Larvae collected near Mariana Back-Arc hydrothermal vents in 2010

Website: https://www.bco-dmo.org/dataset/877284
Data Type: Cruise Results
Version: 1
Version Date: 2022-08-05

Project
» RAPID: Larval Abundance, Behavior and Dispersal at Deep-sea Hydrothermal Vents in the Southern Mariana Trough (Mariana Back-arc Vents)
» RUI: Collaborative: The Predictive Nature of Microbial Biofilms for Cuing Larval Settlement at Deep-Sea Hydrothermal Vents (Vent Settlement Cues)

Contributors	Affiliation	Role
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Abstract
This dataset provides the counts for larvae, identified to varying levels of taxonomic granularity, collected near Mariana Back-Arc hydrothermal vent sites (Snail, Archaean, and Urashima) in 2010 on cruise YK10-11 aboard R/V Yokosuka. Samples were collected using large-volume plankton pumps and sorted morphologically under a dissecting microscope. The larval counts data table is partially aligned to a Darwin Core occurrence table, and the sampling events data table is partially aligned to a Darwin Core event table. Samples were sorted completely, thus concentrations per taxon may be derived from the counts and volume filtered.

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Coverage

Spatial Extent: **N**:12.9526 **E**:143.6485 **S**:12.9225 **W**:143.6188
Temporal Extent: 2010-09-05 - 2010-09-11

Methods & Sampling

Larval collection:
These larvae were collected near three hydrothermal vent sites (Snail, Archaean, or Urashima) on the Mariana Back-Arc Spreading Center in the southern Mariana Trough in September 2010 on R/V Yokosuka cruise YK10-11. See the Sampling Events Supplemental File for specific locations and dates.

To collect larvae, we deployed large-volume plankton pumps (McLane WTS-LV50, East Falmouth, MA, USA) to sample at 3 or 4 m above the bottom. Each pump sampled for up to 24 hrs at 30 liters per minute over a 63 micron mesh, yielding a filtered volume of up to 41.5 cubic meters. We provide as a supplemental data file a table of sampling events matched to Station Information in the Marine Geoscience Data System (https://www.marine-geo.org/tools/search/Events.php?event_set_uid=1185).

Shipboard sample processing:
Upon recovery, pump filters were rinsed with filtered seawater into trays on ice and examined live to select some individuals for experiments reported by Beaulieu et al. (2015, DOI:10.1111/maec.12207). Within an hour the trays were poured over a 63-um sieve and washed using 95% non-denatured ethanol into a 250 mL jar. Individuals used in the experiments were saved separately, either frozen or preserved in ethanol.

Laboratory sorting and morphological identification:
Samples were poured over nested 300-um and 63-um sieves and washed into dishes for sorting under a dissecting scope at magnifications up to 50X. Individuals were identified to morphotypes at lowest taxonomic level (original categories for morphospecies). All morphospecies were enumerated except for ostracods and copepods which were only accounted as “p” present, “a” absent, or “n” not accounted for. We used the original category plus genetic evidence when available to match our lowest-level identification to the World Register of Marine Species (WoRMS) taxonomic database. Some morphotypes contain morphologically indistinguishable larvae from multiple species (e.g., complex nectochaetes); in this case, our final categories for morphospecies group those individuals with genetic evidence into the higher taxon rank. The table is organized such that the first row listing a final category morphospecies is at the higher taxon rank containing the subsequent rows for that category (in general, the subsequent rows are for specimens sent out for genetic analyses). Note that the polychaetes classified to Infraclass Scolecida correspond to the “Capitellid” larval morphotype in Beaulieu et al. (2015). We thank Dr. Takenori Sasaki for guidance for identification of gastropods.

Additional genetic evidence to assist with larval identification:
A subset of these specimens with 28S rRNA sequences is described in a separate BCO-DMO dataset (Beaulieu et al., 2021, DOI:10.26008/1912/bco-dmo.839476.1, https://www.bco-dmo.org/dataset/839476). We'd like to thank Dr. Hiroka Hidaka, Dr. Shigeaki Kojima, and Dr. Hiromi Watanabe for providing histone 3 sequences for gastropod specimens and Dr. Florence Pradillon for providing cytochrome oxidase subunit 1 (CO1) sequences for polychaete specimens. We thank Bethany Fleming for NCBI BLAST query.

