Zooplankton-mediated aggregate formation was measured during seven Bermuda Atlantic Time-series Study (BATS) cruises aboard the R/V Atlantic Explorer Jul 2021 to Mar 2023

Website: https://www.bco-dmo.org/dataset/998220
Data Type: Cruise Results, experimental
Version: 2
Version Date: 2026-05-14

Project
» Collaborative Research: Zooplankton mediation of particle formation in the Sargasso Sea (Zooplankton Mediation)

Contributors	Affiliation	Role
Neuer, Susanne	Arizona State University (ASU)	Principal Investigator
Baird, Kaitlin	Bermuda Institute of Ocean Sciences (BIOS)	Co-Principal Investigator
Blanco-Bercial, Leocadio	Bermuda Institute of Ocean Sciences (BIOS)	Co-Principal Investigator
Maas, Amy Elizabeth	Bermuda Institute of Ocean Sciences (BIOS)	Co-Principal Investigator
Niimi, Yuuki Justin	Arizona State University (ASU)	Student
Mickle, Audrey	Woods Hole Oceanographic Institution (WHOI BCO-DMO)	BCO-DMO Data Manager

Abstract
Zooplankton-mediated aggregate formation was measured during seven Bermuda Atlantic Time-series Study (BATS) cruises (AE2112, AE2114, AE2124, AE2204, AE2214, AE2224, AE2306) aboard the R/V Atlantic Explorer between 2021-07-08 and 2023-03-26 in the Sargasso Sea near Bermuda. This dataset reports roller-tank incubation data documenting the formation of zooplankton-mediated aggregates are also included, with records of individuals used and aggregate production outcomes. Together with the related datasets, these data provide integrated measurements linking zooplankton identity, size, fecal-pellet production, pellet elemental composition, and aggregate formation, supporting process-based analyses of zooplankton roles in particle production and vertical carbon transfer at BATS. The data were collected aboard the R/V Atlantic Explorer through the collaborative efforts of the laboratories of Dr. Susanne Neuer, Dr. Amy Maas, and Dr. Leocadio Blanco-Bercial, affiliated with Arizona State University and the Bermuda Institute of Ocean Sciences.

Table of Contents

Coverage

Location: Bermuda Atlantic Time-series Study (BATS) site, Sargasso Sea in the Western North-Atlantic. 31 50'N 64 10'W. Depths 0-300m.
Spatial Extent: **N**:32.17011667 **E**:-63.91948 **S**:31.617685 **W**:-64.47745
Temporal Extent: 2021-07-16 - 2023-03-26

Methods & Sampling

Zooplankton Collection

Live zooplankton were collected using a 1-m², 150-µm mesh Reeve net for roller tank incubation experiments. Unfiltered seawater used to fill the roller tanks was collected from the same depth as the zooplankton.

Roller Tank Incubations

Roller tank experiments were conducted using eight 5-L acid-washed roller tanks filled with unfiltered seawater collected from the same depth as the zooplankton. These incubations were used to assess the formation of zooplankton-mediated aggregates. Live zooplankton individuals were incubated in rotating tanks under controlled conditions, and aggregate production was recorded over a three-day incubation period. Dataset records include the taxonomic identity of incubated individuals and qualitative and quantitative descriptions of aggregate formation.

Data Processing Description

Raw zooplankton sample metadata (cruise ID, station, date, time, depth interval, and diel period) were recorded at sea during each cruise. Zooplankton taxa used in roller tank experiments were identified to the lowest practical taxonomic level using stereomicroscope images and standard taxonomic references.

Roller tank experiment data were processed by recording the presence, number, and size of aggregates formed during each incubation period and associating these observations with the taxonomic identity of the incubated zooplankton.

All data were compiled, quality-checked for transcription errors, and formatted into standardized tables for submission. No statistical analyses, model-based flux calculations, or graphical processing are included in the submitted datasets.

