Functional traits of colonists collected from colonization surfaces at the East Pacific Rise (EPR) deep-sea vents from 1998-2017

Website: https://www.bco-dmo.org/dataset/844993
Data Type: Other Field Results
Version: 1
Version Date: 2021-03-12

Project
» Trajectories in functional diversity after disturbance at vents on the East Pacific Rise (EPR Functional Diversity)

Contributors	Affiliation	Role
Dykman, Lauren	Woods Hole Oceanographic Institution (WHOI)	Principal Investigator, Contact
Beaulieu, Stace	Woods Hole Oceanographic Institution (WHOI)	Co-Principal Investigator
Mills, Susan	Woods Hole Oceanographic Institution (WHOI)	Co-Principal Investigator
Mullineaux, Lauren	Woods Hole Oceanographic Institution (WHOI)	Co-Principal Investigator
Solow, Andrew	Woods Hole Oceanographic Institution (WHOI)	Co-Principal Investigator
York, Amber D.	Woods Hole Oceanographic Institution (WHOI BCO-DMO)	BCO-DMO Data Manager

Abstract
Functional traits of colonists collected from colonization surfaces at the East Pacific Rise (EPR) deep-sea vents (1998-2017) (Dykman et al., 2021). A dataset of trait modality assignments for 8 functional traits of 58 invertebrate species or higher taxa (when species ID was uncertain) collected from colonization surfaces deployed at hydrothermal vents at 9° 50'N on the East Pacific Rise.

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Coverage

Spatial Extent: **Lat**:9.83 **Lon**:-104.283
Temporal Extent: 1998-01-01 - 2017-01-01

Dataset Description

These data were included as Supplemental Data Table 2 in the results publication Dykman et al. (2021) Ecology. Version 1 of the code used for analyses, statistics, and figures for Dykman et al. (2021) Ecology can be found at Zenodo (Dykman, 2021, DOI: 10.5281/zenodo.4625160).

Methods & Sampling

Location: 9° 50’N on the East Pacific Rise, depth 2500m.

Functional traits were gathered for fifty-eight invertebrate species or higher taxa (when species ID was uncertain) collected from settlement surfaces deployed at deep-sea hydrothermal vents (https://doi.org/10.26008/1912/bco-dmo.733173.2). The identifier columns “scientificNameID” and “AphiaID” in this trait dataset are standardized to World Register of Marine Species (WoRMS), and are an exact subset of the of the same columns in the dataset of colonists from experimental settlement surfaces. Species names are in some cases generic and are not standardized to WoRMS.

Eight traits were chosen to test ecological hypotheses relevant to recovery and succession at deep-sea hydrothermal vents. We define “trait” as a feature or behavior of a species that affects or responds to its environment, and “modality” as a scoring level reflecting how the organism expresses a given trait. Four traits were taken from the sFDvent Database: maximum adult body size, habitat complexity, trophic mode (i.e., trophic level), and relative adult mobility. Four additional traits were added due to their ecological relevance and common use in functional analyses for aquatic invertebrates. These are external protection, feeding method (i.e., how a species feeds), reproductive type, and larval development (Bolam et al. 2016, Greenfield et al. 2016, Veríssimo et al. 2017). For each trait, a modality was assigned for every species based on literature or personal observation. For the traits from sFDvent, modalities were assigned from the recommended data set, except in cases where we suggested updates (Dykman et al., 2021). When species identity was uncertain and individuals were identified to a higher taxonomic level (e.g., amphipods), modalities were assigned from a likely species that is found at our site and included in sFDvent. For the four traits not included in sFDvent, we either provided a citation or cited “expert opinion,” meaning the modality choice was based on direct observation by one of the co-authors. Although the majority of specimens in our study were juveniles, most modality assignments were based on the characteristics of adult organisms due to the availability of data. Modality assignments were fixed for a given species rather than specific to life stages or individuals.

