Differences in mean oxygen consumption of fed and unfed larvae used to understand the metabolic cost of digestion, Specific Dynamic Action (SDA), under ocean acidification and warming treatments - Experiments 2a and 2b

Website: https://www.bco-dmo.org/dataset/924613
Data Type: experimental
Version: 1
Version Date: 2024-04-09

Project
» RUI: Evaluating selection via ocean acidification and evolutionary responses of two coastal fishes (OA and natural selection)

Contributors	Affiliation	Role
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Abstract
These data include the differences in mean oxygen consumption of fed and unfed larvae used to understand the metabolic cost of digestion, Specific Dynamic Action (SDA), under ocean acidification and warming treatments. Data was collected in the summers of 2021 and 2022 using a microplate reader system that uses optical fluorescence to measure dissolved oxygen concentrations in water. Knowing the energetic cost of digestion under future climate change is important as studies, particularly on larval fish, begin to investigate how energy budgets will change. These data help us to understand an important part of daily metabolic costs and how that cost might change under ocean acidification and warming. Data were collected by Emma Siegfried and Dr. Darren Johnson at California State University, Long Beach. These data are from experiments 2a and 2b. Experiment 2a contains delta VO2 values to describe the SDA curve for a single feeding under 4 experimental treatments (low temperature & low CO2; low temperature & high CO2; high temperature & low CO2; high temperature & high CO2). In experiment 2a, food ration was increased at high temperatures. Experiment 2b contains delta VO2 values to describe the SDA curve for a single feeding under the same 4 experimental treatments, except that food ration was held constant across all temperature and CO2 treatments.

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Coverage

Location: nearshore waters of Southern California
Temporal Extent: 2021-08-09 - 2022-04-27

Methods & Sampling

To measure oxygen consumption, individual larvae were placed within chambers of a closed microplate reader system that uses optical fluorescence to measure oxygen concentration (PreSens, Germany). After a 5-minute acclimation period, the change in dissolved oxygen was measured every 30 seconds over 20 minutess. The microplate reader had 2 blocks of 24 wells.

In Experiment 1 (see Related Datasets), 20 fish larvae were measured per run. In Experiment 2, 40 fish were measured per run. For all chambers, the investigators ran a linear regression of oxygen concentration on time (n = 40 measurements). The respiration rate for each fish (VO2, expressed in milligrams of O2 per individual per hour (mg O2 ind-1 h-1)) was calculated as:

VO2 = V (S – B)

where S is the slope describing the change in O2 concentration for individual chambers with the fish,
B is the average slope for the four chambers with no fish (both in units of milligrams O2 per liter per hour (mg O2 L-1 h-1) and inferred to be per individual since each well held only one larvae), and
V is the volume of water in the chamber (1.500 × 10-3 liters (L)).

Note the displacement volume of grunion larvae in this study was <2.5 × 10-6 L and thus negligible in these calculations. Fish were assigned to each chamber at random, and larvae were used once in the respiration measurements and then humanely euthanized.

To describe the duration and magnitude of the Specific Dynamic Action (SDA) response, the investigators first calculated delta.VO2, the difference between the mean rates of oxygen consumption for the pair of fed and non-fed larvae.

These data were summarized by Siegfried and Johnson (2023) and plotted in figures 1, 3, and 5.

Data Processing Description

For all chambers, the investigators ran a linear regression of oxygen concentration on time to obtain the respiration rate of each fish. Respiration rates, referred to as VO2, were expressed in mg O2 ind-1 h-1. Average VO2 values were then calculated for groups of fed and non-fed larvae of the same age and average size, and experiencing the same seawater conditions. The difference in average VO2 values (referred to as delta VO2) provides a measure of the average energetic cost of digestion at a single time post feeding.

BCO-DMO Processing Description

- Imported original files "Expt 2a summary file.xlsx" and "Expt 2b summary file.xlsx" into the BCO-DMO system.
- Concatenated the data from both files into a single dataset.
- Renamed fields to comply with BCO-DMO naming conventions.
- Marked "#VALUE!" as a missing data value (missing data are blank/empty in the final CSV file).
- Saved the final file as "924613_v1_sda_expts2.csv".

