Postsettlement performance in kin groups from shallow seagrass habitats in St. Teresa, Florida, USA in November and December 2017

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Data Type: Other Field Results
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Project
» Consequences of kin structure in benthic marine systems (Marine kin structure)

Contributors	Affiliation	Role
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Abstract
This dataset is part of an integrated series of experiments to study how dispersal affects the density and relatedness of neighbors, and how the density and relatedness of neighbors in turn affect fitness. In a marine bryozoan, the effects of spreading sibling larvae were experimentally determined by manipulating the density and relatedness of settlers and measuring components of fitness in shallow (less than 2 meters) seagrass habitats near the Florida State University Coastal and Marine Laboratory (FSUCML) in St. Teresa, Florida, USA (29° 54' N, 84° 30' W). We found that settler density reduced maternal fitness when settler neighbors were siblings compared to when neighbors were unrelated or absent.

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Coverage

Spatial Extent: **Lat**:29.9 **Lon**:-84.5
Temporal Extent: 2017-11-06 - 2017-12-16

Methods & Sampling

To test the consequences of spreading sibling larvae to progeny survival after dispersal, we established three treatments designed to mimic three possible patterns of larval dispersal for a fixed number of larvae released: 1) siblings each disperse to different vacant locations resulting in more sites being colonized at lower density and lower relatedness, 2) siblings each disperse to different locations but each location also has settlement of individuals from other families resulting in more sites being colonized at higher density but lower relatedness, and 3) siblings settle in aggregations resulting in fewer sites being colonized at higher density, but also higher relatedness. Therefore, the three treatments were: 1) 10 groups of one sib alone (low density, low relatedness), 2) 10 groups of one sib with four unrelated neighbors (high density, low relatedness), and 3) two

groups of five sibs (high density, high relatedness). The distance to the nearest neighbor in the high-density treatments was approximately 1 centimeter, as commonly occurs in the field. There were four maternal families, each with 10 siblings per treatment, resulting in a total of 120 focal individuals. Siblings within a maternal family are likely to be both full and half sibs (Burgess, unpubublished data). Non-focal individuals, that acted as unrelated competitors, within each group all came from different maternal colonies. Note that our experiment was designed to measure the fitness of maternal broods in different contexts, rather than the average fitness of the whole group of unrelated individuals.

To establish the treatments, we collected approximately 30 reproductive colonies from the field on November 6th 2017, and returned them to the lab, where they were kept in the dark in unfiltered aerated seawater. After two days, each colony was placed into a different glass bowl with 250 milliliters (mL) of seawater and exposed to bright light. A roughened, biofilmed acetate sheet (approximately 6 centimeters in diameter) was floated on the surface of the water, onto which larvae readily attached. Acetate sheets, with all settlers from a known mother, were removed from the dish after approximately 3 hours and floated in new dishes of fresh unfiltered seawater with the attached settlers facing downwards. The following day, the acetate sheet around individual settlers was cut with a hollow punch tool resulting in a 5 millimeter (mm) diameter piece of acetate sheet with a single settler attached. Treatments were established by attaching acetate sheets with individual settlers to a 40 x 40 mm acetate sheet (=1 group) using non-toxic super glue. The 40 x 40 mm acetate was then glued to the end of a zip-tie. The base of the zip-tie was attached to the tip of a 760 millimeter (mm) length of food-grade bamboo stick (~7 mm diameter). In the field, experimental groups were held in place by pushing the bamboo stick into the sediment, leaving the experimental individuals at about the same height from the substratum as the height of the surrounding seagrass. A total of 280 individuals in 88 groups were outplanted to the field in a shallow area approximately 0.8 to 1.5 meters) immediately east of the FSUCML. The experimental groups were outplanted in two rows parallel to the shore, covering a distance of approximately 50 meters. Each randomly chosen group was separated by approximately 1 meter.

We monitored the size and survival of all 280 individuals, of which 120 were the focal individuals from the four maternal families. The size was measured 24 days after settlement as the number of bifurcations, which is monotonically related to the number of zooids. Post-settlement survival was measured at 10, 24, and 38 days after settlement by recording whether colonies were alive or dead (absent colonies were recorded as dead). By approximately 21 days after settlement, colonies are usually reproductive (indicated by the appearance of ovicells).

Data Processing Description

Poisson and binomial generalized linear mixed-effects models were used to model post-settlement size and survival, respectively, as a function of the fixed effects of treatment and random effects of maternal sibship.

Models were implemented in R version 4.0.5 using the package ‘lme4’.

BCO-DMO processing description:
- Adjusted field/parameter names to comply with BCO-DMO naming conventions

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Data Files

File	
postsettlement_performance_in_kin_groups.csv	(Comma Separated Values (.csv), 18.04 KB) MD5:0889ca507ad8226f1cb9ec4b3e2ab323
Primary data file for dataset 893158, version 1.	