BCO-DMO Processing Description

Version 1

- Loaded "Roller_Tanks.csv" as resource "roller_tanks" (CSV format, header row 1, treating "" and "nd" as missing values)
- Converted Start_Date from format "%m/%d/%Y" to date output "%Y-%m-%d"
- Converted Takedown_Date from format "%m/%d/%Y" to date output "%Y-%m-%d"
- Combined Start_Date and Start_Time fields (Atlantic/Bermuda timezone) into new datetime field Datetime_Start_UTC, converting to UTC, formatted as "%Y-%m-%dT%H:%MZ"
- Renamed fields: Min_Depth_(m) to Min_Depth, Max_Depth_(m) to Max_Depth, #_of_Zooplankton_At_Beginning to Num_Zooplankton_At_Beginning, #_Zooplankton_Alive to Num_Zooplankton_Alive, #_Fecal_Aggregate to Num_Fecal_Aggregate, #_Fecal_Pellet to Num_Fecal_Pellet, Animal/FecalPellet_Notes to Animal_FecalPellet_Notes
- Edited two cells: row 9 Takedown_Date set to 2021-08-13 and Takedown_Time set to 19:00; row 45 Takedown_Date set to 2022-12-04 and Takedown_Time set to 3:00, upon submitter request
- Renamed resource from "roller_tanks" to "998220_v1_roller_tank_exp"
- Output written to 998220_v1_roller_tank_exp.csv

Version 2

Addition of missing time values provided by submitter. Processing was done using original submitted file with missing data added to edited cells. See details below.

- Loaded "Roller_Tanks.csv" as resource "roller_tanks" (CSV format, header row 1, treating "" and "nd" as missing values)
- Edited cells in rows 21, 22, 38, and 40 to fill missing End_Time, Total_Time, Hours, and Start_Time values provided by submitter

- Converted Start_Date from format "%m/%d/%Y" to date output "%Y-%m-%d"
- Converted Takedown_Date from format "%m/%d/%Y" to date output "%Y-%m-%d"
- Combined Start_Date and Start_Time fields (Atlantic/Bermuda timezone) into new datetime field Datetime_Start_UTC, converting to UTC, formatted as "%Y-%m-%dT%H:%MZ"
- Renamed fields: Min_Depth_(m) to Min_Depth, Max_Depth_(m) to Max_Depth, #_of_Zooplankton_At_Beginning to Num_Zooplankton_At_Beginning, #_Zooplankton_Alive to Num_Zooplankton_Alive, #_Fecal_Aggregate to Num_Fecal_Aggregate, #_Fecal_Pellet to Num_Fecal_Pellet, Animal/FecalPellet_Notes to Animal_FecalPellet_Notes
- Edited two cells: row 9 Takedown_Date set to 2021-08-13 and Takedown_Time set to 19:00; row 45 Takedown_Date set to 2022-12-04 and Takedown_Time set to 3:00, upon submitter request
- Output written to 998220_v2_roller_tank_exp.csv

[table of contents | back to top]

Data Files

File
998220_v2_roller_tank_exp.csv (Comma Separated Values (.csv), 13.94 KB) MD5:01857f1ef558df33dfcfd37ffce2db9f Primary data file for dataset ID 998220, version 2

[table of contents | back to top]

Related Publications

Alldredge, A. L., & Gotschalk, C. C. (1990). The relative contribution of marine snow of different origins to biological processes in coastal waters. Continental Shelf Research, 10(1), 41–58. https://doi.org/10.1016/0278-4343(90)90034-j
Methods

Durkin, C. A., Buesseler, K. O., Cetinić, I., Estapa, M. L., Kelly, R. P., & Omand, M. (2021). A Visual Tour of Carbon Export by Sinking Particles. Global Biogeochemical Cycles, 35(10). Portico. https://doi.org/10.1029/2021gb006985
Methods

Niimi et. al. "Understanding the Seasonal Contributions of Key Zooplankton Fecal Pellet Production in the Sargasso Sea" (in preparation).
Results

