

Microsphere counts in Dendraster excentricus guts following feeding incubations with microspheres differing in size or functionalized surface

Website: <https://www.bco-dmo.org/dataset/1010536>

Data Type: experimental

Version: 1

Version Date: 2026-10-22

Project

» [Collaborative Research: Are all cell surfaces the same? The effects of particle surface property on predator-prey interactions in the microbial loop](#) (Surf Props)

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Abstract

Marine invertebrate larvae are abundant suspension feeders in planktonic ecosystems, yet their role as predators of marine microbes remains poorly resolved. While bacterivory is well documented in some zooplankton, the capacity of ciliated larvae to ingest picoplankton — and the mechanisms governing this interaction — are largely unknown. Here, we show that larvae of the sand dollar *Dendraster excentricus* ingest submicron particles (0.5–1.0 micrometers (μm)). Using artificial prey with functionalized surface chemistry, we demonstrate that ingestion of picoplankton-sized prey (1 μm) is influenced by particle surface properties. This dataset includes raw counts of microspheres within the guts of *Dendraster excentricus* larvae following feeding incubations.

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Coverage

Temporal Extent: 2025-03 - 2025-04

Methods & Sampling

Larval cultures were reared and experimental incubations carried out at the Oregon Institute of Marine Biology from March to April 2025. Experimental feeding incubations using artificial microspheres and natural prey were carried out on 5-day old *D. excentricus* plutei. Prior to incubations, larvae were removed from their culture container and picked into a small volume (~100 milliliters (mL)) of filtered (0.22 µm) seawater (FSW) using a pulled and flamed Pasteur pipette. After starving briefly (up to 1 hour), 10 larvae were picked into 10-mL glass incubation vials with experimental prey field and allowed to feed for up to 1 hour. We carried out several incubations to investigate selectivity based on prey size and surface. To investigate differential ingestion based on prey size, we used 0.5, 1.0, 3.0, and 10 micrometer (µm) polystyrene microspheres with carboxylate-modified surface and yellow-green (YG) fluorescence (see Table 1 under Supplemental Files). Following the results of prey size, we compared 1.0 µm particles with different surface properties, including polystyrene and silica as well as two different functionalized surfaces; those modified with carboxylate groups or amine groups (Table 1).

Each comparison described above included 3 to 4 replicates with 8 to 10 larvae in each. Incubation chambers were manually inverted to mix every 10 minutes. This concentration of approximately 1 larva per mL incubation is below the known clearance rate of *D. excentricus* larvae at this age (<1 mL per hour for 10 larvae, Hart 1996). Following incubations, larvae were removed individually by pipetting from incubation chambers, suspended in 1 mL FSW, and similarly fixed in 0.125% glutaraldehyde. All samples were stored in the dark at 4 degrees Celsius (°C) prior to analysis.

Data Processing Description

Following our feeding incubations, we directly counted microspheres in the guts of each plutei using a Zeiss LSM 880 laser scanning confocal fluorescence microscope or Nikon Eclipse Ni compound epifluorescent microscope with mounted Nikon D850 SLR camera using GFP, CY3, and DAPI filter cubes. Larvae were triple-rinsed in artificial seawater (ASW) prior to counting to wash away any microspheres sticking to larval epidermis from incubation media. Individuals were mounted between a microscope slide and coverslip using small clay feet, which were compressed gently to make counting individual microspheres easier.

BCO-DMO Curation Notes

This section documents curation actions performed prior to publication review with the submitter, and additional information relevant to understanding and reusing this dataset. It distinguishes changes made to the submitted (meta)data from unresolved issues and/or enhancements that improve future reuse and interoperability.

CURATION ACTIONS PERFORMED ON DATA

- Imported original file "Dendraster_Gut_Counts_BCO DMO.xlsx" (sheet 1) into the BCO-DMO data processing system.
- Treated "NA" as a missing data value (NOTE: missing data are empty/blank in the final CSV file).
- Renamed columns to comply with BCO-DMO naming conventions.
- Saved the final file as "1010536_v1_gut_counts.csv".

CURATION ACTIONS PERFORMED ON METADATA

- BCO-DMO's standard metadata entry and text formatting steps were performed. See: <https://www.bco-dmo.org/how-to/standard-curation-edits>
- Saved Table 1 (originally provided as an embedded table in the Methods & Sampling section) as a PDF and attached it as a Supplemental File.

ISSUES POTENTIALLY IMPACTING REUSE

- N/A

Data Files

File
1010536_v1_gut_counts.csv (Comma Separated Values (.csv), 903 bytes) MD5:df3ef6b1ecb9b2c742c97ac782baf2f1
Primary data file for dataset ID 1010536, version 1

Supplemental Files

File
Table_1.pdf (Portable Document Format (.pdf), 47.51 KB) MD5:78a383b0c18929795d99667c53658161
Table 1. Summary of particle types used in incubation experiments. Supplemental file for dataset IDs 1010536 and 1010578.

Related Publications

Conley, K. R., & Sutherland, K. R. (2017). Particle shape impacts export and fate in the ocean through interactions with the globally abundant appendicularian *Oikopleura dioica*. PLOS ONE, 12(8), e0183105. <https://doi.org/10.1371/journal.pone.0183105>
Methods

Hart, M. W. (1996). Variation in Suspension Feeding Rates among Larvae of Some Temperate, Eastern Pacific Echinoderms. Invertebrate Biology, 115(1), 30. <https://doi.org/10.2307/3226940>
Methods

Hiebert, T. C., Aasjord, A. E., Chourrout, D. M., Thompson, A. W., & Sutherland, K. R. (2025). Prey particle surface property mediates differential selection by the ubiquitous appendicularian *Oikopleura dioica*. Limnology and Oceanography, 70(4), 977–988. Portico. <https://doi.org/10.1002/lno.12819>
Methods

Related Datasets

IsRelatedTo

Hiebert, T. C., Sweeney, C. P., Madere, D., Thompson, A. W., Sutherland, K. R., Wallace, E. (2026) **Initial (Ti) and final (Tf) microsphere counts from Dendroaster excentricus feeding incubations with microspheres differing in size or functionalized surface**. Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2026-10-22 doi:10.26008/1912/bco-dmo.1010578.1 [[view at BCO-DMO](#)]
Relationship Description: These datasets are from the same experiment.

