Pyrosome fecal pellet composition measurements collected from the cruise RR2105 on R/V Roger Revelle in the California Current Ecosystem from July to August 2021

Website: https://www.bco-dmo.org/dataset/1004254
Data Type: Other Field Results
Version: 1
Version Date: 2026-08-17

Project
» Collaborative Research: Assessing the causes of the pyrosome invasion and persistence in the California Current Ecosystem (Pyrosomes in the CCE)

Contributors	Affiliation	Role
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Abstract
This dataset contains fecal pellet carbon and nitrogen composition collected from pyrosome fecal pellet production experiments conducted during the cruise RR2105 on R/V Roger Revelle (CCE LTER P2107, July-August 2021) in the California Current Ecosystem.

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Coverage

Spatial Extent: **N**:35.5661 **E**:-120.8396 **S**:34.477 **W**:-130.5421
Temporal Extent: 2021-07-29 - 2021-08-11

Dataset Description

Samples were collected on CCE-NSF process cruise (OCE-1637632, Project: California Current Ecosystem Long Term Ecological Research Site).

Methods & Sampling

Pyrosome colonies for production and sinking experiments were collected from the upper 40 m of the water column using a vertically towed 202 µm net equipped with a 30 L non-filtering cod-end. Tows were preferentially conducted at night, as organisms exhibited distinct DVM behavior, which was possible during the Offshore cycle; however, for the transects we conducted, these tows were conducted whenever the ship arrived on station. For fecal pellet production experiments, colonies were gently transferred from the cod-end, ensuring that no air entered the common canal of the organism, and placed in an appropriately sized container (allowing the organisms to be submerged in typically ~500 mL, but we used containers of up to 1.5L for a handful of large specimens) filled with filtered 0.2 µm seawater for microscopic evaluation. Pellet production experiments were only conducted during the Offshore cycle and the two transects (CCT and AT), while fecal pellet sinking rate determinations were conducted during Onshore 2, Offshore, and one transect (CCT).

Fecal pellet production was measured following the methods described in Drits et al. (1992). Pyrosome colonies were transferred into containers filled with 0.2-µm-filtered seawater and placed under dissecting microscopes to visualize their common cloacal aperture. The number of fecal pellets produced was counted during continuous observations over 2 min. Initially, we observed colony defecation for 1 to 7 min while determining the count period length. Since we observed a noticeable decrease in production over time, beginning after the first ~2-3 minutes, as noted by Drits et al. (1992), we conducted counts for 2 min immediately after transferring the colonies into the observation container. After the production experiments were concluded, pellets were collected for sinking and aging experiments. A subsample of the produced pellets was allowed to sit in natural seawater for 24 and 48 hours and evaluated for sinking rates; these were referred to as ‘aged’ pellets.

Data Processing Description

Pyrosomes were imaged and measured through ImageJ.

Elemental analysis of fecal pellets required pooling pellets from multiple incubations to ensure sufficient biomass for detection in an elemental analyzer. Subsamples of 40 to 100 pellets were imaged using the setup described above (to enumerate the exact number of pellets per filter) and filtered onto pre-combusted GF/F filters (450° C for 4 h), folded with material facing inside, placed into pre-combusted glass vials, and dried at 60° C for 24 h. A blank pre-combusted GF/F filter was processed in a similar way every 5-10 samples and added to the analysis queue. Samples were processed at the UC Santa Cruz Stable Isotope Laboratory using a nanoEA-Delta Plus XP, designed to detect small amounts of carbon and nitrogen. To estimate carbon per pellet, we first subtracted the blank value. Blank values were determined separately for each analytical batch and applied to their associated samples. As a result, blank corrections varied among samples depending on the corresponding batch blank. Ten samples had values ranging from 84-99 µg C filter-1, and the associated blank was 83 µg C filter-1. We thus interpret this as a batch of GFFs with organic carbon contamination, which was corrected using the associated blank. Importantly, the locations with higher carbon per pellet were not those associated with these high blanks, as the contaminated samples were restricted to the AT transect. After subtracting the associated blank, the value was divided by the number of pellets included in the assay. For nitrogen, only 2 blanks were above the detection limit. We averaged these values (0.7) and subtracted this from each sample. The resulting value (minus the blank) was used to calculate nitrogen per pellet. While extreme care was taken in the transfer and estimation of pellet numbers, accurately quantifying the exact number of pellets was sometimes challenging due to pellet fragility (they lack a peritrophic membrane), as some disassemble during transfer, likely contributing to the variability observed. F