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Related Publications

Burgess, S. C., Powell, J., & Bueno, M. (2022). Dispersal, kin aggregation, and the fitness consequences of not spreading sibling larvae. Ecology, 104(1). Portico. https://doi.org/10.1002/ecy.3858
Results

R Core Team (2021). R: A language and environment for statistical computing. R v4.0.5. (March 2021) R Foundation for Statistical Computing, Vienna, Austria. URL https://www.R-project.org/
Software

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Related Datasets

IsRelatedTo

Burgess, S., Powell, J., Bueno, M. M. (2023) **Aggregation kin versus nonkin experiments in marine bryozoans from shallow seagrass habitats in St. Teresa, Florida, USA in June 2017.** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2023-04-04 doi:10.26008/1912/bco-dmo.893150.1 [view at BCO-DMO]

Burgess, S., Powell, J., Bueno, M. M. (2023) **Dispersal distance in a marine bryozoan in shallow seagrass habitats in St. Teresa, Florida, USA, between October and December 2017.** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2023-04-03 doi:10.26008/1912/bco-dmo.893092.1 [view at BCO-DMO]

Burgess, S., Powell, J., Bueno, M. M. (2023) **Marine bryozoan aggregation experiments in shallow seagrass habitats in St. Teresa, Florida, USA in May 2017.** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2023-04-04 doi:10.26008/1912/bco-dmo.893115.1 [view at BCO-DMO]

Burgess, S., Powell, J., Bueno, M. M. (2023) **Microsatellite genotypes of marine bryozoan from shallow seagrass habitats in St. Teresa, Florida, USA in June 2017.** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2023-04-05 doi:10.26008/1912/bco-dmo.893165.1 [view at BCO-DMO]

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Parameters

Parameter	Description	Units
mother_ID	Unique identifier for each maternal colony	unitless
sib_total	A code representing the concatenation of sib_group_size and total_group_size	unitless
sib_group_size	The total number of focal siblings in the group	unitless
total_group_size	The total number of all settlers in the group	unitless
age_d	Days since settlement	unitless
Ind	F = focal individual (an offspring from the corresponding mother.id); NF = Non-focal individual (comes from another maternal colony, NOT from the corresponding mother.id)	unitless
sheet	Unique identifier for each settlement plate (=sheet)	unitless
survival	1 = alive; 0 = dead	unitless
bifurcations	The number of bifurcations on the colony	unitless

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Project Information

Consequences of kin structure in benthic marine systems (Marine kin structure)

Coverage: Gulf of Mexico

NSF Award Abstract:
In marine systems, the production, dispersal, and recruitment of larvae are crucial processes that rebuild depleted adult stocks, facilitate changes in species geographic ranges, and modify the potential for adaptation under environmental stress. Traditionally, the tiny larvae of bottom-associated adults were thought to disperse far from their parents and from each other, making interactions among kin improbable. However, emerging evidence is challenging this view: larval dispersal does not always disrupt kin associations at settlement, and a large fraction of invertebrate diversity on the seafloor contains species in which most larvae disperse short distances. Limited dispersal increases the potential for interactions among kin, which has important consequences for individual fitness across many generations, and therefore the productivity of populations and the potential for adaptation. But when these consequences occur, and how exactly they manifest, remains largely unexplained. The key challenge now is to explain and predict when kin associations are likely to occur, and when they are likely to have positive or negative ecological consequences. Therefore, the key questions addressed by this research are: 1) how and when do kin associations arise and persist, and 2) what are the consequences of living with kin for survival, growth, and reproduction. This concept-driven research combines genomic approaches with experimental approaches in lab and field settings using an experimentally-tractable and representative invertebrate species. The project trains and mentors PhD students and a postdoctoral scholar at Florida State University (FSU). Field and laboratory activities are developed and incorporated into K–12 education programs and outreach opportunities at FSU.

The spatial proximity of relatives has fundamentally important consequences at multiple levels of biological organization. These consequences are likely to be particularly important in a large range of benthic marine systems, where competition, facilitation, and mating depend strongly on the proximity and number of neighbors. However, explaining and predicting the occurrence, magnitude, and direction of such effects remains challenging. Emerging evidence suggest that the ecological consequences of kin structure are unlikely to have a straight-forward relationship with dispersal potential. Therefore, it is crucial to discover new reasons for when kinship structure occurs and why it could have positive, negative, or neutral ecological consequences. This research aims to provide a new understanding of how dispersal and post-settlement processes generate spatial kin structure, how population density and relatedness influence post-settlement fitness, and how the relatedness of mating partners influences the number and fitness of their offspring (inbreeding and outbreeding). The research combines genomic approaches, experimental progeny arrays, and manipulative experiments in field and lab settings to test several hypotheses that are broadly applicable across species. By focusing on an experimentally tractable species to test broadly applicable hypotheses, the project achieves generality and a level of integration that has been difficult to achieve in previous work.

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Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-1948788

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