Parameters

Parameter	Description	Units
Incubation	Incubation name for all incubations was alphabetical. Name is unique to entire project	unitless
Duration	Incubation duration	minutes
C_0_5	Number of 0.5 μm carboxylate-modified microspheres counted	count per gut
C_1_0	Number of 1.0 μm carboxylate-modified microspheres counted	count per gut
C_3_0	Number of 3.0 μm carboxylate- modified microspheres counted	count per gut
C_10_0	Number of 10.0 μm carboxylate-modified microspheres counted	count per gut
A_1_0	Number of 1.0 μm amine- modified microspheres counted	count per gut
P_1_0	Number of 1.0 μm unmodified polystyrene microspheres counted	count per gut
S_1_0	Number of 1.0 μm unmodified silica microspheres counted	count per gut

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Instruments

Dataset-specific Instrument Name	Nikon D850 SLR
Generic Instrument Name	Camera
Generic Instrument Description	All types of photographic equipment including stills, video, film and digital systems.

Dataset-specific Instrument Name	Zeiss LSM 880 laser scanning confocal fluorescence microscope
Generic Instrument Name	Confocal Laser Scanning Microscope
Generic Instrument Description	A laser scanning confocal microscope is a type of confocal microscope that obtains high-resolution optical images with depth selectivity, in which a laser beam passes through a light source aperture and then is focused by an objective lens into a small (ideally diffraction-limited) focal volume within or on the surface of a specimen. The confocal microscope uses fluorescence optics. 'Confocal' means that the image is obtained from the focal plane only, any noise resulting from sample thickness being removed optically. 'Laser scanning' means the images are acquired point by point under localized laser excitation rather than full sample illumination, as in conventional widefield microscopy.

Dataset-specific Instrument Name	Nikon Eclipse Ni compound epifluorescent microscope with mounted Nikon D850 SLR
Generic Instrument Name	Fluorescence Microscope
Generic Instrument Description	Instruments that generate enlarged images of samples using the phenomena of fluorescence and phosphorescence instead of, or in addition to, reflection and absorption of visible light. Includes conventional and inverted instruments.

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Project Information

Collaborative Research: Are all cell surfaces the same? The effects of particle surface property on predator-prey interactions in the microbial loop (Surf Props)

Website: <http://www.sutherlandlab.org>

Coverage: Oregon Institute of Marine Biology, Friday Harbor Labs (FHL), Michael Sars Centre in Bergen, Norway

NSF Award Abstract:

Marine microorganisms are among the most abundant life forms on the planet, playing a key role in ocean nutrient cycling. Though predation on these microorganisms is critical to nutrient cycling, little is known about their interactions with predators - specifically the direct interaction between microorganism cell surfaces and predator capture surfaces. This project examines how cell surfaces may influence the predation of marine microorganisms. Cell surface modification is a recognized strategy for predator avoidance among terrestrial microorganisms, but its application in the ocean is largely unexplored. By examining microbial prey with varying surface characteristics and predators with a range of feeding strategies, this research is providing foundational knowledge for future ocean food web models. This project engages public audiences through exhibits and workshops at museums (e.g., Oregon Museum of Science and Industry) and coastal aquariums with a focus on predator-prey interactions in the ocean from small microbial prey to larger predators. A large-scale art installment emphasizes these food web interactions. These 'Eco Murals' focus on ocean ecosystems and involve participation from community members, especially underrepresented minorities. This project is training the next generation of scientists by involving graduate and undergraduate students in research, professional development, and scientific communication. This research includes independent graduate student research as well as capstone projects in Bioinformatics and Genomics. Undergraduate students participate in this research following the previously successful NSF REU Exploration of Marine Biology on the Oregon Coast model. Finally, by leveraging initiatives aimed at promoting the persistence of historically underrepresented and underserved populations in STEM fields, this project recruits, supports, and retains female, first-generation, and underrepresented minority students.

The differential selection and rejection of microbial prey alters our understanding of carbon fate and nutrient cycling in the ocean. This project directly tests the effects of microbial surface properties on particle selection by globally abundant suspension feeders. Cell surface properties are known to be a fundamental aspect of predation avoidance in terrestrial microbes, but the role of microbial surface properties in avoiding or enhancing predation is a research frontier in ocean science. This knowledge gap limits understanding of microbial mortality, microbial loop function, and prediction of ecosystem response to future climate scenarios. This research links specific particle properties with ecologically-relevant trophic interactions through experiments with widespread suspension feeders representing major feeding strategies by copepod nauplii, pteropods, appendicularians, and echinoderm larvae. First, this project quantifies the surface properties of major marine microbial groups to inform feeding incubations with artificial prey. Second, artificial microspheres with varying surface properties are used in controlled laboratory feeding incubations to determine selectivity and third, to quantify particle fate from released fecal pellets and pseudofeces. Finally, the major marine microbial taxa in the guts of wild-caught suspension feeders are quantified using qPCR. This research forms an

integrative approach, yet the results of each objective have scientific impact which can be applied to diverse fields beyond the ocean.

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-2419056

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