Data Processing Description

Data Processing:
Counts per morphospecies were entered into an electronic online spreadsheet (Google sheet) that was downloaded to a local .xlsx copy. The scientificName column was used with the WoRMS Taxon Match Tool to obtain a text file with the LSID and taxonomic classification and to confirm taxon status accepted on 2022-02-12. The larval_counts sheet in the .xlsx and the Taxon Match .txt were read into an R programming script to join columns into the larval counts data table https://github.com/sbeaulieu/EPR-traits/blob/master/Mariana_larval_counts_BCODMO.R. Another sheet in the .xlsx was exported to a csv file as the sampling event table. The data tables are partially aligned to Darwin Core so that they ultimately can be provided to the Ocean Biodiversity Information System (OBIS) and Global Biodiversity Information Facility (GBIF). Note that 25 individuals with occurrenceID have already been contributed to OBIS and GBIF.

BCO-DMO Processing:
- replaced "NA" with "nd" (no data);
- renamed fields to comply with BCO-DMO naming conventions;
- removed commas from values in columns Fleming_etal_Table, final_category_morphospecies, and original_category_morphospecies;
- changed long text string in original_category_morphospecies, row 13 as requested by PI.

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Data Files

File
larval_counts_2010.csv (Comma Separated Values (.csv), 18.62 KB) MD5:b5eeff98462e047536926a2900f6e3e3 Primary data file for dataset ID 877284

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Supplemental Files

File
Mariana Sampling Events Column Header Definitions filename: Mariana_sampling_events_column_header_definitions_20220222.pdf (Portable Document Format (.pdf), 375.26 KB) MD5:fcb40fbbd2c2c3601dbd17c0817957d3 Column definitions and units for the "Mariana Sampling Events" file.
Mariana Sampling Events filename: Mariana_sampling_events_BCODMO_20220221.csv (Comma Separated Values (.csv), 829 bytes) MD5:ea9edca5a56a5545a2c375d1e7f04687 Table of sampling events associated with the dataset "Larvae collected near Mariana Back-Arc hydrothermal vents in 2010" (ID: 877284). Authors: Stace Beaulieu, Susan Mills, Lauren Mullineaux Date: 2022-02-22 Column definitions and units are below and also in the attached PDF ("Mariana Sampling Events Column Header Definitions"). Column Header: Description (Units) eventID: An identifier for the set of information associated with a sampling event that concatenates the cruise identifier and the mooring deployment Darwin Core term http://rs.tdwg.org/dwc/terms/eventID (unitless) locality: The specific description of the place near the sampling event, using names of vent fields and sites in the InterRidge Vents Database Ver. 3.4 https://doi.org/10.1594/PANGAEA.917894 Darwin Core term http://rs.tdwg.org/dwc/terms/locality (unitless) decimalLatitude: The geographic latitude in decimal degrees of the sampling near the locality. Positive values are north of the Equator, negative values are south of it Darwin Core term http://rs.tdwg.org/dwc/terms/decimalLatitude (degrees) decimalLongitude: The geographic longitude in decimal degrees of the sampling near the locality. Positive values are east of the Greenwich Meridian, negative values are west of it Darwin Core term http://rs.tdwg.org/dwc/terms/decimalLongitude (degrees) Bottom_Depth_Meters: Depth below sea level of the seafloor under the sampling event (meters (m)) minimumDepthInMeters: The lesser depth of a range of depth below sea level for the sampling event Darwin Core term http://rs.tdwg.org/dwc/terms/minimumDepthInMeters (meters (m)) maximumDepthInMeters: The greater depth of a range of depth below sea level for the sampling event Darwin Core term http://rs.tdwg.org/dwc/terms/maximumDepthInMeters (meters (m)) eventDate: The date of the sampling event when the pump stopped Darwin Core term http://rs.tdwg.org/dwc/terms/eventDate Format: YYYY-MM-DD (unitless) Volume_Filtered_L: Volume of seawater pumped over 63-um filter for the sampling event (liters (L)) Station_MGDS: Station Information event_name in Marine Geoscience Data System https://www.marine-geo.org/tools/search/Events.php?event_set_uid=1185 (unitless) Missing data identifier = NA

