Photosynthesic parameters (calculated alpha, Pmax, Respiration, Ek and Ec) for each P-E curve for coral Orbicella faveolata from Rosaria and Varadero reef sites and Cartagena Bay, Colombia, 2016 and 2017

Website: https://www.bco-dmo.org/dataset/719161
Data Type: experimental
Version: 3
Version Date: 2018-03-05

Project
» RAPID: Coral robustness: lessons from an "improbable" reef (Varadero Reef)

Contributors	Affiliation	Role
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Abstract
This dataset contains the results of the photosynthetic parameters calculated based on the analysis of the P-E curves from coral fragment of the species Orbicella faveolata used in the transplant experiment between three sites: Varadero (10°18'23.3"N, 75°35'08.0"W), Rosario (10°11'12.1"N, 75°44'43.0"W) and Abanico (10°18'5.80"N, 75°34'37.10"W). The tag number/color of each fragment, the date of data collection, and the sites of origin and destination are specified.

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Coverage

Spatial Extent: **Lat**:10.3028 **Lon**:-75.5819
Temporal Extent: 2016-10 - 2017-05

Dataset Description

This file contains the primary data of the photosynthetic parameters from coral fragments of the species Orbicella faveolata used in a reciprocal transplant experiment. Data from three study sites are reported: Varadero at 3.5m depth; Rosario at 12m depth; and Cartagena Bay at 3m depth. Both Varadero and Rosario were used as source and destination sites; while Cartagena Bay was only used as destination site for the transplant experiment. The file has one spreadsheet: Photosynthetic parameters, which contains the primary data of several photosynthetic parameters. These parameters were measured on two time points with different groups of corals: before transplantation on October of 2016 (T1) and seven months after transplantation on May of 2017 (T2).

These data were used in the manuscripts:
"Degradation of the underwater light environment: physiological and ecological consequences for reef corals" submitted to the Journal Nature Communications Biology. [under review, 2019-12-28]
and
"Surviving marginalized reefs: assessing the implications of the microbiome on coral physiology and survivorship", submitted to the journal Coral Reefs, special issue "Coral Reefs in a Changing World: Insights from Extremes".

Related Reference:

Pizarro V, Rodríguez SC, López-Victoria M, Zapata FA, Zea S, Galindo-Martínez CT, Iglesias-Prieto R, Pollock J, Medina M. (2017) Unraveling the structure and composition of Varadero Reef, an improbable and imperiled coral reef in the Colombian Caribbean. PeerJ 5:e4119 https://doi.org/10.7717/peerj.4119

Acquisition Description

The Varadero Reef is located south-west of the Cartagena Bay close to the southern strait that connects the Bay to the Caribbean Sea in Colombia (10°18’23.3”N, 75°35’08.0”W). The Bay is a receiving estuary from the Magdalena River through the Canal del Dique, a man-made channel whose construction and operation dates back almost a century. Three study sites with contrasting light regimes were considered in order to evaluate the role of the light-environment perturbation associated with the Dique channel freshwater plume on the photosynthetic performance of corals from Varadero: 1) Varadero reef at 3.5m depth close to the Dique channel mouth (10°18’23.3”N, 75°35’08.0”W), 2) Rosario reef at 12m depth as clear-control site 21 km southwest from Varadero (10°11'12.1"N, 75°44'43.0"W), and 3) Cartagena Bay at 3m depth, the closest site to the Dique channel mouth and most turbid among the three sites (10°18'5.80"N, 75°34'37.10"W).

The values of the photosynthetic efficiency (alpha) are expressed in umol O2 umol quanta-1, the compensating irradiance (Ec) in umol quanta m-2 s-1, the saturating irradiance (Ek) in umol quanta m-2 s-1, the average respiration rate (R-avg) as well as the respiration pre- and post-illumination (R0 and Rf) are expressed in umol O2 m-2 s-1, and the net and gross maximum photosynthesis rates (Pmax(n) and Pmax(gross)) are expressed in umoles O2 m-2 s-1.

