Log sheets (pdf) of Reeve nets from the Tioga from R/V Tioga cruises in the Wilkinson Basin, Gulf of Maine from 2013-2014 (Gulf of Maine Pteropods project, GoME OA Pteropods project)

Website: https://www.bco-dmo.org/dataset/472512
Version: final
Version Date: 2013-12-02

Project
» Seasonal and Ontogenetic Effects of Ocean Acidification on Pteropods in the Gulf of Maine (Gulf of Maine Pteropods)
» Acidification of the Coastal Ocean: Are deep waters of the Gulf of Maine already corrosive to pteropods? (GoME OA Pteropods)

Program
» Science, Engineering and Education for Sustainability NSF-Wide Investment (SEES): Ocean Acidification (formerly CRI-OA) (SEES-OA)

Contributors	Affiliation	Role
Maas, Amy	Woods Hole Oceanographic Institution (WHOI)	Principal Investigator
Copley, Nancy	Woods Hole Oceanographic Institution (WHOI BCO-DMO)	BCO-DMO Data Manager

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Dataset Description

Hand-written Reeve net logs of wire speed and angle, flow counts, cast comments, taxonomic notes, lists of specimens removed, and plots of temperature and salinity vs. depth when available (pdf)

The objective of Reeve net sampling was to gently collect live specimens to be sampled for physiological and genetic analyses. These trawls were short in duration and aimed to maximize pteropod catch.

Methods & Sampling

A 1-m diameter Reeve net with a 150-um mesh net was deployed via the A-frame. The book-clamp to attach the net was borrowed from the rigging shop. Ship speed during tows was ~1-1.5 knots. The downcast was done at ca. 5 m/min and the upcast at 5 m/min with a tow-yo pattern.

Data Processing Description

In the wet lab, the cod end was promptly divided among a number of buckets. These buckets were individually poured into a white plastic tray for sorting. Since pteropods tend to sink, the bottom buckets were examined first.

See cruise reports for preliminary results of the tows. (Click on Deployment links, below, then Deployment Report URL.)

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Data Files

File
Reeve_logs.csv (Comma Separated Values (.csv), 906 bytes) MD5:f82a8b096dc44873eebbff0748a3e3fd Primary data file for dataset ID 472512

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Parameters

Parameter	Description	Units
cruise_id	cruise identification	unitless

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Instruments

Dataset-specific Instrument Name	Reeve Net
Generic Instrument Name	Reeve Net
Dataset-specific Description	A 1-m diameter Reeve net with a 150-um mesh net was deployed via the A-frame. A bookclamp was used attach the net to the wire.
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

TI668

Website	https://www.bco-dmo.org/deployment/59095
Platform	R/V Tioga
Report	http://bcodata.whoi.edu/GoME_Pteropods/cruise_reports/Tioga668_Cruise_Report_final_Dec.pdf
Start Date	2013-05-21
End Date	2013-05-22
Description	The central goal of this cruise was to sample the carbonate chemistry profile of two sites in the GoME and to document the abundance and vertical distribution of the pteropod species Limacina retroversa. The long-term goal of this research is to understand forcings by climate, enhanced atmospheric CO2 levels, and coastal eutrophication on seasonal and inter-annual variability in carbonate chemistry of the Gulf of Maine and the associated implications to planktonic calcifiers, notably pteropods. The specific goals of this project are to: 1. Quantify seasonal variations of carbonate system parameters and buffer intensity in deep waters of the Gulf of Maine in order to evaluate the sensitivity of these waters in response to acidification due to anthropogenic forcing, such as increase in atmospheric CO2, freshening of the GoME (decrease in total alkalinity) and increases in water-column respiration due to eutrophication. We will test the hypotheses that deep waters of the GoME are already seasonally under-saturated with respect to aragonite saturation state, and that these waters have low buffer intensity compared to overlying water, which would cause them to be more susceptible to acidification pressures and to reach critical ecological thresholds (OA < 1) more readily. 2. Quantify seasonal patterns in the abundance of the pteropod Limacina retroversa and its vertical distribution relative to concurrent measurements of water column chemical properties, testing the hypothesis that this species is absent in the acidic waters of the near-bottom nepheloid layer. The specific goals of this particular cruise were to: 1. Measure the carbonate chemistry of the water column at multiple sites in the Gulf of Maine, targeting regions where there the depth is greatest and the deep waters are mostly likely to be undersaturated 2. Measure the carbonate chemistry in the nephloid layer 3. Catch pteropods with a vertically stratified net system to quantify their size class, abundance and vertical distribution in the context of the carbonate chemistry. 4. Collect surface water and pteropods to test out methods for shell (70% ethanol), physiology (live) and gene expression studies (RNAlater). DMO NOTE: Revised cruise report with updated eventlog submitted 20 Dec. 2013.