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Related Publications

Beaulieu, S. (2022). Script to join Mariana larval counts with WoRMS Taxon Match. https://github.com/sbeaulieu/EPR-traits/blob/master/Mariana_larval_counts_BCODMO.R
Software

Beaulieu, S. E., Mills, S., Mullineaux, L., Pradillon, F., Watanabe, H., & Kojima, S. (2011). International study of larval dispersal and population connectivity at hydrothermal vents in the U.S. Marianas Trench Marine National Monument. OCEANS'11 MTS/IEEE KONA. https://doi.org/10.23919/oceans.2011.6107064 https://doi.org/10.23919/OCEANS.2011.6107064
Related Research

Beaulieu, S. E., Sayre-McCord, R. T., Mills, S. W., Pradillon, F., & Watanabe, H. (2015). Swimming speeds of polychaete larvae collected near deep-sea hydrothermal vents. Marine Ecology, 36, 133–143. Portico. https://doi.org/10.1111/maec.12207
Related Research

Carrier, T. J., Beaulieu, S. E., Mills, S. W., Mullineaux, L. S., & Reitzel, A. M. (2021). Larvae of Deep-Sea Invertebrates Harbor Low-Diversity Bacterial Communities. The Biological Bulletin, 241(1), 65–76. doi:10.1086/715669
Related Research

Fleming, B. et al., 2022, manuscript in prep.
Results

R Core Team (2020). R: A language and environment for statistical computing. R v4.0.3. R Foundation for Statistical Computing, Vienna, Austria. URL https://www.R-project.org/
Software

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Related Datasets

IsRelatedTo

Beaulieu, S., Carrier, T., Mills, S., Mullineaux, L., Reitzel, A. (2021) **Sampling locations and identifications for larvae collected near three deep-sea hydrothermal vent fields from 2007 to 2017.** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2021-02-02 doi:10.26008/1912/bco-dmo.839476.1 [view at BCO-DMO]
Relationship Description: A subset of specimens identified in dataset 877284 ("Larvae collected near Mariana Back-Arc hydrothermal vents in 2010") with 28S rRNA sequences is described in dataset 839476 ("Deep-sea larvae for microbiome study").

R/V Yokosuka cruise YK10-11 in Marine Geoscience Data System. http://www.marine-geo.org/tools/search/entry.php?id=YK10-11

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Parameters

Parameter	Description	Units
Fleming_etal_Table	Category with some morphospecies grouped for analysis by Fleming et al. manuscript in prep.	unitless
scientificName	Scientific name at the lowest level that matches original_category_morphospecies from the World Register of Marine Species that pairs to the LSID Darwin Core term http://rs.tdwg.org/dwc/terms/scientificName	unitless

LSID	Life Science Identifier for the AphiaID in the World Register of Marine Species that pairs to the scientificName	unitless
taxonRank	Taxon rank for the scientificName in the World Register of Marine Species Darwin Core term http://rs.tdwg.org/dwc/terms/taxonRank	unitless
final_category_morphospecies	Final category for determining abundance from morphological sorting. Some individuals in this morphospecies may be identified to lower taxonomic level but that could not be applied to all individuals.	unitless
original_category_morphospecies	Original category for morphological sorting to lowest taxonomic level	unitless
individuals_with_genetic_sequences	Identifiers for individuals with genetic sequence data. Those listed with occurrenceID match to TubeID in DOI:10.26008/1912/bco-dmo.839476.1, otherwise gastropod identifiers for H. Hidaka, polychaete identifiers for F. Pradillon.	unitless
occurrenceID	A unique identifier for the Occurrence record in DOI:10.26008/1912/bco-dmo.839476.1 provided to OBIS and GBIF that concatenates the eventID with the individual identifier Darwin Core term http://rs.tdwg.org/dwc/terms/occurrenceID	unitless
Pump1_Snail_300	Count for individuals retained on 300 um sieve from pump mooring deployment 1 at locality Snail	Integer count or p,a,n ("present", "absent", "not accounted for")
Pump1_Snail_63	Count for individuals that passed through 300 um retained on 63 um sieve from pump mooring deployment 1 at locality Snail	Integer count or p,a,n ("present", "absent", "not accounted for")
Pump1_Snail_ship	Count for individuals sorted live onboard ship from pump mooring deployment 1 at locality Snail	Integer count or p,a,n ("present", "absent", "not accounted for")
Pump2_Snail_300	Count for individuals retained on 300 um sieve from pump mooring deployment 2 at locality Snail	Integer count or p,a,n ("present", "absent", "not accounted for")