Silver, M. W., & Bruland, K. W. (1981). Differential feeding and fecal pellet composition of salps and pteropods, and the possible origin of the deep-water flora and olive-green "Cells" Marine Biology, 62(4), 263–273. https://doi.org/10.1007/bf00397693
Methods

[table of contents | back to top]

Related Datasets

IsRelatedTo

Brenner, A., Maas, A., Blanco-Bercial, L., Noyes, K., Neuer, S. (2025) **Measurements of sinking particle types from deployed Particle Interceptor Trap System (PITS) at the Bermuda Atlantic Time-series Study (BATS) site from Jul 2021 to Mar 2023.** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2025-10-08 doi:10.26008/1912/bco-dmo.982170.1 [view at BCO-DMO]
Relationship Description: The roller tank and fecal pellet production experiments used zooplankton collected during the same cruises and from the same depth strata associated with the PITs aggregate collections.

Maas, A., Blanco-Bercial, L. (2024) **ZooSCAN images of zooplankton collected with MOCNESS tows**

during six R/V Atlantic Explorer cruises in the northwest Atlantic (Sargasso Sea) from 2021 to 2023. Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2024-07-11 doi:10.26008/1912/bco-dmo.932236.1 [view at BCO-DMO]
Relationship Description: ZooSCAN images were generated from zooplankton community samples collected during these cruises to characterize zooplankton abundance, size structure, and taxonomy associated with aggregate formation and particle flux processes.

Neuer, S., Blanco-Bercial, L., Maas, A. E., Baird, K., Niimi, Y. J. (2026) **Fecal pellet elemental composition (CHN), production rates, and morphometrics from zooplankton incubation experiments collected during R/V Atlantic Explorer cruise AE2306 at the Bermuda Atlantic Time-series Study (BATS) site in Mar 2023.** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2026-05-13 doi:10.26008/1912/bco-dmo.998152.1 [view at BCO-DMO]
Relationship Description: Roller tank and fecal pellet production experiments used zooplankton collected during the same cruises and from the same depth strata associated with the PITs aggregate collections.

Neuer, S., Blanco-Bercial, L., Maas, A. E., Baird, K., Niimi, Y. J. (2026) **Quantification of zooplankton fecal-pellet production by on-board incubation experiments during seven Bermuda Atlantic Time-series Study (BATS) cruises aboard the R/V Atlantic Explorer from Jul 2021 to Mar 2023.** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2026-05-07 doi:10.26008/1912/bco-dmo.997926.1 [view at BCO-DMO]
Relationship Description: Roller tank and fecal pellet production experiments used zooplankton collected during the same cruises and from the same depth strata associated with the PITs aggregate collections.

[table of contents | back to top]

Parameters

Parameter	Description	Units
Start_Date	Date of experiment start (Atlantic/Bermuda timezone (GMT-4)) when animals were placed into the roller tanks and the zooplankton incubation began	unitless
Latitude	Latitude of sampling or experiment location, positive is North	decimal degrees
Longitude	Longitude of sampling or experiment location, negative is West	decimal degrees
Cruise	R/V Atlantic Explorer (AE) cruise ID number	unitless
Start_Time	Time incubation started when animals were placed into the roller tanks and the zooplankton incubation began (Atlantic/Bermuda timezone (GMT-4))	unitless
End_Time	Time roller tank incubation ended and the tanks were removed from the roller table (Atlantic/Bermuda timezone (GMT-4))	unitless
Total_Time	Duration of incubation	unitless
Hours	The Hours column represents the total deployment duration expressed as whole hours. It is calculated by rounding the Total_Time (hh:mm) up to the nearest hour	hours