For the column “FUNCTIONAL_GUILD,” species were clustered into guilds based on the similarity of their modalities for all eight traits. The pairwise dissimilarity of species was calculated using the function gowdis in the R package FD (Laliberté et al. 2015). We chose Gower dissimilarity because it accepts both numerical and categorical data and handles missing values (Gower 1971). Podani’s extension was implemented to include ordinal variables (Podani 1999). Clusters were computed from the Gower dissimilarity matrix using the hclust function in the R package cluster (Maechler 2018) and plotted as a dendrogram. The cutoff for assigning functional guilds was chosen by optimizing the tradeoff between minimizing within-group distance and maximizing between-group distance. Code for this and all subsequent analyses are available at Zenodo (Dykman, 2021, DOI: 10.5281/zenodo.4625160).

Data Processing Description

This data set includes traits and modalities that were gathered from literature and existing databases. The column Functional Guild was generated by hierarchical clustering in R using the function gowdis in the package FD as described in Dykman et al. (2021). Scripts to run these analyses are available at Zenodo (Dykman, 2021, DOI: 10.5281/zenodo.4625160).

BCO-DMO data manager processing notes:
* Data submitted to BCO-DMO in file DataS2_BCO-DMO_Dykman.csv which had missing values as "NA" imported into the BCO-DMO data system. When this data table is served the missing data identifier will vary depending upon the data format. For example, Matlab files will use NaN. References to NA values in the metadata changed to refer instead to null values (no value).
* Could not find a 2006 Edition of Barnes et al. with the title "The Invertebrates: A new synthesis" which the submitter indicated came from http://www.marinespecies.org/introduced/wiki/Traits:Multivoltine. This dataset references Barnes et al. (2006) but the reference list associated with this dataset has the information for the edition I was able to find is for "The Invertebrates: A synthesis" in 2007 (ISBN: 9780632047611). The reference in the reference list does show 2006 though it may in fact be the 2007 edition.

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Data Files

File
epr_colonist_traits.csv (Comma Separated Values (.csv), 45.67 KB) MD5:47c9a4c72e77a7344c0851f1cc243fa0 Primary data file for dataset ID 844993

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Related Publications

Barnes R.S.K., Calow P., Olive P.J.W., Golding, D.W, and Spicer, J.I., (2006) The invertebrates: a synthesis, Oxford: Blackwell Science Ltd.
Methods

Barnes, R.S.K., Calow, P. & Olive P.J.W. (1993) The invertebrates: a new synthesis. Oxford: Blackwell Science Ltd. https://isbnsearch.org/isbn/9780632031252
Methods

Bolam, S. G., McIlwaine, P. S. O., & Garcia, C. (2016). Application of biological traits to further our understanding of the impacts of dredged material disposal on benthic assemblages. Marine Pollution Bulletin, 105(1), 180–192. doi:10.1016/j.marpolbul.2016.02.031
Methods

Dykman, L. (2021, March 20). ldykman/FD_EPR: Github repository release associated with Dykman et al. (2021) Ecology (Version v1.0.0). Zenodo. https://doi.org/10.5281/zenodo.4625160
Software

Dykman, L. N., Beaulieu, S. E., Mills, S. W., Solow, A. R., & Mullineaux, L. S. (2021). Functional traits provide new insight into recovery and succession at deep-sea hydrothermal vents. Ecology, 102(8). Portico. https://doi.org/10.1002/ecy.3418
Results

Gower, J. C. (1971). A General Coefficient of Similarity and Some of Its Properties. Biometrics, 27(4), 857. doi:10.2307/2528823
Methods

Greenfield, B., Kraan, C., Pilditch, C., & Thrush, S. (2016). Mapping functional groups can provide insight into ecosystem functioning and potential resilience of intertidal sandflats. Marine Ecology Progress Series, 548, 1–10. doi:10.3354/meps11692
Methods

Laliberté, E. et al. (2015) FD: measuring functional diversity from multiple traits, and other tools for functional ecology. R Package: Version 1.0-12. Available from https://cran.r-project.org/package=FD [Accessed 2021-03-12]
Software