Pump2_Snail_63	Count for individuals that passed through 300 um retained on 63 um sieve from pump mooring deployment 2 at locality Snail	Integer count or p,a,n ("present", "absent", "not accounted for")
Pump2_Snail_ship	Count for individuals sorted live onboard ship from pump mooring deployment 2 at locality Snail	Integer count or p,a,n ("present", "absent", "not accounted for")
Pump3_Archaean_300	Count for individuals retained on 300 um sieve from pump mooring deployment 3 at locality Archaean	Integer count or p,a,n ("present", "absent", "not accounted for")
Pump3_Archaean_63	Count for individuals that passed through 300 um retained on 63 um sieve from pump mooring deployment 3 at locality Archaean	Integer count or p,a,n ("present", "absent", "not accounted for")
Pump3_Archaean_ship	Count for individuals sorted live onboard ship from pump mooring deployment 3 at locality Archaean	Integer count or p,a,n ("present", "absent", "not accounted for")
Pump4_Archaean_300	Count for individuals retained on 300 um sieve from pump mooring deployment 4 at locality Archaean	Integer count or p,a,n ("present", "absent", "not accounted for")
Pump4_Archaean_63	Count for individuals that passed through 300 um retained on 63 um sieve from pump mooring deployment 4 at locality Archaean	Integer count or p,a,n ("present", "absent", "not accounted for")
Pump4_Archaean_ship	Count for individuals sorted live onboard ship from pump mooring deployment 4 at locality Archaean	Integer count or p,a,n ("present", "absent", "not accounted for")
Pump5_Urashima_300	Count for individuals retained on 300 um sieve from pump mooring deployment 5 at locality Urashima	Integer count or p,a,n ("present", "absent", "not accounted for")

Pump5_Urashima_63	Count for individuals that passed through 300 um retained on 63 um sieve from pump mooring deployment 5 at locality Urashima	Integer count or p,a,n ("present", "absent", "not accounted for")
Pump5_Urashima_ship	Count for individuals sorted live onboard ship from pump mooring deployment 5 at locality Urashima	Integer count or p,a,n ("present", "absent", "not accounted for")
Pump6_Urashima_300	Count for individuals retained on 300 um sieve from pump mooring deployment 6 at locality Urashima	Integer count or p,a,n ("present", "absent", "not accounted for")
Pump6_Urashima_63	Count for individuals that passed through 300 um retained on 63 um sieve from pump mooring deployment 6 at locality Urashima	Integer count or p,a,n ("present", "absent", "not accounted for")
Pump6_Urashima_ship	Count for individuals sorted live onboard ship from pump mooring deployment 6 at locality Urashima	Integer count or p,a,n ("present", "absent", "not accounted for")
Kingdom	Kingdom for the scientificName in the World Register of Marine Species	unitless
Phylum	Phylum for the scientificName in the World Register of Marine Species	unitless
Class	Class for the scientificName in the World Register of Marine Species	unitless
Order	Order for the scientificName in the World Register of Marine Species	unitless
Family	Family for the scientificName in the World Register of Marine Species	unitless
Genus	Genus for the scientificName in the World Register of Marine Species	unitless
Species	Species for the scientificName in the World Register of Marine Species	unitless

