Respiration rates for pH experiments on L. pertusa specimens collected in the Norwegian Skagerrak and the Gulf of Mexico (Lophelia OA project)

Website: https://www.bco-dmo.org/dataset/659403
Data Type: experimental
Version: 1
Version Date: 2016-09-20

Project
» Physiological and genetic responses of the deep-water coral, Lophelia pertusa, to ongoing ocean acidification in the Gulf of Mexico (Lophelia OA)

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

Contributors	Affiliation	Role
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Abstract
Respiration rates for pH experiments on L. pertusa specimens collected in the Norwegian Skagerrak and the Gulf of Mexico (Lophelia OA project)

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Dataset Description

Respiration rates from pH manipulation experiments on *Lophelia pertusa.* Specimens were collected from Tisler Reef in the Norwegian Skagerrak and from the Gulf of Mexico.

Related References: Georgian S.E. et al., 2016.

Methods & Sampling

Acquisition Description for Tisler Reef Data:

Net calcification was measured using the total alkalinity anomaly (Smith & Key 1975; Ohde & Hossain 2004). Corals were individually placed in closed glass chambers (220 ml) in a water bath that maintained temperature

to +/-0.2 degrees C during all trials. To avoid hypoxia or the severe reductions of pH during incubations, ambient air was continuously bubbled into the chambers at a slow rate (1-2 bubbles s-1). This also provided adequate circulation within the chamber. A 60 ml water sample was collected by syringe before and after the incubation period, and measured for total alkalinity in duplicate. The respiration rate of each colony was measured as oxygen consumption in a 400 ml closed acrylic chamber during hour-long incubations. Dissolved oxygen concentrations were measured in umol L-1 using a Strathkelvin 782 dual oxygen meter and SI130 microcathode electrode. The feeding rate of each colony was measured as the capture rate of adult *Artemia salina* during a one-hour period in 0.8 L incubation chambers containing a starting prey density of 125 *Artemia* L-1.

Acquisition Description for Gulf of Mexico Data:

The buoyant weight of each colony was obtained at the start and end of the two-week experimental period by weighing fragments submerged in seawater and attached by a hook to an analytical balance (Denver Instrument, precision of 0.1 mg). The respiration rate of each colony was measured as oxygen consumption in an 800 ml closed acrylic chamber during hour-long incubations. Dissolved oxygen concentrations were measured in umol L-1 using a Strathkelvin 782 dual oxygen meter and SI130 microcathode electrode. The feeding rate of each colony was measured as the capture rate of adult *Artemia salina* during a one-hour period in 0.8 L incubation chambers containing a starting prey density of 125 *Artemia* L-1.

Data Processing Description

Processing Description for Tisler Reef Data:

Net calcification was calculated as umol CaCO3 gTW-1 h-1 using the following formula: Calcification = 0.5 * V * [(DeltaTAF) - (DeltaTAC)] / T * TW, where V is the volume of seawater in liters, DeltaTAF is the average change in total alkalinity during the incubation of each fragment, DeltaTAC is the average change in total alkalinity during the control incubations, T is the incubation time in hours, and TW is the final tissue weight of each fragment in grams. To allow for comparison to other studies, we then calculated net calcification as percent starting weight day-1. Capture rate was standardized to polyp number and reported as *Artemia* polyp-1 h-1.

Processing Description for Gulf of Mexico Data:

Buoyant weights were converted to dry weights in air using the density of the skeleton and of the seawater. A correction for the contribution of tissue to buoyant weights (following Davies 1989) was applied to obtain the dry weight of the skeleton alone. Net calcification was then calculated as the change in skeletal dry weight over the two-week experimental period, expressed as % starting weight day-1. Capture rate was standardized to polyp number and reported as *Artemia* polyp-1 h-1.

Data Management Office Notes:

-Separate spreadsheets in the original file (one for each location) have been combined and served as one object.
-Re-formatted column names to comply with BCO-DMO naming standards.

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Data Files

File	
physiology_respiration.csv	(Comma Separated Values (.csv), 5.56 KB) MD5:5b95cd0ca701085ff8df7d375f371b3d
Primary data file for dataset ID 659403	

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Related Publications

Georgian, S. E., Dupont, S., Kurman, M., Butler, A., Strömberg, S. M., Larsson, A. I., & Cordes, E. E. (2016). Biogeographic variability in the physiological response of the cold-water coralLophelia pertusato ocean acidification. Marine Ecology, 37(6), 1345–1359. https://doi.org/10.1111/maec.12373
General

Ohde, S., & Mozaffar Hossain, M. M. (2004). Effect of CaCO3 (aragonite) saturation state of seawater on calcification of Porites coral. GEOCHEMICAL JOURNAL, 38(6), 613–621. https://doi.org/10.2343/geochemj.38.613
Methods

Smith, S. V., & Key, G. S. (1975). Carbon dioxide and metabolism in marine environments1. Limnology and Oceanography, 20(3), 493–495. doi:10.4319/lo.1975.20.3.0493
Methods

