Effect of microplastic ingestion on heterotrophic dinoflagellate growth rates

Website: https://www.bco-dmo.org/dataset/855583
Data Type: experimental
Version: 1
Version Date: 2021-07-13

Project
» Quantifying Temperature Dependence In Growth & Grazing Rates of Planktonic Herbivores (Planktonic Herbivore Temp Dependence)

Contributors	Affiliation	Role
Fulfer, Victoria	University of Rhode Island (URI-GSO)	Principal Investigator
Menden-Deuer, Susanne	University of Rhode Island (URI-GSO)	Co-Principal Investigator
Rauch, Shannon	Woods Hole Oceanographic Institution (WHOI BCO-DMO)	BCO-DMO Data Manager

Abstract
Data were collected examining the effect of microplastic ingestion on heterotrophic dinoflagellate growth rates. Heterotrophic dinoflagellate species O. marina and Gyrodinium sp. were incubated for 5 days under two conditions: a control, fed only algal prey I. galbana, and a treatment fed algal prey and microplastic particles. Samples were taken every 24 hours, with abundances of dinoflagellates, algal prey, and microplastics measured with a Beckman Coulter Counter and verified via microscopy. Ingestion rates were measured and compared between treatments.

Table of Contents

Coverage

Spatial Extent: **Lat**:41.4501 **Lon**:-71.4495
Temporal Extent: 2020-11-09 - 2020-11-15

Methods & Sampling

Methodology:
Heterotrophic dinoflagellate species *O. marina* and *Gyrodinium* sp. were incubated for 5 days under two conditions: a control, fed only algal prey *I. galbana,* and a treatment fed algal prey and microplastic particles. Samples were taken every 24 hours, with abundances of dinoflagellates, algal prey, and microplastics measured with a Beckman Coulter Counter and verified via microscopy. Growth rates were measured and compared between treatments.

Microplastic Ingestion Experiments:

The possibility and subsequent effects of microplastic ingestion by heterotrophic dinoflagellate species were determined using two treatment conditions: first, a treatment with microplastics, in which heterotrophic dinoflagellates were fed a mixture of algal prey and microplastic particles; and second, an algae-only control, in which heterotrophic dinoflagellates were fed algal prey.

For the grazing experiments, each of the three target heterotrophic dinoflagellate species was incubated with *I. galbana* and microplastic particles, when applicable, diluted in filtered seawater (FSW) to the target concentrations (Table 1 of Fulfer & Menden-Deuer, 2021). Control treatments of the two prey types in the absence of predators were incubated alongside the grazing experiments. All treatments were prepared in triplicate and in a total volume of 125 mL and incubated in 250 mL polycarbonate bottles on a 12 h: 12 h light-dark cycle at 15°C and a light intensity of 8 – 15 µmol photons m^{-2} s^{-1} on a shaker table at 60 rotations-per-minute (rpm) to reduce settling of microplastic particles.

Fluorescent yellow polystyrene (PS) microplastic particles ranging in diameter from 2.5 to 4.5 µm were used in all microplastic feeding experiments (Spherotech, FP-3052-2). This size range was chosen to mimic the size of the algal prey species. Microplastic particles were rinsed three times in DI water and resuspended in autoclaved, filtered seawater directly before use. For each experiment, prey (IG) control treatments were prepared in triplicate in 125 mL polycarbonate bottles with *I. galbana* diluted in filtered seawater (FSW) to a final concentration of 70,000 - 100,000 prey cells mL^{-1}.

Microplastic ingestion experiments were run for up to 5 days and sampled daily. Samples of 3 mL were fixed with 10% glutaraldehyde to a final concentration of 0.1% glutaraldehyde. Heterotrophic dinoflagellates were counted via light microscopy. To measure growth rates, subsamples of 10 mL were taken at T0 and every 24 hours for 5 days. Abundances of prey, predators, and microplastic particles were measured with a Beckman Coulter Multisizer 3 (Beckman Coulter) using a 100 µm aperture. Rates were calculated over the entire experimental span and over the exponential growth phase.

Data Processing Description

Data Processing:
Specific growth rates of prey and heterotrophic dinoflagellates were calculated by a linear regression of natural log-transformed abundance. Growth rates of heterotrophic dinoflagellates were calculated over the time span for which exponential growth occurred in the algal-only treatments, days 0 to 4 for *O. marina* and days 1 to 5 for *Gyrodinium* sp.