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Instruments

Dataset-specific Instrument Name	McLane WTS-LV50
Generic Instrument Name	McLane Large Volume Pumping System WTS-LV
Generic Instrument Description	The WTS-LV is a Water Transfer System (WTS) Large Volume (LV) pumping instrument designed and manufactured by McLane Research Labs (Falmouth, MA, USA). It is a large-volume, single-event sampler that collects suspended and dissolved particulate samples in situ. Ambient water is drawn through a modular filter holder onto a 142-millimeter (mm) membrane without passing through the pump. The standard two-tier filter holder provides prefiltering and size fractioning. Collection targets include chlorophyll maximum, particulate trace metals, and phytoplankton. It features different flow rates and filter porosity to support a range of specimen collection. Sampling can be programmed to start at a scheduled time or begin with a countdown delay. It also features a dynamic pump speed algorithm that adjusts flow to protect the sample as material accumulates on the filter. Several pump options range from 0.5 to 30 liters per minute, with a max volume of 2,500 to 36,000 liters depending on the pump and battery pack used. The standard model is depth rated to 5,500 meters, with a deeper 7,000-meter option available. The operating temperature is -4 to 35 degrees Celsius. The WTS-LV is available in four different configurations: Standard, Upright, Bore Hole, and Dual Filter Sampler. The high-capacity upright WTS-LV model provides three times the battery life of the standard model. The Bore-Hole WTS-LV is designed to fit through a narrow opening such as a 30-centimeter borehole. The dual filter WTS-LV features two vertical intake 142 mm filter holders to allow simultaneous filtering using two different porosities.

Dataset-specific Instrument Name	dissecting scope
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".

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Deployments

YK10-11

Website	https://www.bco-dmo.org/deployment/783909
Platform	R/V Yokosuka
Report	http://www.godac.jamstec.go.jp/catalog/data/doc_catalog/media/YK10-11_all.pdf
Start Date	2010-09-03
End Date	2010-09-15
Description	For more cruise information, visit http://www.godac.jamstec.go.jp/darwin/cruise/yokosuka/yk10-11/e and http://www.marine-geo.org/tools/search/entry.php?id=YK10-11.

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Project Information

RAPID: Larval Abundance, Behavior and Dispersal at Deep-sea Hydrothermal Vents in the Southern Mariana Trough (Mariana Back-arc Vents)

Coverage: Southern Mariana Trough

NSF Award Abstract:
Summary: Since the discovery of deep-sea hydrothermal vents over thirty years ago, scientists have been perplexed by the question: How are these vent sites colonized and, more specifically, How are the faunal populations established and maintained at these very discrete and often ephemeral habitats. For animals that are sessile or have limited mobility as adults, dispersal to these habitats occurs early in the life cycle, as planktonic larvae in the water column. Due to the difficulties in sampling deep-sea larvae, including low abundances (dilute concentrations), we have very few quantitative estimates of larval dispersal between or larval supply to hydrothermal vents. We also have little to no knowledge of the behavior of vent larvae. The PIs will use large-volume plankton pumps to collect larvae near vents in the southern Mariana Trough in a collaborative effort to quantify larval abundance, behavior, and dispersal in this little-studied region. The collaboration combines the PI's strengths in the collection and morphological identification of larvae and quantifying and modeling dispersal between deep-sea vents, and those of Japanese partners in rearing larvae of hydrothermal vent fauna, molecular genetic identification of larvae, and population genetics of vent fauna.

Intellectual merit: The southern Mariana Trough is a very interesting region in which to study dispersal of vent-endemic fauna, due to the proximity of vents in the back-arc spreading center to vents along the Mariana Arc. These two tectonic settings create different habitat conditions and support vent communities with different species composition. Vent sites the PIs will visit, in the axis and just off-axis of the back-arc spreading center are as close as 25 km to vents on the arc, yet 600 km south of the other known vents in the back-arc. In addition to the new information on larval abundance, diversity, behavior, and dispersal that will be gained for this little-studied region of the world's ridge system, this project has direct relevance to the integration and synthesis goals of the U.S. Ridge 2000 Program. The PI's lab group has conducted previous work at the Ridge 2000 East Pacific Rise (EPR) Integrated Studies Site (ISS). They will be making a direct comparison of the larval abundance and diversity at the EPR ISS to this very different setting along the global 'baseball seam' of oceanic spreading centers. No other such comparison has been possible due to the lack of sampling effort for larvae with large-volume pumps. Also, they are proposing the first experiments with live vent larvae (to the best of our knowledge - with the exception of brachyuran megalopae at 1 atm) to estimate swimming and sinking rates that are important for adding behavioral information to models of larval dispersal.