Photosynthetic parameters of corals were obtained from PE (photosynthesis vs. irradiance) curves conducted under laboratory conditions. A custom-made water-jacket acrylic chamber with four independent hermetic compartments (~650 ml each) was used to run the PE curves, maintaining a constant temperature of 28 °C, close to natural conditions, with an external circulating water bath (Isotemp, Fisher Scientific). During each incubation, corals were submerged on filtered seawater (0.45 µm) under constant agitation by magnetic stirrers. Ten levels of irradiance between 0 and ~1400 µmol quanta m-2 s-1 were supplied at 10-min intervals with four 26 W LED bulbs (UL PAR38, LED Wholesalers Inc, USA). The light intensity was controlled with a custom-made software. The LEDs were operated in continuous mode with a multifunction I/O card (USB-6001, National Instruments Corp., USA) to avoid potential artefacts related to the effect of different pulsating frequencies on photosynthesis. Oxygen concentrations inside the compartments within the chamber were measured with a 4-channel fiber optical oxygen meter system (FireSting, Pyroscience, Germany). The photosynthetic efficiency (α), compensating irradiance (Ec), saturating irradiance (Ek), respiration rates (Rd), and maximum photosynthetic rates (Pmax), were calculated from the light-limited and light-saturated regions of the PE curves. Chlorophyll a (Chl a) content per unit of coral surface area was determined after obtaining coral tissue slurries with the help of an air gun connected to a scuba tank. Pigment extraction was performed in acetone/dimethyl sulfoxide (95:5 vol/vol) after homogenizing the slurries with a Tissue-Tearor Homogenizer (BioSpec Inc, USA). Chl a density was estimated spectrophotometrically with a modular spectrometer (Flame-T-UV-VIS, Ocean Optics Inc., USA). The specific absorption coefficient of Chl a (a*Chl a) was calculated using the equation: $a^{*}\text{Chl a} = (D675/\rho) \cdot \ln(10)$, where D675 is the estimated absorbance value of corals at 675 nm, calculated from reflectance (R) measurements as [D675 = log (1/R675)],

and ρ is the pigment content per projected surface area (mg Chl a m-2).

The software Pyro Oxygen Logger was used to operate the fiber optical oxygen meter system. The software OceanView was used to operate there modular spectrometer.

Processing Description

BCO-DMO Processing Notes:
- added conventional header with dataset name, PI name, version date
- modified parameter names to conform with BCO-DMO naming conventions

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Related Publications

Degradation of the underwater light environment: physiological and ecological consequences for reef corals" submitted to the Journal Nature Communications Biology [under review, 2020-01] [details]

Iglesias-Prieto, R. & R.K. Trench. 1994. Acclimation and adaptation to irradiance in symbiotic dinoflagellates. I. Responses of the photosynthetic unit to changes in photon flux density. Mar Ecol Prog Ser 113: 163-175. Stable URL: http://www.jstor.org/stable/24849586 [details]

Johnson, M. D., Price, N. N., & Smith, J. E. (2014). Contrasting effects of ocean acidification on tropical fleshy and calcareous algae. PeerJ, 2, e411. doi:10.7717/peerj.411 [details]

Osinga, R., R. Iglesias-Prieto & S. Enríquez. 2012. Measuring photosynthesis in symbiotic invertebrates: a review of methodologies, rates and processes. 220-256. In: Najafpour, M.N. (Ed.) Applied Photosynthesis. InTech. 422 p. Full text url: http://library.wur.nl/WebQuery/wurpubs/fulltext/245530 [details]

Pizarro, V., Rodríguez, S. C., López-Victoria, M., Zapata, F. A., Zea, S., Galindo-Martínez, C. T., … Medina, M. (2017). Unraveling the structure and composition of Varadero Reef, an improbable and imperiled coral reef in the Colombian Caribbean. PeerJ, 5, e4119. doi:10.7717/peerj.4119 [details]

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Parameters

Parameter	Description	Units
Source_site	coral collection site	unitless
Tag_num	coral tag number	unitless
Tag_color	tag color	unitless
Destination_site	relocation site	unitless
Data_Timepoint	data collection timepoint: T1= pre-transplant (Oct. 2016); T2= 7 months post-transplant (May 2017)	unitless
Date_collected	month and year of data collection	unitless
Area_cm2	area of coral fragment	centimeter^2
Chl_a	Chlorophyll a content per unit area	milligrams Chla meter^-2
D_675	Absorbance at 675 nm	unitless
a_star_675	Specific absorption coefficient of Chl a	meters^2 milligram Chla^-1
alpha	Photosynthetic efficiency	mol Oxygen mol quanta^-1
Ec	Compensating irradiance	micromol quanta meter^-2 second^-1
Ek	Saturating irradiance	micromol quanta meter^-2 second^-1
Rd	Respiration rate (dark)	micromol Oxygen meter^-2 second^-1
Pmax	Maximum photosynthesis	micromol Oxygen meter^-2 second^-1

