Net calcification of L. pertusa specimens exposed to different pH treatments collected on R/V Ronald Brown in Florida from October to November 2010 (Lophelia OA project)

Website: https://www.bco-dmo.org/dataset/659109
Data Type: experimental
Version: 1
Version Date: 2016-09-19

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
Cordes, Erik E.	Temple University (Temple)	Principal Investigator, Contact
Lunden, Jay	Lock Haven University (LHU)	Contact
Ake, Hannah	Woods Hole Oceanographic Institution (WHOI BCO-DMO)	BCO-DMO Data Manager

Abstract
Net calcification of L. pertusa specimens exposed to different pH treatments collected on R/V Ronald Brown in Florida from October to November 2010 (Lophelia OA project)

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Dataset Description

Net calcification data (percent total weight per day) for *Lophelia pertusa* exposed to different pH treatments. Specimens used in this experiment were collected on RB-10-07: NOAA Ship Ronald H. Brown, from October-November 2010.

Methods & Sampling

All methods are fully described in:

Lunden et al. 2014 Frontiers in Marine Science “Acute survivorship of the deep-sea coral *Lophelia pertusa* from the Gulf of Mexico under acidification, warming, and deoxygenation”

From the Paper:

Forty-one nubbins of *L. pertusa* used in the experiments were collected in November 2010 on the NOAA Ship Ronald H. Brown with ROV Jason II as part of the “Lophelia II” project jointly sponsored by the Bureau of Ocean Energy Management and the NOAA Office of Ocean Exploration and Research in the Gulf of Mexico (GoM). Permits for the collection of corals were obtained from the U.S. Department of the Interior prior to any collection activities. Spatially discrete coral branches were collected with the ROV and placed in temperature-insulated bioboxes (volume = 20 l) at depth. Upon return to the surface, corals were kept alive in 20 l aquaria in the ship’s constant-temperature room. Partial water changes were made regularly while at sea. Upon return to port, corals were immediately transported overnight to the laboratory on wet ice.

In the laboratory, corals were maintained in one of two 570 liter recirculating aquaria systems at temperature 8 degrees celsius and salinity 35 ppt (Lunden et al., 2014). Regular partial water changes (15–20%) were performed with seawater made using Instant Ocean sea salt. Submersible power heads were placed in each holding tank to ensure water movement and turbulence sufficient to cause swaying of coral polyps. Corals were fed three times weekly using a combination of MarineSnow PlanktonDiet (Two Little Fishies, Miami Gardens, FL) and freshly hatched Artemia nauplii.

Survivorship was assessed by daily observations of polyp tissue presence and behavior. Final survivorship counts were taken 3 to 4 days following the end of each treatment after transfer to the maintenance tank. Survivorship is reported as percent cumulative mortality.

Net calcification was measured using the buoyant weight technique (Davies, 1989). Coral nubbins were buoyantly weighed at the start and end of each experimental period (days eight and fifteen) using a Denver Instruments SI-64 analytical balance (d = 0.1mg, Fisher Scientific, Waltham, MA). A weighing chamber was constructed using 1/2” plexiglass to prevent disturbances from air movement during weighing. Each coral nubbin was transported individually from its respective aquarium to the weighing chamber in a four-liter Pyrex beaker and suspended from the balance. The buoyant weight was recorded after the coral nubbin stabilized, typically 2 min. Each coral nubbin was weighed three times to determine measurement precision (2–3 mg). Seawater density was determined in each aquarium by buoyantly weighing a 2.5 cm^2 aluminum block with known density (2.7 g/cm^−3). Coral weight in air (i.e., dry weight) was calculated by the following equation:

Wa = Ww / (1− (Dw/SD))

Where
Wa = coral weight in air (dry weight)
Ww = coral weight in water (buoyant weight)
Dw = density of seawater
SD = coral skeletal density (= 2.82 g/cm^−3, Lunden et al., 2013).