Maechler, M. (2018) Finding Groups in Data: Cluster Analysis Extended Rousseeuw et al. R Packag Version 2. Available from https://cran.r-project.org/package=cluster [Accessed 2021-03-21]
Software

Mullineaux, L. (2020). *Counts of colonists collected from colonization plates at the East Pacific Rise (EPR) deep-sea vents (1998-2017)* (Version 2) [Data set]. Biological and Chemical Oceanography Data Management Office (BCO-DMO). https://doi.org/10.26008/1912/BCO-DMO.733173.2 https://doi.org/10.26008/1912/bco-dmo.733173.2
Results

Podani, J. (1999). Extending Gower's general coefficient of similarity to ordinal characters. TAXON, 48(2), 331–340. doi:10.2307/1224438
Methods

Ruppert, E.E. & Barnes, R.D. (1994) Invertebrate zoology (6th ed.). Fort Worth, USA: Saunders College Publishing. https://isbnsearch.org/isbn/9780030266683
Methods

Veríssimo, H., Verdelhos, T., Baeta, A., van der Linden, P., Garcia, A. C., & Marques, J. C. (2017). Comparison of thermodynamic-oriented indicators and trait-based indices ability to track environmental changes: Response of benthic macroinvertebrates to management in a temperate estuary. Ecological Indicators, 73, 809–824.

doi:10.1016/j.ecolind.2016.10.040
Methods

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Related Datasets

IsRelatedTo

Chapman, A. S. A., Beaulieu, S. E., Colaço, A., Gebruk, A. V., Hilario, A., Kihara, T. C., … Bates, A. E. (2019). sFDvent: A global trait database for deep-sea hydrothermal-vent fauna. Global Ecology and Biogeography, 28(11), 1538–1551. doi:10.1111/geb.12975

Mullineaux, L. (2020) **Counts of colonists collected from colonization plates at the East Pacific Rise (EPR) deep-sea vents (1998-2017).** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 2) Version Date 2020-08-31 doi:10.26008/1912/bco-dmo.733173.2 [view at BCO-DMO]
Relationship Description: Data from the same settlement surfaces deployed at deep-sea hydrothermal vents.

Mullineaux, L. (2020) **Dates and locations of colonization sampler deployments and recoveries from East Pacific Rise (EPR) deep-sea vents, 1998-2017.** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 3) Version Date 2020-08-24 doi:10.26008/1912/bco-dmo.733210.3 [view at BCO-DMO]
Relationship Description: Dates and locations of the colonization sampler deployments.

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Parameters

Parameter	Description	Units
SCIENTIFIC_OR_COMMON_NAME	Name used by the data provider to identify the taxon or morphogroup; not necessarily a scientific name	unitless
scientificNameID	Machine-readable Life Science Identifier (LSID) containing the AphiaID from World Register of Marine Species at the lowest level that matches the data provider name. This corresponds to Darwin Core term http://rs.tdwg.org/dwc/terms/scientificNameID	unitless
AphiaID	Numerical identifier from World Register of Marine Species at the lowest level that matches the scientific or common name	unitless
MAXIMUM_ADULT_BODY_SIZE	An estimate of the size of the organism with four categories: 1mm, 10mm, 100mm, and 1000mm. Measurements are rounded to the nearest estimate value. Note: the measurement used to express body size varies within taxonomic groups. For example, some disciplines measure diameter, others carapace length, total body length or wing span. Also body size can vary with gender and life stage. This category is the same as Estimated Maximum Body Size (mm) in sFDVent	millimeters
MAXIMUM_ADULT_BODY_SIZE_CITATION	If applicable, a citation for maximum adult body size. If no data were available and the maximum adult body size value is a null value (no value), “No reference” is used instead of a citation. If the maximum adult body size value was based on the direct observation of one of the co-authors, “Expert opinion” is used instead of a citation.	unitless

