Smallmouth grunt condition/otolith morphology data and SEM images

Website: https://www.bco-dmo.org/dataset/876937
Data Type: Other Field Results
Version: 1
Version Date: 2022-07-13

Project
» Ocean Acidification: Effects on Morphology and Mineralogy in Otoliths of Larval Reef Fish (OA-OTO MIN)

Program
» Science, Engineering and Education for Sustainability NSF-Wide Investment (SEES): Ocean Acidification (formerly CRI-OA) (SEES-OA)

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Abstract
This dataset includes condition and morphology measurements from Haemulon chrysargyreum (Smallmouth grunt) otoliths and scanning electron microscope (SEM) images after completion of an experimental trial in which subjects were raised under one of four pH treatments (8.10, 7.80, 7.60, 7.30).

Table of Contents

- Coverage
- Dataset Description
  - Methods & Sampling
  - Data Processing Description
- Data Files
- Related Publications
- Related Datasets
- Parameters
- Instruments
- Project Information
- Program Information
- Funding

Coverage

Temporal Extent: 2013-11 - 2019-08

Methods & Sampling

Several clutches of *Haemulon chrysargyreum* eggs were purchased and shipped from a supplier in Florida,

USA, and inspected for quality and development. A clutch was selected, eggs hatched, and larvae distributed among the 20 experimental aquaria at a stocking density of 130 individuals per aquarium. Larvae in each aquarium were subjected to one of 4 seawater pH treatments (8.10, 7.80, 7.60, 7.30) randomly assigned and replicated 5x. Seawater temperature in all aquaria was held constant at 28 C. Aquaria were filled with sterilized natural seawater, and 25% water changes were completed every 48 hrs. Larvae were fed ad libitum with wild copepods from monoculture (*Pseudodiaptomus spp.*) in a background of live microalgae (*Isochrysis spp.*). Larvae were reared under experimental conditions for 30 days until the majority achieved settlement competency.

Upon completion of the experimental trial, all surviving fish were removed from each aquarium, euthanized with a lethal dose of tricaine mesylate (MS-222) in seawater, and counted. Survival counts were subtracted from the initial stocking density to calculate mortality counts (see Related Dataset).

Smallmouth grunt otoliths were sampled and quantified for morphological variables according to the methodology reported in Holmberg et al. 2019 (earlier project). Briefly, otoliths were extracted from each experimental fish using microsurgical dissection techniques and photographed using a polarizing dissection microscope for morphometric analysis. Then, otoliths were mounted to aluminum stubs, coated with gold, and imaged using a scanning electron microscope for mineralogical analysis. The attached file "images.tar.gz" contains the SEM images.

The experimental trial took place between November and December 2013. The otolith morphology, fish length, and fish mortality data were collected over a 5-year span between January 2014 and August 2019.

Data Processing Description

Data Processing:
Otolith morphology data were processed according to Holmberg et al. 2019. Briefly, otolith morphometrics including area, perimeter, and major/minor axes were quantified using ImageJ v1.51n. Circularity was calculated from major/minor axes. Otolith mineralogical variables including lateral development, visible crystals, vaterite replacement, finger counts, and lobe counts were scored from SEM micrographs according to a rubric designed for this project.

BCO-DMO Processing:
- modified column names to comply with BCO-DMO naming conventions.

[table of contents | back to top]

Data Files

File	
grunt_morphology.csv Primary data file for dataset ID 876937	(Comma Separated Values (.csv), 261.09 KB) MD5:24aeaf4deea64ea0b12ce44a8f38e7bf
images.tar.gz Scanning electron micrograph images associated with dataset 876937 from Robert Holmberg. Image file names correspond to the "ID" column in the data.	(GZIP (.gz), 31.49 GB) MD5:e52086d0c2e33f1d232a5c5e7028ddd7

[table of contents | back to top]

Related Publications

Holmberg, R. J., Wilcox-Freeburg, E., Rhyne, A. L., Tlusty, M. F., Stebbins, A., Nye Jr., S. W., Honig, A., Johnston, A. E., San Antonio, C. M., Bourque, B., & Hannigan, R. E. (2019). Ocean acidification alters morphology of all otolith types in Clark's anemonefish (Amphiprion clarkii). PeerJ, 7, e6152. Portico. https://doi.org/10.7717/peerj.6152
Methods