BCO-DMO Processing:
- renamed fields to conform with BCO-DMO naming conventions (removed spaces and special characters)

[table of contents | back to top]

Data Files

File	
microplastic_growth_rates.csv	(Comma Separated Values (.csv), 2.27 KB) MD5:e1486d1a99b634a27d059432cda9e602
Primary data file for dataset ID 855583	

[table of contents | back to top]

Related Publications

Fulfer, V. & Menden-Deuer, S. (2021). Heterotrophic Dinoflagellate Growth and Grazing Rates Reduced by Microplastic Ingestion. Frontiers in Marine Science. doi: 10.3389/fmars.2021.716349
Results

[table of contents | back to top]

Related Datasets

IsRelatedTo

Fulfer, V., Menden-Deuer, S. (2021) **Effect of microplastic ingestion on heterotrophic dinoflagellate functional responses.** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2021-07-13 doi:10.26008/1912/bco-dmo.855595.1 [view at BCO-DMO]

Fulfer, V., Menden-Deuer, S. (2021) **Effect of microplastic ingestion on heterotrophic dinoflagellate ingestion rates.** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2021-07-13 doi:10.26008/1912/bco-dmo.855573.1 [view at BCO-DMO]

[table of contents | back to top]

Parameters

Parameter	Description	Units
Species	Dinoflagellate species	unitless
Treatment	Experimental treatment: IG = fed algae only; MP + IG = fed algae and Microplastics	unitless
Replicate	Experimental replicate id (A, B, C)	unitless
Time	Time phase the rate was calculated over (number of days)	days
Growth_Rate	Growth rate of predator or, for I. Galbana control, prey	per day (day-1)

[table of contents | back to top]

Instruments

Dataset-specific Instrument Name	Beckman Coulter Multisizer 3
Generic Instrument Name	Particle Size Analyzer
Dataset-specific Description	Abundances of prey, predators, and microplastic particles were measured with a Beckman Coulter Multisizer 3 (Beckman Coulter) using a 100 µm aperture.
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.

[table of contents | back to top]

Project Information

Quantifying Temperature Dependence In Growth & Grazing Rates of Planktonic Herbivores (Planktonic Herbivore Temp Dependence)

Coverage: Narragansett Bay

NSF Award Abstract:
Plankton, single-celled organisms that inhabit the world's oceans are responsible for the generation of oxygen, cycling energy and matter between the atmosphere and the deep ocean and are the basis for virtually all seafood harvested. These life-giving functions critically depend on the relative rates at which plankton grow and get eaten. How temperature influences those rates is essential to understand plankton responses to environmental changes and ocean dynamics. It is well established that plankton grow faster when temperatures are higher however, whether feeding has a similar temperature dependence is unknown. That means oceanographers are missing key data required to build global predictive models. This project will fill essential knowledge gaps and measure physiological rates of singled celled zooplankton across temperature gradients representing the global ocean, from polar to tropical regions and throughout the seasonal cycle. Researchers will combine laboratory experiments with specimens taken from the coastal ocean (Narragansett Bay), which is exemplary in its strong seasonal temperature variations. These data will provide a clear picture of the production capacity and activity of plankton in a global and dynamic ocean. The project supports an early career scientist, as well as graduate and undergraduate students. Scientists will continue communicating their research to the public through large-scale outreach events, education at the high-school level, and engagement through online and other media. Moreover, researchers will continue collaborating with the Metcalf Institute for Marine & Environmental Reporting to support their Annual Science Immersion Workshop for Journalists and their ongoing work to disseminate research findings through web-based seminars.

Grazing is the single largest loss factor of marine primary production and thus affects a key transfer rate between global organic and inorganic matter pools. Remarkably, data for herbivorous protist growth and grazing rates at temperatures representative of the vast polar regions and during winter and spring periods are extremely sparse. By combining laboratory experiments with ground truthing fieldwork, this project alleviates a central knowledge gap in oceanography and delivers the empirical measurements necessary to derive algorithms to incorporate temperature dependence of heterotrophic protist growth and grazing rates into biogeochemical models. The extraordinary seasonal temperature fluctuations in a temperate coastal estuary (Narragansett Bay) are exploited to measure rates of heterotrophic protists isolated from different temperatures and seasons and to quantify the temperature and acclimation responses of these ecotypes. This project delivers data urgently needed to solve the conundrum of whether herbivorous growth and predation is depressed at low temperatures, implying low trophic transfer rates and high carbon export, or if predation proceeds at rates comparable to temperate systems with primary production largely lost to predation. Large temperature gradients in the global ocean mean that cross-biome and biogeochemical models are particularly sensitive to assumptions about the temperature dependence in modeled rate processes. Establishment of the dependence of heterotrophic plankton physiological rates (growth and grazing) to gradients of temperature, mimicking realistic conditions experienced by plankton in a changing ocean, is a key step towards integrating much needed biological information in biogeochemical modeling efforts. This project makes a significant contribution to linking ecological research with ecosystem models by providing empirically rooted algorithms of the temperature dependence of protistan herbivory and growth rates, key processes in the transformation of organic matter in global biogeochemical cycles and tools critically missing in ecosystem models.

[table of contents | back to top]

Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-1736635

[table of contents | back to top]