HABITAT_COMPLEXITY	Whether a species adds to the complexity of the habitat in which it is found, for example by introducing complex structures by its body form or by aggregating. This trait is taken from sFDVent, and has five modalities. “Does not add habitat complexity” indicates the species does not add complexity to its habitat. “Mat forming (10 cm)” indicates this species forms bed-like habitat, which is higher or deeper than 10 centimeters, and more undulated in appearance than mat. It adds relief to the environment. “Open bush forming” indicates this species forms an open, penetrable habitat with a bush-like appearance. “Dense bush forming” indicates this species forms bush-like habitat that would be difficult to penetrate or observe fauna living within	unitless
HABITAT_COMPLEXITY_CITATION	If applicable, a citation for habitat complexity. If no data were available and the habitat complexity assignment is a null value (no value), “No reference” is used instead of a citation. If the habitat complexity assignment was based on the direct observation of one of the co-authors, “Expert opinion” is used instead of a citation.	unitless
TROPHIC_MODE	This trait relates to the trophic level and nutritional requirements of a species. There are five modalities, four of which are taken from sFDVent. “Symbiont host” is not in sFDVent, but was included here to indicate organisms which do not feed but instead host chemosynthetic bacteria that provide food. “Bacterivore” indicates this species is a primary consumer feeding on bacteria. “Detritivore” indicates this species is a primary consumer feeding on fragmented particulate organic matter (detritus). “Carnivore S” indicates this species is a secondary consumer feeding on fragments of dead other animals (scavenger). “Carnivore O” indicates this species is a secondary consumer feeding on live animal tissue or killing prey (other)	unitless
TROPHIC_MODE_CITATION	If applicable, a citation for trophic mode. If no data were available and the trophic mode assignment is a null value (no value), “No reference” is used instead of a citation. If the trophic mode assignment was based on the direct observation of one of the co-authors, “Expert opinion” is used instead of a citation.	unitless

FEEDING_METHOD	This trait pertains to the feeding strategy of a species, or how it obtains its food. This trait taken from the Biological Traits Information Catalogue (BIOTIC), MarLIN 2006. It is similar to “functional feeding group” or “feeding guild” for freshwater invertebrates (Ding et al. 2017), “feeding position” in Veríssimo et al. (2017), “feeding mode” in Bolam et al. (2016), and “feeding type” in the online polychaete trait database Polytraits (Faulwetter et al. 2014). “Non-feeding” means this animal has no mouth or gut and does not feed. “Deposit feeder” indicates this species consumes organic matter from the substrate. “Suspension feeder” indicates this species filter feeds or gathers food from the water column. “Predator” indicates this species actively hunts and captures animal prey. “Parasite/commensal” indicates this species lives within or upon another organism and feeds off of its tissue. In some cases, species fell into two feeding categories. In these cases, both feeding categories were listed with a forward slash, for example “Deposit feeder/Suspension feeder,” “Deposit feeder/Predator,” and “Suspension feeder/Predator”	unitless
FEEDING_METHOD_CITATION	If applicable, a citation for feeding method. If no data were available and the feeding method assignment is a null value (no value), “No reference” is used instead of a citation. If the feeding method assignment was based on the direct observation of one of the co-authors, “Expert opinion” is used instead of a citation.	unitless
RELATIVE_ADULT_MOBILITY	A scoring level with four modalities taken from sFDVent, which captures the ability of a species to move around its environment as an adult. “Sessile” (level 1) indicates this species is permanently attached at the base. “Movement restricted” (level 2) indicates the movement of this species is restricted, for example, a species only lives in (or moves in) a burrow. “Crawler” (level 3) indicates movement is partially restricted or slow, for example a snail or echinoderm that crawls along the substratum. “Freely mobile” (level 4) indicates movement is unrestricted, for example a swimmer, which moves through the water column	unitless
RELATIVE_ADULT_MOBILITY_CITATION	If applicable, a citation for relative adult mobility. If no data were available and the mobility assignment is a null value (no value), “No reference” is used instead of a citation. If the mobility assignment was based on the direct observation of one of the co-authors, “Expert opinion” is used instead of a citation.	unitless
EXTERNAL_PROTECTION	A scoring level with three modalities that categorizes the external protection of a species. “Soft bodied” indicates this species has no external protection. An example would be an unsclerotized worm. “Moderately protected” indicates this species has an exposed body, but has a slightly protective cuticle or lives in a thin mucous or papery tube. “Well protected” indicates this species has a hard protective shell or exoskeleton. An example would be a crab or snail.	unitless

