Experimental results: Temporal CO2-sensitivity in Menidia menidia; conducted at Southampton Marine Station from 2011-2015

Website: https://www.bco-dmo.org/dataset/551998
Version: 24 Feb 2015
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Project
» Will rising pCO2 levels in the ocean affect growth and survival of marine fish early life stages? (OA Fish)

Contributors	Affiliation	Role
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Dataset Description

The investigators used a novel experimental approach that combined bi-weekly sampling of a wild, spawning fish population (Atlantic silverside *Menidia menidia*) with standardized offspring CO2 exposure experiments and parallel pH monitoring of a coastal ecosystem. They assessed whether offspring produced at different times of the spawning season (April to July) would be similarly susceptible to elevated (1100 uatm, pH_NIST = 7.77) and high CO2 levels (2300 uatm, pH_NIST = 7.47). Early in the season (April), high CO2 levels significantly ($p < 0.05$) reduced fish survival by 54% (2012) and 33% (2013) and reduced 1 to 10 d post-hatch growth by 17% relative to ambient conditions. However, offspring from parents collected later in the season became increasingly CO2-tolerant until, by mid-May, offspring survival was equally high at all CO2 levels.

This dataset provides the source data to:
Murray, Christopher S; Malvezzi, Alex; Gobler, Christopher J; Baumann, Hannes. 2014. Offspring sensitivity to ocean acidification changes seasonally in a coastal marine fish. Marine Ecology Progress Series, 504, 1-11, doi:10.3354/meps10791

Note: This dataset has also been contributed to Pangaea and can be found at http://doi.pangaea.de/10.1594/PANGAEA.838990

Methods & Sampling

Refer to the Methods section of:
Murray, Christopher S; Malvezzi, Alex; Gobler, Christopher J; Baumann, Hannes. 2014. Offspring sensitivity to ocean acidification changes seasonally in a coastal marine fish. Marine Ecology Progress Series, 504, 1-11, doi:10.3354/meps10791

Data Processing Description

BCO-DMO Processing:
- Modified parameter names to conform with BCO-DMO naming conventions.
- Replaced spaces with underscores.
- Replaced "Menidia menidia (fish)" with "Menidia menidia" in the species column.

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Data Files

File
CO2_sensitivity_M_menidia.csv (Comma Separated Values (.csv), 4.08 KB) MD5:43195ff0d0f322916ebbe3da3ffc0b58 Primary data file for dataset ID 551998

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Parameters

Parameter	Description	Units
species	Name of the species.	unitless
experiment	Experiment number/description.	unitless
date	Date of fertilization in mm/dd/yyyy format.	unitless
treatment	Treatment type.	unitless
replicates	Number of replicates.	unitless
survival_fert_to_1d	Survival rate (%) from fertilization date to 1 day post hatch (dph).	percent (%)
survival_stderr_fert_to_1d	Standard error of survival rate (%) from fertilization date to 1 day post hatch (dph).	+/- percent (%)
survival_1_to_10d	Survival rate (%) from 1 to 10 days post hatch (dph).	percent (%)
survival_stderr_1_to_10d	Standard error of survival rate (%) from 1 to 10 days post hatch (dph).	+/- percent (%)

survival_fert_to_10d	Survival rate (%) from fertilization date to 10 dph.	percent (%)
survival_stderr_fert_to_10d	Standard error of survival rate (%) from fertilization date to 10 dph.	+/- percent (%)
length_1dph	Standard length at 1 dph.	millimeters (mm)
length_stderr_1dph	Standard error of standard length at 1 dph.	+/- millimeters (mm)
length_10dph	Standard length at 10 dph.	millimeters (mm)
length_stderr_10dph	Standard error of standard length at 10 dph.	+/- millimeters (mm)
growth_rate	Growth rate from 1 to 10 dph.	millimeters per day (mm/day)
growth_rate_stderr	Standard error of growth rate from 1 to 10 dph.	+/- millimeters per day (mm/day)
temp	Water temperature.	degrees C
sal	Salinity.	?
pH	pH.	pH on the NBS scale
ph_stddev	Standard deviation of pH.	pH on the NBS scale
pCO2	Partial pressure of carbon dioxide (water) at sea surface temperature (wet air). Calculated using CO2SYS (URI: http://cdiac.ornl.gov/oceans/co2rprt.html).	microatmospheres (uatm)
DIC	Dissolved inorganic Carbon. Determined by Coulometric titration.	micromoles per kilogram (umol/kg)
TALK	Total alkalinity. Calculated using CO2SYS (URI: http://cdiac.ornl.gov/oceans/co2rprt.html).	micromoles per kilogram (umol/kg)