[table of contents | back to top]

Related Datasets

IsRelatedTo

Holmberg, R. J., Bourque, B., Gallagher, E. D., Hannigan, R. E., Rhyne, A. L., Tlusty, M. F. (2022) **Smallmouth grunt mortality data after exposure to experimental pH treatments.** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2022-07-13 doi:10.26008/1912/bco-dmo.876987.1 [view at BCO-DMO]

[table of contents | back to top]

Parameters

Parameter	Description	Units
ID	Aquaria/Fish/Otolith ID	unitless
FISH	Aquaria/Fish ID	unitless
TANK	Aquaria ID	unitless
OBS	Fish ID	unitless
OTIE	Otolith Side/Type	unitless
OSIDE	Otolith Side	unitless
OTYPE	Otolith Type	unitless
SETPOINT	Seawater pH Setpoint	pH units
pCO2	Calculated Seawater pCO2	microatmospheres (uatm)
AREA	Otolith Surface Area	square micrometers (um^2)
PERIM	Otolith Perimeter	micrometers (um)
MINAX	Otolith Minor Axis	micrometers (um)
MAJAX	Otolith Major Axis	micrometers (um)

CIRC	Otolith Circularity	unitless
SL	Fish Standard Length	millimeters (mm)
LATD	Otolith Lateral Development	convexity score
VISC	Otolith Visible Crystals	percent (%) crystals
VATR	Otolith Vaterite Replacement	percent (%) vaterite
FING	Otolith Finger Count	fingers
LOBES	Otolith Lobe Count	lobes
BAD_IMAGE	Values of GOOD or BAD to indicate if the SEM Micrograph is usable	unitless

[table of contents | back to top]

Instruments

Dataset-specific Instrument Name	Olympus Polarizing Dissection Microscope
Generic Instrument Name	Microscope - Optical
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	JEOL JSM-6010LA IntouchScope Scanning Electron Microscope
Generic Instrument Name	Scanning Electron Microscope
Generic Instrument Description	A scanning electron microscope (SEM) scans a focused electron beam over a surface to create an image. The electrons in the beam interact with the sample, producing various signals that can be used to obtain information about the surface topography and composition.

[table of contents | back to top]

Project Information

Ocean Acidification: Effects on Morphology and Mineralogy in Otoliths of Larval Reef Fish (OA-OTO MIN)

Coverage: Laboratory-based

If a larval fish cannot avoid predators and cannot orient itself in three-dimensional space, the consequences to the individual and the population are dramatic. Otoliths (ear stones), formed precipitation of calcium carbonate from a bicarbonate-rich and alkaline pH fluid, are critical to fish movement and orientation. Although marine fish compensate for carbon dioxide levels in the surrounding waters little is known about how increased dissolved carbon dioxide and changes in bicarbonate concentrations will impact the formation of otoliths. Increasing atmospheric carbon dioxide concentrations, leading to decreased ocean pH (ocean acidification) may have profound impact on the deposition, growth and function of these critical structures, particularly in larval fish. Focusing on pre-settlement age larval reef fish (*Amphiprion clarkii* and *Chrysiptera parasema*), this research integrates expertise in carbonate mineralogy, otolith development, and reef fish biology and leverages this unique combination of expertise to answer fundamental questions regarding the impact of ocean acidification on the structure and function of otoliths.

Specifically, the research will answer two fundamental questions: What are the natural morphological and mineralogical variations within growing otoliths? How do these change when larvae are exposed to high dissolved carbon dioxide concentrations? Larvae will be hatched and reared under high carbon dioxide-induced low pH and three types of otoliths (sagittae, lapilli, asterisci) will be extracted over the duration of the experiments. Changes in calcium carbonate mineralogy from aragonite (most common) to vaterite (less common, less dense) as well as changes in crystal habit (well formed to poorly formed) will be evaluated using a combination of microscopic and morphometric techniques. The gap in understanding of otolith morphology and mineralogy precludes our ability to accurately evaluate the impact of ocean acidification on larval fish survival. Given that we know very little about the morphology and mineralogy of all three otolith types in larval marine fish, this research will provide fundamental data regarding natural variability. Data from unexposed and exposed larvae will inform our understanding of the development of otoliths and structure-function relationships. Additionally, otoliths provide long-term records of environmental life histories that could be better exploited if we understood the relation between environmental conditions and otolith morphology and mineralogy.