BCO-DMO Curation Notes

* Loaded the Cawleyetal_2026_PelletComposition.csv file treating blank values and "nd" as missing data
* Adjusted column names to use consistent, machine-friendly names (no spaces or special characters)
* Corrected the Long_DD longitude values by adding negative signs where needed
* Renamed the final table from cawleyetal_2026_pelletcomposition to 1004254_v1_pelletcomposition

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Data Files

File
1004254_v1_pelletcomposition.csv (Comma Separated Values (.csv), 3.99 KB) MD5:690d64e8f7297fbcb7de88e8ac6e6fc6 Primary data file for dataset ID 1004254, version 1

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Supplemental Files

File
Pellet Composition Images.zip (ZIP Archive (ZIP), 188.63 MB) MD5:dff84df3c36ed5e3236eb1ce780fb12f Images included in the dataset. Filenames correspond to the entries in the “Image” column, allowing users to easily match each image to its corresponding dataset entry.

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Related Publications

Cawley G.F., Matthews, S.A., Llopis-Monferrer, N., Padilla Villa, M., Barbeau, K., & Décima, M.R. (in review). Pyrosoma atlanticum fecal pellet production in the California Current: implications for grazing and carbon export dynamics. In review with Minor Revisions for Limnology and Oceanography.
Results

Drits, A. V., Arashkevich, E. G., & Semenova, T. N. (1992). Pyrosoma atlanticum (Tunicata, Thaliacea): grazing impact on phytoplankton standing stock and role in organic carbon flux. Journal of Plankton Research, 14(6), 799–809. https://doi.org/10.1093/plankt/14.6.799
Results

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Related Datasets

IsRelatedTo

Cawley, G., Decima, M., Barbeau, K., Matthews, S., Llopis Monferrer, N. (2026) **Pyrosome fecal pellet sinking measurements collected from the cruise RR2105 on R/V Roger Revelle in the California Current Ecosystem from July to August 2021.** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2026-08-17 doi:10.26008/1912/bco-dmo.1003542.1 [view at BCO-DMO]
Relationship Description: The "P2107 Pyrosome Fecal Pellet Sinking" dataset provides sinking-rate measurements associated with fecal pellets from the same experimental material used for carbon and nitrogen analyses in this dataset.

Cawley, G., Decima, M., Barbeau, K., Matthews, S., Llopis Monferrer, N., Padilla Villa, M. (2026) **Pyrosome count and length data collected from the cruise RR2105 on R/V Roger Revelle in the California Current Ecosystem from July to August 2021.** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2026-08-17 doi:10.26008/1912/bco-dmo.1003320.1 [view at BCO-DMO]
Relationship Description: Pyrosomes collected and characterized in the "P2107 Pyrosome Length and Abundance" dataset provided the individuals from which fecal pellets were produced for carbon and nitrogen analysis in this dataset.

Cawley, G., Decima, M., Barbeau, K., Matthews, S., Llopis Monferrer, N., Padilla Villa, M. (2026) **Pyrosome fecal pellet biogenic silica measurements collected from the cruise RR2105 on R/V Roger Revelle**

in the California Current Ecosystem from July to August 2021. Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2026-08-14 doi:10.26008/1912/bco-dmo.1004017.1 [view at BCO-DMO]
Relationship Description: This dataset provides carbon and nitrogen measurements that complement the biogenic silica measurements reported for related fecal pellets in the "P2107 Pyrosome Pellet bSi" dataset.

Cawley, G., Decima, M., Barbeau, K., Matthews, S., Llopis Monferrer, N., Padilla Villa, M. (2026) **Pyrosome fecal pellet production measurements collected from the cruise RR2105 on R/V Roger Revelle in the California Current Ecosystem from July to August 2021.** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2026-08-17 doi:10.26008/1912/bco-dmo.1003881.1 [view at BCO-DMO]
Relationship Description: Fecal pellets analyzed for carbon and nitrogen content in this dataset were generated during the "P2107 Pyrosome Fecal Pellet Production Measurements."