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Deployments

lab_Baumann_Gobler_FP

Website	https://www.bco-dmo.org/deployment/551842
Platform	Flax Pond Marine Lab
Start Date	2011-09-01
End Date	2015-02-01

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Project Information

Will rising pCO2 levels in the ocean affect growth and survival of marine fish early life stages? (OA Fish)

Coverage: Long Island Sound, Shinnecock Bay, Long Island, NY

Description from NSF award abstract:
Ocean acidification has the potential to affect a broad spectrum of marine organisms and thereby transform the composition and function of our oceans. In contrast to calcifying marine invertebrates, marine fish are widely believed to be unaffected by the CO2 concentrations projected for the future. While this may be so for juvenile and adult fish stages, the fate of fish embryos and larvae in high CO2 oceans is less certain as CO2-sensitivity data for these stages are largely unavailable. Recognizing this knowledge gap and inspired by the findings of two recent studies on clownfish and sea bass larvae (Munday et al. PNAS 107 (2010); Checkley et al. Science 324 (2009)), the investigators performed a series of experiments exposing eggs and early larvae of inland silversides (*Menidia beryllina*) to elevated CO2 levels while strictly adhering to current "best practice" guidelines for ocean acidification research. At 1,000 ppm CO2, average *M. beryllina* survival ~1wk post-hatch significantly and consistently (five experiments) declined by ~75% compared to current day CO2 levels (390 ppm), while average length of newly hatched larvae decreased by 22%. Together with prior studies, these results suggest a surprisingly high susceptibility of fish early life stages to the CO2 increases that are projected to occur this century. Given that the abundance of many fish stocks, including most commercial species, is often regulated by processes affecting early life history growth and survival, ocean acidification may impact the dynamics of future fish populations and become yet another challenge to sustainable fisheries.

The investigators believe that there is now a pressing need to better understand how CO2 affects the viability of fish embryos and larvae in the ocean. This requires novel approaches involving longer-term, larger-scale experiments across multiple species. The investigators will comprehensively examine the impacts of current and future CO2 levels (400 - 1,000 ppm) during the egg and larval stages of three model fish species: Atlantic silversides (*M. menidia*), inland silversides (*M. beryllina*) and sheepshead minnows (*Cyprinodon variegatus*). They will also investigate populations of the same species (*M. menidia*) from differing latitudes. These species/populations are ecologically important due to their intermediate trophic position, have comparable life histories to commercial marine fish, offer differences in genetic growth capacity and presumed sensitivity, and are highly amenable to laboratory experimentation. Survival and growth (weight- and length-based) will be measured in experiments performed at different CO2, temperature (21, 27°C) and feeding conditions (low, ad libitum), thus permitting the affects of CO2 to be considered in parallel with thermal stress and food limitation. Quantification of feeding rates, gross growth efficiency, and oxygen consumption will characterize the physiological costs of high CO2 environments. Changes in calcification of larval fish otoliths and skeletal elements will be determined from weights and a Ca45 radiotracer approach. Finally, surviving *M. menidia* (or *M. beryllina*) will be reared to maturity and their offspring will be challenged with differing levels of CO2. Repeating this approach over several generations will demonstrate the extent to which CO2 resistance may evolve through natural selection. Collectively, this study will make significant advances toward understanding how ocean acidification may challenge the world's most valuable marine resource, fish.

Note that PI Hannes Baumann has since moved to the University of Connecticut. See his current contact information.

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Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-1129622

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