EXTERNAL_PROTECTION_CITATION	If applicable, a citation for external protection. If no data were available and the external protection assignment is a null value (no value), “No reference” is used instead of a citation. If the external protection assignment was based on the direct observation of one of the co-authors, “Expert opinion” is used instead of a citation.	unitless
LARVAL_DEVELOPMENT	A trait with four modalities expressing how a species develops as larvae. “Lecithotrophic” indicates larvae of this species develop at the expense of internal resources (i.e., yolk) provided by the female (Barnes et al., 2006). “Planktotrophic” indicates the larvae of this species feed (at least in part) on materials captured from the plankton (Barnes et al., 2006). “Direct” indicates this species develops without a larval stage (Barnes et al., 2006). “Brooding” indicates this species incubates eggs either inside or outside the body. Eggs may be brooded to a variety of developmental stages. Males or females may be responsible for brooding (Ruppert and Barnes 1994).	unitless
LARVAL_DEVELOPMENT_CITATION	If applicable, a citation for larval development. If no data were available and the larval development assignment is a null value (no value), “No reference” is used instead of a citation. If the larval development assignment was based on the direct observation of one of the co-authors, “Expert opinion” is used instead of a citation.	unitless
REPRODUCTIVE_TYPE	A trait with three modalities indicating how a species reproduces. “Gonochoristic” indicates this species has separate sexes (Barnes et al., 1993). “Hermaphroditic” indicates this species has individuals capable of producing both ova and spermatozoa (Barnes et al., 1993). “Asexual” indicates this species has at least one asexual stage in its life cycle. Defined as reproduction that does not involve the exchange of genetic material. In at least one life stage, individuals are derived form a single parent (Barnes et al., 2006).	unitless
REPRODUCTIVE_TYPE_CITATION	If applicable, a citation for reproductive type. If no data were available and the reproductive type assignment is a null value (no value), “No reference” is used instead of a citation. If the reproductive type assignment was based on the direct observation of one of the co-authors, “Expert opinion” is used instead of a citation.	unitless
FUNCTIONAL_GUILD	An alphabetical assignment that groups organisms into twelve functional guilds based on Gower dissimilarity in the modalities of all twelve traits. Methods for this clustering are described in Dykman et al. (2021; submitted) and R scripts to run this analysis are provided at https://github.com/ldykman/FD_EPR.	unitless

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Deployments

AT15-12

Website	https://www.bco-dmo.org/deployment/734057
Platform	R/V Atlantis
Report	http://datadocs.bco-dmo.org/docs/Larval_Supply_EPR_Vents/data_docs/AT15-12_LADDER-1_Cruise_Report_36250.pdf
Start Date	2006-10-24
End Date	2006-11-18
Description	Part of Ridge Interdisciplinary Global Experiments (Ridge2000).

AT15-14

Website	https://www.bco-dmo.org/deployment/734059
Platform	R/V Atlantis
Report	http://datadocs.bco-dmo.org/docs/Larval_Supply_EPR_Vents/data_docs/AT15-14_LADDER-2_Cruise_Report_39303.pdf
Start Date	2006-12-05
End Date	2007-01-05
Description	Part of Ridge Interdisciplinary Global Experiments (Ridge2000).

AT15-26

Website	https://www.bco-dmo.org/deployment/734071
Platform	R/V Atlantis
Report	http://datadocs.bco-dmo.org/docs/Larval_Supply_EPR_Vents/data_docs/AT15-26_LADDER-3_Cruise_Report_Feb4_36252.pdf
Start Date	2007-11-13
End Date	2007-12-03
Description	Part of Ridge Interdisciplinary Global Experiments (Ridge2000).

