EN683 FLA-Bead Data and ULake

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Project
» Substrate structural complexity and abundance control distinct mechanisms of microbially-driven carbon cycling in the ocean (Substrate complexity and microbes)

Contributors	Affiliation	Role
Arnosti, Carol	University of North Carolina at Chapel Hill (UNC-Chapel Hill)	Principal Investigator
DeMaesschalck, Michael	University of North Carolina at Chapel Hill (UNC-Chapel Hill)	Student
Lloyd, Chad	University of North Carolina at Chapel Hill (UNC-Chapel Hill)	Student
Ghobrial, Sherif	University of North Carolina at Chapel Hill (UNC-Chapel Hill)	Data Manager

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Coverage

Spatial Extent: **Lat**:0 **Lon**:0

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Parameters

Parameters for this dataset have not yet been identified

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Project Information

Substrate structural complexity and abundance control distinct mechanisms of microbially-driven carbon cycling in the ocean (Substrate complexity and microbes)

Coverage: Western North Atlantic

Substrate Structural Complexity and Abundance Control Distinct Mechanisms of Microbially-Driven Carbon Cycling in the Ocean

Almost half of the organic carbon produced in the ocean is processed by bacteria. Bacteria use extracellular (outside the cell) enzymes to break down large organic molecules to small sizes that can be transported into their cells. It has recently been discovered that bacteria use extracellular enzymes in two ways: ‘selfish uptake’ and ‘external hydrolysis’. External hydrolysis releases low molecular weight products to the environment where they can be used by other organisms. ‘Selfish uptake’ releases little or no products. This research will determine the extent and location of ‘selfish uptake’ in ocean waters. This process affects the distribution of organic carbon in the ocean, the flow of small organic molecules to feed a wider range of bacteria, and the composition and dynamics of the bacterial community. Recent results show that ‘selfish’ bacteria are active in deep ocean waters, where they take up complex polysaccharides (sugars) that are not hydrolyzed externally. These results inspired a new model that links ‘selfish uptake’ and external hydrolysis to the amount and complexity of the organic matter that is used by bacteria. This project will test the model by describing the polysaccharide fraction of marine organic matter, and studying the relationships between organic matter abundance, structural complexity, and extracellular enzyme use. Graduate and undergraduate students will participate in the project as members of the research team in the field and in the laboratory.

This research will test the hypothesis that the mechanism of polysaccharide processing is related to the cost to a cell of producing the enzymes required for its hydrolysis, and the probability that a cell will receive sufficient return on investment for producing the enzymes. The conceptual model that will be tested suggests that external hydrolysis is favored when organic matter is abundant, or when enzyme production costs can be shared (e.g., on particles, in biofilms); selfish uptake would be a better strategy when high molecular weight (HMW) organic matter is scarce, and particularly when the HMW organic matter is very complex. This study will test this model by characterizing the structure of polysaccharide-containing components of dissolved organic matter (DOM) and particulate organic matter (POM) collected from the ocean, by determining the extent of selfish uptake and rates of external hydrolysis of different polysaccharides by natural microbial communities from the surface and the deep ocean, and by incubation experiments that control for the abundance of polysaccharides of different structural complexity. This project will be carried out in collaboration with colleagues at the Max Planck Institute for Marine Microbiology, whose expertise in carbohydrate chemistry and structural analyses, and in advanced microscopy and analysis of complex microbial communities, are central to the project.

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-2022952

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