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Parameters

Parameter	Description	Units
location	Location where specimen was collected; Tisler Reef or the Gulf of Mexico	unitless
pH_treatment	Level of pH treatment	unitless
tank	Tank number	unitless
fragment_num	Fragment ID number	unitless
polyps_num	Number of polyps on fragment	count
starting_DW	Starting dry weight	grams
AFDM	Ash free dry mass	grams
day	Day of measurement; 0 or 14	day
respiration_umolPerHour	Respiration rate	micromoles per hour (umol/hr)
respiration_umolPer_gTWPerHour	Respiration rate	micromoles per gTW per hour (umol/gTW/hr)

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Instruments

Dataset-specific Instrument Name	SI130 microcathode electrode
Generic Instrument Name	Oxygen Microelectrode Sensor
Dataset-specific Description	Measured dissolved oxygen concentrations
Generic Instrument Description	Any microelectrode sensor that measures oxygen.

Dataset-specific Instrument Name	Strathkelvin 782 dual oxygen meter
Generic Instrument Name	Oxygen Sensor
Dataset-specific Description	Measured dissolved oxygen concentrations
Generic Instrument Description	An electronic device that measures the proportion of oxygen (O2) in the gas or liquid being analyzed

Dataset-specific Instrument Name	Scale
Generic Instrument Name	scale
Dataset-specific Description	Used to weigh specimens
Generic Instrument Description	An instrument used to measure weight or mass.

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Deployments

Gulf_of_Mexico

Website	https://www.bco-dmo.org/deployment/659172
Platform	lab Cordes

Tisler_Reef

Website	https://www.bco-dmo.org/deployment/659168
Platform	lab Cordes

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Project Information

Physiological and genetic responses of the deep-water coral, Lophelia pertusa, to ongoing ocean acidification in the Gulf of Mexico (Lophelia OA)

Coverage: Northern Gulf of Mexico

The Gulf of Mexico deep water ecosystems are threatened by the persistent threat of ocean acidification. Deep-water corals will be among the first to feel the effects of this process, in particular the deep-water scleractinians that form their skeleton from aragonite. The continued shoaling of the aragonite saturation horizon (the depth below which aragonite is undersaturated) will place many of the known, and as yet undiscovered, deep-water corals at risk in the very near future. The most common deep-water framework-forming scleractinian in the world's oceans is *Lophelia pertusa*. This coral is most abundant in the North Atlantic, where aragonite saturation states are relatively high, but it also creates extensive reef structures between 300 and 600 m depth in the Gulf of Mexico where aragonite saturation states were previously unknown. Preliminary data indicate that pH at this depth range is between 7.85 and 8.03, and the aragonite saturation state is typically between 1.28 and 1.69. These are the first measurements of aragonite saturation state for the deep Gulf of Mexico, and are among the lowest Aragonite saturation state yet recorded for framework-forming corals in any body of water, at any depth.

This project will examine the effects of ocean acidification on *L. pertusa*, combining laboratory experiments, rigorous oceanographic measurements, the latest genome and transcriptome sequencing platforms, and quantitative PCR and enzyme assays to examine changes in coral gene expression and enzyme activity related to differences in carbonate chemistry. Short-term and long-term laboratory experiments will be performed at Aragonite saturation state of 1.45 and 0.75 and the organismal (e.g., survivorship and calcification rate) and genetic (e.g., transcript abundance) responses of the coral will be monitored. Genomic DNA and RNA will be extracted, total mRNA purified, and comprehensive and quantitative profiles of the transcriptome generated using a combination of 454 and Illumina sequencing technologies. Key genes in the calcification pathways as well as other differentially expressed genes will be targeted for specific qPCR assays to verify the Illumina sequencing results. On a research cruise, *L. pertusa* will be sampled (preserved at depth) along a natural gradient in carbonate chemistry, and included in the Illumina sequencing and qPCR assays. Water samples will be obtained by submersible-deployed niskin bottles adjacent to the coral collections as well as CTD casts of the water column overlying the sites. Water samples will be analyzed for pH, alkalinity, nitrates and soluble reactive

phosphorus. These will be used in combination with historical data in a model to hindcast Aragonite saturation state.

This project will provide new physiological and genetic data on an ecologically-significant and anthropogenically-threatened deepwater coral in the Gulf of Mexico. An experimental system, already developed by the PIs, offers controlled conditions to test the effect of Aragonite saturation state on calcification rates in scleractinians and, subsequently, to identify candidate genes and pathways involved in the response to reduced pH and Aragonite saturation state. Both long-term and population sampling experiments will provide additional transcriptomic data and specifically investigate the expression of the candidate genes. These results will contribute to our understanding of the means by which scleractinians may acclimate and acclimatize to low pH, alkalinity, and Aragonite saturation state. Furthermore, the investigators will continue a time series of oceanographic measurements of the carbonate system in the Gulf of Mexico, which will allow the inclusion of this significant body of water in models of past and future ocean acidification scenarios.

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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)

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Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-1220478

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