This research represents a unique interdisciplinary collaboration between faculty and students at the University of Massachusetts Boston (a minority-serving institution), New England Aquarium (NEAq; not-for-profit research aquarium), and, through a formal partnership with NEAq, Roger Williams University (primarily undergraduate institution).

[table of contents | back to top]

Program Information

Science, Engineering and Education for Sustainability NSF-Wide Investment (SEES): Ocean Acidification (formerly CRI-OA) (SEES-OA)

Website: https://www.nsf.gov/funding/pgm_summ.jsp?pims_id=503477

Coverage: global

NSF Climate Research Investment (CRI) activities that were initiated in 2010 are now included under Science, Engineering and Education for Sustainability NSF-Wide Investment (SEES). SEES is a portfolio of activities that highlights NSF's unique role in helping society address the challenge(s) of achieving sustainability. Detailed information about the SEES program is available from NSF (https://www.nsf.gov/funding/pgm_summ.jsp?pims_id=504707).

In recognition of the need for basic research concerning the nature, extent and impact of ocean acidification on oceanic environments in the past, present and future, the goal of the SEES: OA program is to understand (a) the chemistry and physical chemistry of ocean acidification; (b) how ocean acidification interacts with

processes at the organismal level; and (c) how the earth system history informs our understanding of the effects of ocean acidification on the present day and future ocean.

Solicitations issued under this program:
NSF 10-530, FY 2010-FY2011
NSF 12-500, FY 2012
NSF 12-600, FY 2013
NSF 13-586, FY 2014
NSF 13-586 was the final solicitation that will be released for this program.

PI Meetings:
1st U.S. Ocean Acidification PI Meeting(March 22-24, 2011, Woods Hole, MA)
2nd U.S. Ocean Acidification PI Meeting(Sept. 18-20, 2013, Washington, DC)
3rd U.S. Ocean Acidification PI Meeting (June 9-11, 2015, Woods Hole, MA – Tentative)

NSF media releases for the Ocean Acidification Program:

Press Release 10-186 NSF Awards Grants to Study Effects of Ocean Acidification

Discovery Blue Mussels "Hang On" Along Rocky Shores: For How Long?

Discovery nsf.gov - National Science Foundation (NSF) Discoveries - Trouble in Paradise: Ocean Acidification This Way Comes - US National Science Foundation (NSF)

Press Release 12-179 nsf.gov - National Science Foundation (NSF) News - Ocean Acidification: Finding New Answers Through National Science Foundation Research Grants - US National Science Foundation (NSF)

Press Release 13-102 World Oceans Month Brings Mixed News for Oysters

Press Release 13-108 nsf.gov - National Science Foundation (NSF) News - Natural Underwater Springs Show How Coral Reefs Respond to Ocean Acidification - US National Science Foundation (NSF)

Press Release 13-148 Ocean acidification: Making new discoveries through National Science Foundation research grants

Press Release 13-148 - Video nsf.gov - News - Video - NSF Ocean Sciences Division Director David Conover answers questions about ocean acidification. - US National Science Foundation (NSF)

Press Release 14-010 nsf.gov - National Science Foundation (NSF) News - Palau's coral reefs surprisingly resistant to ocean acidification - US National Science Foundation (NSF)

Press Release 14-116 nsf.gov - National Science Foundation (NSF) News - Ocean Acidification: NSF awards $11.4 million in new grants to study effects on marine ecosystems - US National Science Foundation (NSF)

[table of contents | back to top]

Funding

Funding Source	Award
NSF Emerging Frontiers Division (NSF EF)	EF-1220480

[table of contents | back to top]