated seawater to determine zero and saturated oxygen values, respectively. Before each series of experiments, a control chamber with no larvae was monitored to establish background microbial oxygen consumption rates, which were then subtracted from the values obtained during trial runs. During each trial, eight first-stage larvae were removed from the culturing system and placed in the chamber for respirometry analysis, and visual analysis indicated that their activity was sufficient to maintain flow over the surface of the electrode. Seawater oxygen saturation state was measured every two minutes for one hour, though the investigators only analyzed data from the start of the trial until the oxygen in the test chamber reached 5 mg/L to eliminate potential effects of hypoxia in the chamber on larval respiration. Trials with larvae from each pCO2 treatment were run sequentially in pairs (i.e., one trial with larvae from ambient pCO2 conditions was followed by one trial with larvae from elevated pCO2 conditions), and 13 pairs of trials were run at salinities of 34 over a period of 14 days.

Distilled water was added to filtered, ambient-pCO2 seawater (salinity 34) to make salinity 22 solution, and artificial seawater (Instant Ocean, Spectrum Brands, Inc.) was added to make salinity 40 solution. This procedure created two altered salinity treatments for testing effects of salinity stress on larvae drawn from each of the preceding pCO2 treatments. Larvae were allowed to acclimatize in treatment solutions for ten minutes prior to respirometry trials to attenuate a startle response, and the system was calibrated before each trial. Paired trials (4 pairs at salinity 22 and 3 pairs at salinity 40) with larvae from each pCO2 treatment were run sequentially over a period of seven days.

Data Processing Description

BCO-DMO processing:
- modified parameter names to conform with BCO-DMO naming conventions;
- replaced missing data with "nd" ("no data").

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Data Files

File
crab_treatment.csv (Comma Separated Values (.csv), 2.19 KB) MD5:8f1c977e2919db8e2a63fd5985732d93 Primary data file for dataset ID 659950

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Parameters

Parameter	Description	Units
trial	Trial number	unitless
target_pCO2	Target pCO2	microatmospheres (uatm)
sal	Salinity	practical salinity units
O2_start	Starting seawater O2	milligrams per liter (mg/L)
O2_5mgL	Seawater O2 when oxygen in the test chamber approached 5 mg/L	milligrams per liter (mg/L)
O2_1hr	Seawater O2 at 1hr	milligrams per liter (mg/L)
time_to_5mgL	Time for oxygen in the test chamber to reach to reach 5 mg/L	minutes
O2_consump_5mgL	O2 Consumption/larva/min to until oxygen in the test chamber reached 5 mg/L	O2 consumption/larva/minute
O2_consump_end	O2 Consumption/larva/min from 5 mg/L to end of trial	O2 consumption/larva/minute
salinity_stress	Salinity stress (yes/no)	unitless
overall_stress	Overall nature of stress	unitless

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Instruments

Dataset-specific Instrument Name	Accumet Excel XL60
Generic Instrument Name	Benchtop pH Meter
Dataset-specific Description	pH (total scale) was measured using a glass electrode (Accumet Excel XL60; Thermo Fisher Scientific, Waltham, Massachusetts, USA)
Generic Instrument Description	An instrument consisting of an electronic voltmeter and pH-responsive electrode that gives a direct conversion of voltage differences to differences of pH at the measurement temperature. (McGraw-Hill Dictionary of Scientific and Technical Terms) This instrument does not map to the NERC instrument vocabulary term for 'pH Sensor' which measures values in the water column. Benchtop models are typically employed for stationary lab applications.

Dataset-specific Instrument Name	781b Strathkelvin Instruments Ltd.
Generic Instrument Name	Oxygen Sensor
Dataset-specific Description	Respirometry trials were conducted in seawater at ambient pCO2 using a dissolved oxygen meter (model 781b Strathkelvin Instruments Ltd., Glasgow, UK) with a Clark-type microcathode polarographic electrode with a 22 micron diameter platinum cathode and silver/silver chloride anode connected by a buffered potassium chloride electrolyte solution (model 1302).
Generic Instrument Description	An electronic device that measures the proportion of oxygen (O2) in the gas or liquid being analyzed

Dataset-specific Instrument Name	Metrohm 809
Generic Instrument Name	Titrator
Dataset-specific Description	Total alkalinity (TA) was measured by autotitration (Metrohm 809; Metrohm, Herisau, Switzerland).
Generic Instrument Description	Titrators are instruments that incrementally add quantified aliquots of a reagent to a sample until the end-point of a chemical reaction is reached.

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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

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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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