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Data Files

File	
924613_v1_sda_expts2.csv	(Comma Separated Values (.csv), 15.33 KB) MD5:6bf9b19ee4070b5fe669ea9c06e4e5cb
Primary data file for dataset ID 924613, version 1	

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Related Publications

Siegfried, E., & Johnson, D. W. (2023). Effects of ocean acidification and warming on the specific dynamic action of California Grunion (Leuresthes tenuis) larvae. Journal of Experimental Marine Biology and Ecology, 563, 151893. https://doi.org/10.1016/j.jembe.2023.151893
Results

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Related Datasets

IsRelatedTo

Johnson, D. (2024) **Differences in mean oxygen consumption of fed and unfed larvae used to understand the metabolic cost of digestion, Specific Dynamic Action (SDA), under ocean acidification and warming treatments - Experiment 1.** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2023-09-06 doi:10.26008/1912/bco-dmo.907464.1 [view at BCO-DMO]

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Parameters

Parameter	Description	Units
experiment_ID	Experiment ID; either 2a or 2b	unitless
DPH	Age in days post hatching	days
deltaVO2	difference in average oxygen consumption rates between fed and unfed larvae	milligrams O2 per liter per hour
deltaVO2_SE	Standard error of the difference in average oxygen consumption rates between fed and unfed larvae	milligrams O2 per liter per hour
temperature	Temperature	degrees Celsius
OA_treat	short description of the combinations of temperature and pCO2	unitless
pCO2	Partial pressure of carbon dioxide in seawater	microatmospheres
time_elapsed	Time after feeding, in hours	hours

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Instruments

Dataset-specific Instrument Name	closed microplate reader system
Generic Instrument Name	plate reader
Dataset-specific Description	Oxygen consumption was measured within a closed microplate reader system that uses optical fluorescence to measure oxygen concentration (Loligo Systems, Denmark and PreSens, Germany).
Generic Instrument Description	Plate readers (also known as microplate readers) are laboratory instruments designed to detect biological, chemical or physical events of samples in microtiter plates. They are widely used in research, drug discovery, bioassay validation, quality control and manufacturing processes in the pharmaceutical and biotechnological industry and academic organizations. Sample reactions can be assayed in 6-1536 well format microtiter plates. The most common microplate format used in academic research laboratories or clinical diagnostic laboratories is 96-well (8 by 12 matrix) with a typical reaction volume between 100 and 200 uL per well. Higher density microplates (384- or 1536-well microplates) are typically used for screening applications, when throughput (number of samples per day processed) and assay cost per sample become critical parameters, with a typical assay volume between 5 and 50 µL per well. Common detection modes for microplate assays are absorbance, fluorescence intensity, luminescence, time-resolved fluorescence, and fluorescence polarization. From: http://en.wikipedia.org/wiki/Plate_reader, 2014-09-0-23.

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Project Information

RUI: Evaluating selection via ocean acidification and evolutionary responses of two coastal fishes (OA and natural selection)

Coverage: Southern California coastal waters near Seal Beach and Long Beach

NSF Award Abstract:
Ongoing increases in atmospheric carbon dioxide have changed the acidity of the ocean, which could affect growth and survival of marine organisms. For fishes, the projected decreases in ocean pH could cause severe increases in mortality during the larval and juvenile stages. In turn, these effects may lead to major reductions in the numbers and size of adult fish, loss of fishery yields, and a loss of income for people whose livelihoods depend on the sea. However, if species can genetically adapt to become more tolerant of ocean acidification conditions, then evolutionary responses may play a role in the long-term dynamics of populations. This project examines how ocean acidification may alter patterns of natural selection for two species of fish in a set of breeding experiments that test tolerances to low pH of different genetic lineages. These experiments are determining the genetic capacity present in these populations to adapt to future conditions and offset the negative effects of changes in seawater chemistry. Broader impacts of this project include the training of two graduate students and at least nine undergraduates at an institution that is recognized as both a Hispanic Serving Institution and an Asian American, Native American, and Pacific Islander Serving Institution, and is one of the most culturally diverse universities in the world. Additional broader impacts include public outreach activities through local aquaria and regular meetings with local city and beach managers. Presentations focus on long-term population predictions of two fish species that are culturally and economically valuable.

The goal of the project is to understand how ocean acidification will affect both offspring survival and maternal fitness. The project combines quantitative genetic studies with laboratory experiments and population modeling to examine tradeoffs between fecundity and offspring survival under present and predicted ocean acidification conditions. Breeding experiments are assessing the natural genetic variance underlying larval traits. The experimental protocol includes testing for parental effects by exposing adult fishes to high-pCO2 seawater during gametogenesis and measuring the survival of offspring experiencing conditions of ocean acidification. The capacity for genetic change in response to changes in ocean carbonate chemistry is being investigated

through mathematical models. Quantitative evaluation includes 1) how selection operates as seawater chemistry changes; 2) levels of genetic (co)variation underlying larval traits; 3) whether non-genetic inheritance may affect responses to ocean acidification; and 4) whether evolutionary changes are fast enough to affect the dynamics of populations over relevant timeframes (e.g., 10-100 years). The project is developing a genetic model for describing how changes in ocean chemistry are driving natural selection.

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-1948975

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