Microsphere counts from incubation chambers of Oikopleura dioica prior to and following feeding incubations for experiment with artificial microspheres with two functionalized surfaces in three sizes

Website: https://www.bco-dmo.org/dataset/956298
Data Type: experimental
Version: 1
Version Date: 2025-03-18

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

Contributors	Affiliation	Role
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Abstract
Cell surface properties can strongly mediate microbial interactions with predators in soil and host-pathogen systems. Yet, the role of microbial surface properties in avoiding or enhancing predation in the ocean remains a research frontier. Appendicularians are globally abundant marine suspension feeders that capture marine microorganisms in a complex mucous filtration system. We used artificial microspheres to test whether the surface properties of prey particles influenced selection by the appendicularian, O. dioica. Across microsphere sizes (0.5, 1, 2 and 3 µm) and concentrations (~103-106 particles ml-1), which were varied to represent realistic microbial communities, carboxylate- and amine-modified particles were handled differently by the appendicularians. The carboxylate-modified particles were enriched in the gut while the amine-modified particles were enriched in the mucous filters, leading to different particle fates. This dataset includes incubation chamber concentrations at the beginning and end of feeding incubations.

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Coverage

Location: Sars Centre for Marine Molecular Biology in Bergen, Norway (60.38147, 5.33145)
Spatial Extent: **Lat**:60.38147 **Lon**:5.33145
Temporal Extent: 2022-10 - 2023-10

Methods & Sampling

Experiments with 5-day old *O. dioica* were conducted at the Michael Sars Centre in Bergen, Norway in October 2022 and 2023. Individual animals (15-24 replicates) were removed from their culture chamber, probed to abandon their house, and placed in a staging beaker containing 0.22 µm filtered seawater (FSW) to build fresh houses. Up to 12 actively pumping animals were then transferred from the staging beaker to an incubation chamber. Feeding incubations were carried out in a 12˚C water table with a motorized stir paddle to maintain suspension for 10 minutes. Following the 10-minute incubation, 3-8 animals were individually pipetted into watch glasses and probed to abandon houses so that the appendicularian and house could be preserved separately. Appendicularians were fixed by pipetting animal in 1 mL FSW into a 1.8 mL cryovial with 5 µl 25% microscopy grade glutaraldehyde (0.125% final concentration) to stop digestion. Houses were pipetted into cryovials in a volume of 100 µl without fixative.

Laboratory feeding incubations were carried out on two occasions with two experimental designs. One with all particle sizes (1.0 and 2.0 µm) available in equal concentration to appendicularians. The other with particle sizes (0.5, 1.0 and 3.0 µm) simulated environmental conditions with smaller particles available in higher concentration. For each particle size, two different microsphere types were used with different functionalized surfaces (carboxylate- and amine-modified).

Data Processing Description

Artificial particles were quantified from incubation suspension samples using a Nikon Eclipse Ei compound microscope with GFP and CY3 filter cubes for fluorescent particles and dark-field condenser for non-fluorescent particles (Abdel-Fattah et al. 2002). Counts were made using a Petroff-Hausser Bacteria Counter (0.2 mm deep, Fisher Scientific) with a 20x or 40x objective. All samples were vortexed for 30 s prior to counting. Nine grids were counted per 10-µl replicate, in duplicate.

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Data Files

File
956298_v1_chambers.csv (Comma Separated Values (.csv), 1.41 KB) MD5:89e94e33d99b4fcc1b1efb65d7c134f6 Primary data file for dataset ID 956298, version 1

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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

Hiebert TC, Aasjord AE, Chourrout DM, Thompson AW, Sutherland KR (in review) Prey particle surface property mediates differential selection by the ubiquitous appendicularian Oikopleura dioica. Limnology and Oceanography
Results

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Parameters

Parameter	Description	Units
Incubation	Incubation name for all incubations was alphabetical. Name is unique to entire project	unitless
Sample_Number	Sample number in incubation. Cumulative for incubations A-D and 1-4 for incubations E and F	unitless
Ti_Tf	Sample from incubation start (Ti) or end (Tf), Ti = Time initial, Tf = Time final	unitless
C_0_5_um_ml	Number of 0.5 µm carboxylate-modified microspheres counted	Count per grid
C_1_um_ml	Number of 1.0 µm carboxylate-modified microspheres counted	Count per grid
C_2_um_ml	Number of 2.0 µm carboxylate- modified microspheres counted	Count per grid
C_3_um_ml	Number of 3.0 µm carboxylate-modified microspheres counted	Count per grid
A_0_5_um_ml	Number of 0.5 µm amine-modified microspheres counted	Count per grid
A_1_um_ml	Number of 1.0 µm amine- modified microspheres counted	Count per grid
A_2_um_ml	Number of 2.0 µm amine-modified microspheres counted per ml	Count per grid
A_3_um_ml	Number of 3.0 µm amine-modified microspheres counted per ml	Count per grid

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Instruments

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

Dataset-specific Instrument Name	Nikon Eclipse
Generic Instrument Name	Fluorescence Microscope
Dataset-specific Description	Nikon Eclipse Ni epifluorescence 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 Proposal: 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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