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Instruments

Dataset-specific Instrument Name	cosine light sensor (Waltz)
Generic Instrument Name	Light Meter
Generic Instrument Description	Light meters are instruments that measure light intensity. Common units of measure for light intensity are umol/m2/s or uE/m2/s (micromoles per meter squared per second or microEinsteins per meter squared per second). (example: LI-COR 250A)

Dataset-specific Instrument Name	Optical oxygen meter FireStingO2 (Pyroscience)
Generic Instrument Name	Dissolved Oxygen Sensor
Dataset-specific Description	Used to measure oxygen evolution.
Generic Instrument Description	An electronic device that measures the proportion of oxygen (O2) in the gas or liquid being analyzed

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Project Information

RAPID: Coral robustness: lessons from an "improbable" reef (Varadero Reef)

Coverage: Caribbean Sea (10°18’10”N, 75°34’ 55”W)

NSF Award Abstract: Coral reefs provide invaluable services to coastal communities, but coral populations worldwide are in a state of unprecedented decline. Studying resilient reefs is of primary importance for coral conservation and restoration efforts. A unique natural experiment in coral resilience to stress has been playing out in Cartagena Bay, Colombia since the Spanish conquistadors diverted the Magadalena River into the Bay in 1582. Varadero Reef at the southern mouth of the Bay has survived centuries of environmental insults and changing conditions with up to 80% coral cover. This reef provides an ideal system to test biological

robustness theory. Given that Varadero is a highly perturbed system, we hypothesize that while likely more robust to perturbation than nearby pristine reefs, it will be less physiologically efficient. Some of the large star coral colonies (Orbicella faveolata) at this site have existed since before the construction of the Canal del Dique. These coral specimens contain invaluable information regarding the conditions of the Magdalena River wathershed and its construction in the XIV century. Changes in turbidity of the plume associated with the urban industrial and agricultural development of Colombia can be documented as variations in calcification rates and changes in the microstructure of the skeleton. The Colombian government has announced the approval for the construction of a shipping channel that will go right over this reef, with the goal to start dredging as early as Fall 2016 or early 2017. The RAPID funding mechanism would enable immediate collection of data and information of why this reef has survived centuries of environmental stress that can shed light on what genotype combinations of coral and its microbial constituents will fare better in similar conditions at other reef locations around the world. Coral reef conservation biology will benefit from this study by generating data for the development of stress diagnostic tools to identify resilient corals. This project will help broaden participation in science by training a diverse cohort of students to work effectively in the global arena while fostering productive collaborations with several Colombian researchers and educational institutions. Students will also gain cultural empathy and sensitivity through direct engagement with the members of society who are most directly impacted by coral reef degradation (e.g. fishermen). Student researchers from Penn State University will work alongside their Colombian counterparts to develop a series of bilingual blog posts to record the cultural and scientific aspects of this project's research expeditions. The blog postings will be submitted for wide dissemination to the Smithsonian's Ocean Portal where Penn State students have published in the past. An educational coral kit developed by the Medina Lab and extensively tested in schools in the US has been translated into Spanish and will be used in local schools in Cartagena and vicinities. All expedition data and metadata will be incorporated into the Global Coral Microbiome Project's interactive web portal, a responsive outreach tool allows researchers, students and/or teachers to access a wealth of information about every coral colony we sample and to virtually explore coral reefs around the world from any internet-enabled device. This research will generate information to understand functional traits related to symbioses stability under different perturbation regimes. Comparative analyses of microbiome modifications generated during the reciprocal transplantation will allow us to document possible differential responses of the holobionts to acute and chronic stressors relative to corals not exposed to significant levels of perturbation. The development of local bio-optical models of coral calcification and the characterization of the coral holobiont will permit the distinction between the effects in calcification attributed to local turbidity from those that can be ;attributed to differences in host genotype and/or microbial community composition and function. The information recorded in coral skeletons can be used to reconstruct the rates of agricultural, industrial and urban development of Colombia through the last 5 centuries as changes in the turbidity of the effluent of the Magdalena River.

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Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-1642311

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