Rolling_Start_Time	Time after experiment began when the roller tank rotation was started (Atlantic/Bermuda timezone (GMT-4))	unitless
Takedown_Date	Date when the tanks were taken down and particles were picked out of the tanks for processing (Atlantic/Bermuda timezone (GMT-4))	unitless
Takedown_Time	Time when the tanks were taken down and particles were picked out of the tanks for processing (Atlantic/Bermuda timezone (GMT-4))	unitless
Min_Depth	Minimum depth of sampling or incubation	meters (m)
Max_Depth	Maximum depth of sampling or incubation	meters (m)
Experiment	Experimental treatment or experiment identifier	unitless
Zooplankton_Groups	Broad taxonomic or functional group of zooplankton	unitless
Zooplankton_Taxa	Lowest identified taxonomic classification of zooplankton	unitless
Num_Zooplankton_At_Beginning	Number of live zooplankton individuals at experiment start	unitless
Num_Zooplankton_Alive	Number of zooplankton alive or present at end of experiment or analysis	unitless
Num_Fecal_Aggregate	Number of fecal aggregates observed	unitless
Num_Fecal_Pellet	Number of fecal pellets produced or analyzed	unitless
Saved_for_DNA	Indicates whether sample was preserved for genetic analysis	unitless
Created_Slides	Indicates whether microscopy slides were prepared	unitless
Animal_FecalPellet_Notes	Qualitative observations on animal condition, pellet structure, or anomalies	unitless
Datetime_Start_UTC	Datetime incubation started when animals were placed into the roller tanks and the zooplankton incubation began (UTC), combines Start_Date and Start_Time	unitless

[table of contents | back to top]

Instruments

Dataset-specific Instrument Name	stereomicroscope
Generic Instrument Name	Microscope - Optical
Dataset-specific Description	Zooplankton taxa used in roller tank experiments were identified to the lowest practical taxonomic level using stereomicroscope images and standard taxonomic references.
Generic Instrument Description	Instruments that generate enlarged images of samples using the phenomena of reflection and absorption of visible light. Includes conventional and inverted instruments. Also called a "light microscope".

Dataset-specific Instrument Name	Reeve net
Generic Instrument Name	Reeve Net
Dataset-specific Description	Live zooplankton were collected using a 1-m², 150-µm mesh Reeve net for roller tank incubation experiments.
Generic Instrument Description	A Reeve Net is a conventional ring net with a very large acrylic cylindrical cod-end (30 liters) designed to collect fragile gelatinous animals. The net is lowered to a particular depth and then hauled slowly back to the surface (5-10 m/min). Reeve (1981) also described a double net system with no bridle and flotation at the net mouth that is attached to a roller mechanism that rides on a tow wire. The roller system is locked in place by a pressure release device. Once below a set pressure, the roller and nets are released and they float slowly up the wire, gently collecting the zooplankton, without being influenced by the motion of the vessel and associated vertical wire movements. (from Wiebe and Benfield, 2003)

Dataset-specific Instrument Name	rotating tanks
Generic Instrument Name	Roller Tank
Dataset-specific Description	Live zooplankton individuals were incubated in rotating tanks under controlled conditions, and aggregate production was recorded over a three-day incubation period.
Generic Instrument Description	Rolling tanks, which keep particles in suspension, thus simulating aggregate formation in situ. Marine snow experiments are conducted in roller tanks, which turn continuously, keeping marine snow in suspension. It is important for marine snow not to touch surfaces. The rolling tanks, which keep particles in suspension, thus simulate aggregate formation in situ. Marine snow formation due to different types of oil was tested. Some treatments are easily identifiable as containing oil by their color (middle). UCSB, CA 2012.