AT15-38

Website	https://www.bco-dmo.org/deployment/660807
Platform	R/V Atlantis
Start Date	2008-10-13
End Date	2008-11-05

AT26-10

Website	https://www.bco-dmo.org/deployment/529031
Platform	R/V Atlantis
Report	http://dmoserv3.bco-dmo.org/data_docs/Microbe_Vent_Communities/AT26-10_Cruise_Report_v2_2015-07-09.pdf
Start Date	2013-12-29
End Date	2014-01-27
Description	Samples were collected by ROV Jason II at the 9N deep-sea hydrothermal vent field on the East Pacific Rise, Pacific Ocean

AT26-23

Website	https://www.bco-dmo.org/deployment/550442
Platform	R/V Atlantis
Start Date	2014-11-02
End Date	2014-11-21
Description	Study of in situ metabolism of microorganisms carrying out CO2-fixation at deep-sea hydrothermal vents.

AT3-19

Website	https://www.bco-dmo.org/deployment/820163
Platform	R/V Atlantis
Start Date	1998-05-10
End Date	1998-06-01

AT37-12

Website	https://www.bco-dmo.org/deployment/734074
Platform	R/V Atlantis
Report	http://datadocs.bco-dmo.org/docs/Vent_O2_NO3_Roles/data_docs/AT37-12_Cruise_Report.pdf
Start Date	2017-04-24
End Date	2017-05-15

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Project Information

Trajectories in functional diversity after disturbance at vents on the East Pacific Rise (EPR Functional Diversity)

Coverage: East Pacific Rise

NSF Award Abstract:
Hydrothermal vents support oases of life in the deep sea and are inhabited by unusual organisms that use chemical energy instead of photosynthesis as the basis of their food web. However, because the vents occur in geologically active areas of the seafloor, entire communities can be eradicated by catastrophic natural disturbances such as eruptions. The main objectives of this project are to quantify how quickly these communities recover from catastrophic disturbance and to determine what processes influence their resilience. The project focuses on both the structure (species diversity) and function (trait diversity) of the communities. The investigators will examine vents on an active segment of the East Pacific Rise where eruptive disturbance occurs on decadal time scales. These activities will create an unprecedented long-term (>14-year) quantitative time-series of colonist species composition and function. The application of trait-based analysis to the question of biological succession at vents has the potential to change the way we think about resilience in other patchy, transient and regionally-connected ecosystems. By considering how traits change over time, the researchers can untangle which species-level characteristics most influence abundance and distribution. The project objectives have broad significance with the growing potential for human-caused disturbances at deep-sea vents through deep-sea mining. Additional impacts include strengthening participation of under-represented minorities in marine science and contributing to international database development for functional

traits of deep-sea vent species.

The unique, chemosynthesis-fueled fauna inhabiting deep-sea hydrothermal vents are subject to tectonic and eruptive disturbance that can eradicate entire communities. The main objectives of this project are to quantify how quickly these communities recover from catastrophic disturbance and to determine what processes influence their resilience. The focus is on vents on an active segment of the East Pacific Rise where eruptive disturbance occurs on decadal time scales. Field data on colonization and larval supply are used to characterize not only species succession but also the trajectory of functional diversity after a recent (2006) eruption. A new, promising approach to the colonization studies comes from incorporating trait-based analysis of functional diversity. Functional trait analysis is increasingly recognized in terrestrial and freshwater systems as a tool to holistically answer ecological questions, but trait analysis has not been often applied to marine systems. By considering how traits of incoming colonists change over time, the investigators can untangle which species-level factors most influence abundance and distribution. This project will create an unprecedented long-term (>14-year) quantitative time-series of colonist species composition and function. It includes multiple vent sites to encompass the full diversity of habitat conditions, and assesses both local processes and regional connectivity through larval supply. Field observations at individual sites contribute to broader questions when placed in the context of metacommunity theory. In this theoretical framework, field data such as this can be used to answer such questions as how the eradication of the vent community at a particular site affects the persistence of the metacommunity overall, and which vent sites contribute most to regional biodiversity.

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Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-1829773

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