Broader Impacts: The project involves reciprocal training and cultural exchange - the PIs will learn field and laboratory research techniques from the Japanese PIs, and they will learn from the U.S. PIs. The project will also benefit the career development of a junior researcher (Beaulieu). The proposed activity broadens the participation of both U.S. and Japanese women scientists in sea-going, oceanographic research. The PIs will broadcast the cruise activities in a web log posted by the international InterRidge Program Office, and they anticipate at least three scientific publications will emerge. New species will be added to the online photographic identification guide for vent larvae and included in the second edition of the printed guide.

Additional cruise data and information are available from MGDS: http://www.marine-

geo.org/tools/search/entry.php?id=YK10-11

RUI: Collaborative: The Predictive Nature of Microbial Biofilms for Cuing Larval Settlement at Deep-Sea Hydrothermal Vents (Vent Settlement Cues)

Coverage: East Pacific Rise, 9 North hydrothermal vents

NSF Award Abstract:
Over four decades of research have shown that tiny free-swimming offspring of the unique inhabitants of hydrothermal vents can disperse effectively between their specialized habitats. Yet, we know almost nothing about how these larval animals complete the journey by locating and settling down in suitable locations. This question remains one of the key unresolved puzzles in the ecology of the deep sea and is becoming increasingly important to solve as hydrothermal vents are becoming threatened by human impacts. The investigators suggest that the films of bacteria that first form at vents are good signposts for settlement of larvae because they indicate that the hydrothermal vents are suitable for life. This project uses a combined program of field experiments, cutting-edge molecular biology techniques, and shipboard experiments with hydrothermal-vent larvae and cultured bacterial films. The project also connects undergraduate research interns at a primarily undergraduate institution (Western Washington University) with undergraduate research interns at two research institutions (Rutgers and Woods Hole Oceanographic Institution) while working on the project at sea together. Finally, the team is producing a science-in-action documentary filled with ocean science and exploration intended for television distribution and museum screenings. The investigators are using footage of the deep-sea vents, shipboard and diving operations, and laboratory work to create a documentary that highlights the foundation of scientific research—hypothesis-driven research, the application of the scientific method, and the importance of critical thinking—all in the framework of the study of an exciting, but threatened, ecosystem.

Hydrothermal vents are particularly tractable systems in which to study questions about the roles of biofilms in larval settlement because biofilms at vents are relatively low-complexity; vent animals are strictly dependent on vent microbes, often through symbiotic partnerships acquired after settlement; and environmental variations are present within the range of a common larval pool. Moreover, decades of research on settlement in model organisms give us good insight into biofilm cues; there is solid foundational understanding about colonization patterns at vents; we now have excellent tools to collect, identify, and culture vent larvae and microbes; and modern environmental "-omics" techniques are a good tool to characterize biological cues produced by biofilms. The project provides an unprecedented, quantitative look into the role of microbial biofilms in structuring larval settlement at hydrothermal vents, achieved only through the close collaboration of microbial and larval ecologists. The combined field program of short-term settlement experiments, microbial "-omics" work, and subsequent shipboard settlement experiments allows the investigative team to use field experiments to statistically model the factors that best predict larval settlement in the field, then test those predictions with shipboard experiments that decouple covarying conditions. This extensive characterization of putative larval settlement cues and their relationship to colonization success in heterogeneous vent habitat niches will contribute to a broader understanding of colonization success across diverse marine ecosystems. Understanding the role that the initial settlement of larvae plays in the recovery and resilience of hydrothermal-vent ecosystems is critical to developing informed management plans for deep-sea mining.

This award reflects NSF's statutory mission and has been deemed worthy of support through evaluation using the Foundation's intellectual merit and broader impacts review criteria.

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Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-1028862
NSF Division of Ocean Sciences (NSF OCE)	OCE-1947735

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