Growth behaviors of diatom monoculture and diatom-bacteria co-cultures in the lab

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Project
» Interactions between phytoplankton and bacterioplankton mediated by volatile organic compounds (Plankton Interactions and VOC)

Contributors	Affiliation	Role
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Abstract
This dataset represents the growth behaviors of diatom (Phaeodactylum tricornutum) monoculture and diatom-bacteria co-cultures in the lab.

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Coverage

Temporal Extent: 2021-11 - 2021-11

Acquisition Description

This dataset represents the growth behaviors of diatom (*Phaeodactylum tricornutum*) monoculture and diatom-bacteria co-cultures in the lab.

The cultures described in the dataset were grown as follows:
Cultures were inoculated in f/2+Si media and grown under 60 micro-einsteins, 12 hours light:12 hour dark cycles at 19 degrees Celsius. Sampling for VOCs was done in triplicate during exponential and stationary growth phases. Exponential phase sampling was done when the cell density of P. tricornutum was 2-4 * 10^5 per milliliter (ml) and at 6-7 hours after dawn. Stationary phase sampling was done when the cell density of P. tricornutum was 2-4 * 10^6 per milliliter (ml) at 6-7 hours after dawn.

Cell densities were measured by a particle counter (Coulter) or Guava flow cytometry.

Processing Description

BCO-DMO processing description:
- Adjusted field/parameter names to comply with BCO-DMO naming conventions
- Added a conventional header with dataset name, PI names, version date
- Replaced "NA" with "nd" to represent "no data"

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Parameters

Parameter	Description	Units
Culture_ID	identification of microbial culture	unitless
Algae	name of algae in culture	unitless
Bacteria	name of bacteria in culture	unitless
Time	time of experiment in hours	unitless
Algal_cell_density	density in number of algal cells per unit volume	unitless
Bacterial_cell_density	density in number of bacterial cells per unit volume	unitless

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Instruments

Dataset-specific Instrument Name	Guava
Generic Instrument Name	Flow Cytometer
Generic Instrument Description	Flow cytometers (FC or FCM) are automated instruments that quantitate properties of single cells, one cell at a time. They can measure cell size, cell granularity, the amounts of cell components such as total DNA, newly synthesized DNA, gene expression as the amount messenger RNA for a particular gene, amounts of specific surface receptors, amounts of intracellular proteins, or transient signalling events in living cells. (from: http://www.bio.umass.edu/micro/immunology/facs542/facswhat.htm)

Dataset-specific Instrument Name	Coulter
Generic Instrument Name	Particle Size Analyzer
Generic Instrument Description	Particle size analysis, particle size measurement, or simply particle sizing is the collective name of the technical procedures, or laboratory techniques which determines the size range, and/or the average, or mean size of the particles in a powder or liquid sample.

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Project Information

Interactions between phytoplankton and bacterioplankton mediated by volatile organic compounds (Plankton Interactions and VOC)

NSF Award Abstract:
Communication amongst plants and animals often occurs through molecules that readily evaporate at normal temperatures, called volatile organic compounds (VOCs). Some VOCs that are produced in the ocean and then enter the atmosphere as gases have been seen to play an important role in climate. Since marine microbes both produce and consume these compounds they affect the concentration of VOCs in the surface ocean. The investigators found that as much as 20% of the carbon resulting from photosynthesis leaked out of microscopic plants in the form of VOCs. These molecules were then used by bacteria as a source of carbon and energy. This suggests that VOCs may play a more important role in the flow of carbon in the marine environment than previously thought. This project examines how microscopic plants and bacteria produce and consume different VOCs. It supports professional development training workshops for Oregon high school teachers from rural areas in OSU's Science & Math Investigative Learning Experiences (SMILE) program. SMILE's mission is to close the achievement gap for underserved students by increasing their STEM-content knowledge, preparing them to succeed in higher education, and inspiring them to pursue STEM careers. This project also contributes to three workshops per year, training teachers and engaging students with hands-on learning activities on the topic of Carbon Cycling by Marine Microorganisms such as "Clouds in a Bottle". One graduate student, one post-doctoral scholar, and at least six undergraduate researchers are being trained by participating in research activities.

Field observations suggest that volatile organic compounds (VOCs) produced by phytoplankton are either rapidly consumed by bacterioplankton in the surface ocean or emitted into the atmosphere. VOCs are an understudied path for carbon transfer in microbial food webs throughout sunlit marine ecosystems because these compounds require specialized detection methods. Using a new system to study VOCs in suspensions of live plankton cells, 20% of photosynthetic carbon fixation was seen to be transferred as VOCs from a diatom to SAR11 bacterioplankton in co-cultures. Many of these transferred VOC compounds were not known to be growth substrates for bacterioplankton. Both the magnitude and complexity of the observed VOC transfer were surprising. This project extends these observations to a larger set of phytoplankton and bacterioplankton through controlled studies of cultures, co-cultures, and mesocosms. VOC are detected via proton transfer reaction time-of-flight mass spectrometry and isotopic labeling is used to measure the impact of VOC exchange on rates of photosynthesis and bacterial production. VOC production by phytoplankton is measured in response to nutrient-driven variation in growth rates, and over day-night cycles to discern the relationship of VOC production to photosynthetic metabolism and other cellular processes. These experiments enable a better understanding of field observations, in which bacterial consumption of VOCs can appear to significantly outpace production, while temporal variability in VOC production across daily to seasonal scales can cause VOCs to accumulate transiently to pM-nM concentrations in the surface ocean. This project contributes to close the significant gap in knowledge about the range and quantity of VOCs produced by phytoplankton, and about the roles played by these compounds in phytoplankton metabolism.

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-1948163

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