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Parameters

Parameter	Description	Units
Cycle	Sampling cycle identifier	unitless
day_sta	Day and/or station identifier	unitless
date	date	unitless
Lat_DD	Latitude in decimal degrees	unitless
Long_DD	Longitude in decimal degress	unitless
Image	Associated image	unitless
pellets	Number of pellets analyzed	unitless
Major_um_average	Major axis average of the group of pellet used	um
delta13C_permil_VPDB	Stable carbon isotope ratio relative to VPDB standard	‰ VPDB
delta15N_permil_AIR	Stable nitrogen isotope ratio relative to AIR standard	‰ AIR
microg_C	Measured carbon mass in micrograms	µg C
microg_C_blank	Carbon mass corrected for blank values	µg C
microg_N	Measured nitrogen mass in micrograms	µg N
microg_N_average_blank	Nitrogen mass corrected for average blank values	µg N
C_N	Atomic carbon-to-nitrogen ratio	atm:atm

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Instruments

Dataset-specific Instrument Name	nanoEA-Delta Plus XP
Generic Instrument Name	Isotope-ratio Mass Spectrometer
Dataset-specific Description	nanoEA-Delta Plus XP
Generic Instrument Description	The Isotope-ratio Mass Spectrometer is a particular type of mass spectrometer used to measure the relative abundance of isotopes in a given sample (e.g. VG Prism II Isotope Ratio Mass-Spectrometer).

Dataset-specific Instrument Name	Reeve Net
Generic Instrument Name	Reeve Net
Dataset-specific Description	Reeve Net with 202-µm mesh and 30L non-filter cod end to collect live pyrosomes.
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)

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Deployments

RR2105

Website	https://www.bco-dmo.org/deployment/926884
Platform	R/V Roger Revelle
Start Date	2021-07-13
End Date	2021-08-13
Description	California Current Ecosystem Long Term Ecological Research Process Cruise, CCE LTER III. Also referred to as "P2107". See more information from R2R: https://www.rvdata.us/search/cruise/RR2105

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Project Information

Collaborative Research: Assessing the causes of the pyrosome invasion and persistence in the California Current Ecosystem (Pyrosomes in the CCE)

Coverage: California Current ecosystem off the U.S. West Coast

NSF Award Abstract:
A key component of the ocean food web is comprised of floating animals, or zooplankton, that transfer energy from phytoplankton to fish, whales, and birds. Zooplankton include many different types of organisms that can be broadly categorized as crustacean or gelatinous, with most fish and whales preferring crustaceans as a fat-rich food source over gelatinous animals, which are higher in water content. Historically, the California Current ecosystem off the U.S. West Coast has been dominated by crustacean zooplankton, such as krill and copepods, but in 2014 there were huge abundances of a type of colonial, gelatinous zooplankton known as pyrosomes, which caused widespread damage to fisheries by fouling fishing gear and dominating catch. Although the arrival of pyrosomes coincided with an extensive marine heatwave, lower abundances have since persisted despite a return to cooler ocean temperatures. Analysis of time series data from the California Cooperative Oceanic Fisheries Investigations (CalCOFI) indicate that pyrosomes were also observed in the California Current many decades ago when the ocean was not particularly warm. This study combines analysis of past samples from CalCOFI, ocean circulation models, and biological models to understand the causes of these quickly growing pyrosome populations in the California Current. It supports training for undergraduate and graduate students. In addition, the project is reaching K-12 students through a unique partnership with the San Diego County Office of Education that is developing Next Generation Science Standards (NGSS)-aligned resources for middle and high school science teachers in California. The educational resources are being disseminated through the California Science Project and California Environmental Literacy Initiative. Public outreach in San Diego (CA) is through the Enhancing Your Horizons San Diego conference and the San Diego Regional Competition of the National Ocean Sciences Bowl, and in Santa Cruz (CA) through the Seymour Marine Discovery Center.

Predicting how ecosystems respond to accelerating climate change is a major challenge. The recent appearance of the pyrosome Pyrosoma atlanticum in the California Current is a major perturbation to the ecosystem, and the cause remains unknown. Both ocean physics and plankton food-web dynamics are key determinants of variability in pelagic community composition in this ecosystem, yet unraveling the degree to which variability in physics (through warming and advection) combines with shifting biological interactions (through nutrient cycling and altered food-web dynamics) to determine composition and function is complicated. This project combines the analysis of past historical samples from seven decades of the CalCOFI time series, data-assimilative and non-data assimilative ocean circulation models, and biological population models to determine the role ocean physics and biological interactions have played in shaping pyrosome abundance, trophic dynamics, and population growth and mortality in the California Current. This novel framework is providing mechanistic understanding that is required to predict how plankton communities respond to climate change.

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-2329559
NSF Division of Ocean Sciences (NSF OCE)	OCE-2224726

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