Coral growth rate is reported as percent growth per day (%/d−1), which was calculated by the equation:

Gt = 100 × (Mt2 − Mt1)/(Mt1(T2 −T1))

Where
Gt =growth rate as %/d^−1
Mt2 = mass (mg, dry weight) at time 2 (end of experimental period, day 15)
Mt1= mass (mg, dry weight) at time 1 (start of experimental period, day 8)
T2 = time 2 (end of experimental period, day 15)
T1= time 1 (start of experimental period, day 8)

Data Processing Description

Data Management Office Notes:

-Separate tabs in the original file have been served as separate datasets.
-Re-formatted column names to comply with BCO-DMO naming standards.

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Data Files

File
lophelia_pH.csv (Comma Separated Values (.csv), 3.56 KB) MD5:552374e432002fec84455ad57163febe Primary data file for dataset ID 659109

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Related Publications

Davies, P.S. (1989). Short-term growth measurements of corals using an accurate buoyant weighing technique. Marine Biology, 101(3), 389–395. doi:10.1007/bf00428135 https://doi.org/10.1007/BF00428135
Methods

Lunden, J. J., Georgian, S. E., & Cordes, E. E. (2013). Aragonite saturation states at cold-water coral reefs structured byLophelia pertusain the northern Gulf of Mexico. Limnology and Oceanography, 58(1), 354–362. doi:10.4319/lo.2013.58.1.0354
Methods

Lunden, J. J., McNicholl, C. G., Sears, C. R., Morrison, C. L., & Cordes, E. E. (2014). Acute survivorship of the deep-sea coral Lophelia pertusa from the Gulf of Mexico under acidification, warming, and deoxygenation. Frontiers in Marine Science, 1. doi:10.3389/fmars.2014.00078
Methods

Lunden, J. J., Turner, J. M., McNicholl, C. G., Glynn, C. K., & Cordes, E. E. (2014). Design, development, and implementation of recirculating aquaria for maintenance and experimentation of deep-sea corals and associated fauna. Limnology and Oceanography: Methods, 12(6), 363–372. doi:10.4319/lom.2014.12.363
Methods

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Parameters

Parameter	Description	Units
pH_treatment	pH treatment; ambient, low, or very low	unitless
group	Specimen group	unitless
individual	Specimen ID number	unitless
temperature	Water temperature	celsius
salinity	Salinity of water	PPT
TA	Total alkalinity of water	micromoles per kilogram (umol/kg -1)
pH_total	pH measured on the total hydrogen scale	unitless
omega_Ar	Saturation state of aragonite	unitless
dry_weight_start	Dry weight at start of experiment	grams
dry_weight_end	Dry weight at end of experiment	grams
net_calcification	Percent growth of coral colony per day	percent per day (%/d -1)
percent_survivorship	Percent survivorship	percent

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Instruments

Dataset-specific Instrument Name	Aquarium
Generic Instrument Name	Aquarium
Dataset-specific Description	20 L aquaria were used on the ship and 570 L recirculating aquaria systems were used in the lab
Generic Instrument Description	Aquarium - a vivarium consisting of at least one transparent side in which water-dwelling plants or animals are kept

Dataset-specific Instrument Name	Denver Instruments SI-64 Analytical Balance
Generic Instrument Name	scale
Dataset-specific Description	Used for buoyant weights; d = 0.1mg, Fisher Scientific
Generic Instrument Description	An instrument used to measure weight or mass.

Dataset-specific Instrument Name	Temperature sensor
Generic Instrument Name	Water Temperature Sensor
Dataset-specific Description	Indicates water temperature
Generic Instrument Description	General term for an instrument that measures the temperature of the water with which it is in contact (thermometer).

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Deployments

RB1007

Website	https://www.bco-dmo.org/deployment/659009
Platform	NOAA Ship Ronald H. Brown
Start Date	2010-10-14
End Date	2010-11-04

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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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