[table of contents | back to top]

Deployments

AE2306

Website	https://www.bco-dmo.org/deployment/931901
Platform	R/V Atlantic Explorer
Start Date	2023-03-18
End Date	2023-03-26

AE2112

Website	https://www.bco-dmo.org/deployment/931891
Platform	R/V Atlantic Explorer
Start Date	2021-07-08
End Date	2021-07-16

AE2114

Website	https://www.bco-dmo.org/deployment/964699
Platform	R/V Atlantic Explorer
Start Date	2021-08-05
End Date	2021-08-08

AE2124

Website	https://www.bco-dmo.org/deployment/931893
Platform	R/V Atlantic Explorer
Start Date	2021-11-16
End Date	2021-11-19

AE2204

Website	https://www.bco-dmo.org/deployment/931895
Platform	R/V Atlantic Explorer
Start Date	2022-03-28
End Date	2022-04-04

AE2214

Website	https://www.bco-dmo.org/deployment/931897
Platform	R/V Atlantic Explorer
Start Date	2022-07-13
End Date	2022-07-18

AE2224

Website	https://www.bco-dmo.org/deployment/931899
Platform	R/V Atlantic Explorer
Start Date	2022-11-23
End Date	2022-11-30

[table of contents | back to top]

Project Information

Collaborative Research: Zooplankton mediation of particle formation in the Sargasso Sea (Zooplankton Mediation)

Coverage: Sargasso Sea/BATS area

NSF Award Abstract:
The purpose of this collaborative project is to advance understanding of the role of marine planktonic animals (or zooplankton) in the biological pump, or transport of carbon from surface to deeper ocean waters. This movement of carbon from surface to deep ocean water can ultimately affect carbon dioxide in the atmosphere, with implications for global climate. Many marine zooplankton, including species of copepods and krill, play a direct role in the biological pump both because they are abundant and because they can migrate from surface waters at night, where they feed, to depths of more than 500 m at night. At the same time, some organisms called flux feeders will remain at depth and do not migrate. Instead, they rely on particles produced by other zooplankton feeding in surface waters. In this project, the investigators are focusing on populations of flux feeders in the deeper ocean waters of the Sargasso Sea. They are leveraging an ongoing long-term research program, conducting field collections using specialized nets and particle traps, as well lab experiments, as a way to understand how these organisms modify the particles around them. This project is supporting a postdoctoral scientist and providing research experiences for undergraduates at two institutions. An education specialist is creating lesson plans for an award-winning Ask-A-Biologist website, designed for public and K-12 audiences. Images of zooplankton will be disseminated to the public and scientific community via EcoTaxa (a web platform devoted to plankton biodiversity, with images and taxonomic annotation) and physical samples will be archived as part of a teaching library.

The oceanic biological carbon pump refers to the export of dissolved and particulate organic carbon to the deep ocean, and it is a significant driver of atmospheric carbon uptake by the oceans. Evidence from long-term research carried out at the Bermuda Atlantic Time-series Study (BATS) site suggests that the spectrum of particles collected by gel-traps below the euphotic zone changes drastically below 150 m, which is attributed to resident populations of zooplankton that feed on vertically migrating zooplankton as well as sinking particles. The goals of this study are to investigate the role of different zooplankton taxa on both particle aggregate formation and in particle transformation, and to compare and characterize the particles generated by the zooplankton communities with those collected by particle traps. The investigators are combining field collections with experiments onboard ship and in environmental chambers. They are collecting samples over two years, with three cruises a year to capture distinct seasons. They are assessing high-resolution vertical distribution of zooplankton in the upper 600 m using Multiple Opening-Closing Net and Environmental Sensing System (MOCNESS) tows during day- and night-time, to distinguish diel vertical migrators from resident populations and to quantify contributions to particulate organic carbon flux via fecal pellet production. On each cruise, sinking particles are being collected using gel trap tubes attached to the particle traps deployed monthly at BATS. In addition, roller tank experiments are determining how individual zooplankton mediate aggregate formation. Particle types and fecal pellets are being characterized using image analysis and DNA-based analysis of microbial communities. Finally, ongoing data collection from the long-term BATS program is providing invaluable environmental context and will ensure results from this study contribute to ongoing community efforts to observe and predict the fate of carbon in our global system.

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.

[table of contents | back to top]

Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-2023621
NSF Division of Ocean Sciences (NSF OCE)	OCE-2023372

[table of contents | back to top]