TI700

Website	https://www.bco-dmo.org/deployment/472226
Platform	R/V Tioga
Report	http://bcodata.whoi.edu/GoME_Pteropods/cruise_reports/Tioga700_Cruise_Report_final.pdf
Start Date	2013-08-27
End Date	2013-08-28
Description	The central goal of this cruise was to sample the carbonate chemistry profile of two sites in the GoME and to document the abundance and vertical distribution of the pteropod species Limacina retroversa. The long-term goal of this research is to understand forcings by climate, enhanced atmospheric CO2 levels, and coastal eutrophication on seasonal and inter-annual variability in carbonate chemistry of the Gulf of Maine and the associated implications to planktonic calcifiers, notably pteropods. The specific goals of this project are to: 1. Quantify seasonal variations of carbonate system parameters and buffer intensity in deep waters of the Gulf of Maine in order to evaluate the sensitivity of these waters in response to acidification due to anthropogenic forcing, such as increase in atmospheric CO2, freshening of the GoME (decrease in total alkalinity) and increases in water-column respiration due to eutrophication. We will test the hypotheses that deep waters of the GoME are already seasonally under-saturated with respect to aragonite saturation state, and that these waters have low buffer intensity compared to overlying water, which would cause them to be more susceptible to acidification pressures and to reach critical ecological thresholds (OA < 1) more readily. 2. Quantify seasonal patterns in the abundance of the pteropod Limacina retroversa and its vertical distribution relative to concurrent measurements of water column chemical properties, testing the hypothesis that this species is absent in the acidic waters of the near-bottom nepheloid layer. The specific goals of this particular cruise were to: 1. Measure the carbonate chemistry of the water column at multiple sites in the Gulf of Maine, targeting regions where there the depth is greatest and the deep waters are mostly likely to be undersaturated 2. Measure the carbonate chemistry in the nephloid layer 3. Catch pteropods with a vertically stratified net system to quantify their size class, abundance and vertical distribution in the context of the carbonate chemistry. 4. Collect surface water and pteropods to test out methods for shell (70% ethanol), physiology (live) and gene expression studies (RNAlater).

TI715

Website	https://www.bco-dmo.org/deployment/472270
Platform	R/V Tioga
Report	http://bcodata.whoi.edu/GoME_Pteropods/cruise_reports/Tioga715_Cruise_Report_final.pdf
Start Date	2013-10-21
End Date	2013-10-23
Description	The central goal of this cruise was to sample the carbonate chemistry profile of two sites in the GoME and to document the abundance and vertical distribution of the pteropod species Limacina retroversa. The long-term goal of this research is to understand forcings by climate, enhanced atmospheric CO2 levels, and coastal eutrophication on seasonal and inter-annual variability in carbonate chemistry of the Gulf of Maine and the associated implications to planktonic calcifiers, notably pteropods. The specific goals of this project are to: 1. Quantify seasonal variations of carbonate system parameters and buffer intensity in deep waters of the Gulf of Maine in order to evaluate the sensitivity of these waters in response to acidification due to anthropogenic forcing, such as increase in atmospheric CO2, freshening of the GoME (decrease in total alkalinity) and increases in water-column respiration due to eutrophication. We will test the hypotheses that deep waters of the GoME are already seasonally under-saturated with respect to aragonite saturation state, and that these waters have low buffer intensity compared to overlying water, which would cause them to be more susceptible to acidification pressures and to reach critical ecological thresholds (OA < 1) more readily. 2. Quantify seasonal patterns in the abundance of the pteropod Limacina retroversa and its vertical distribution relative to concurrent measurements of water column chemical properties, testing the hypothesis that this species is absent in the acidic waters of the near-bottom nepheloid layer. The specific goals of this particular cruise were to: 1. Measure the carbonate chemistry of the water column at multiple sites in the Gulf of Maine, targeting regions where there the depth is greatest and the deep waters are mostly likely to be undersaturated 2. Measure the carbonate chemistry in the nephloid layer 3. Catch pteropods with a vertically stratified net system to quantify their size class, abundance and vertical distribution in the context of the carbonate chemistry. 4. Collect surface water and pteropods to test out methods for shell (70% ethanol), physiology (live) and gene expression studies (RNAlater).

TI729

Website	https://www.bco-dmo.org/deployment/506265
Platform	R/V Tioga
Report	http://bcodata.whoi.edu/GoME_Pteropods/cruise_reports/Tioga729_Cruise_Report.pdf
Start Date	2014-01-29
End Date	2014-01-30
Description	The central goal of this cruise was to document the abundance and vertical distribution of the pteropod species Limacina retroversa, to capture live individuals for experimentation, and to sample the carbonate chemistry profile of two sites in the Gulf of Maine.

TI725

Website	https://www.bco-dmo.org/deployment/491406
Platform	R/V Tioga
Report	http://bcodata.whoi.edu/GoME_Pteropods/cruise_reports/Tioga725_Cruise_Report.pdf
Start Date	2014-01-10
End Date	2014-01-10
Description	Cruise to collect live Limacina retroversa pteropods for physiological studies.

TI746

Website	https://www.bco-dmo.org/deployment/517985
Platform	R/V Tioga
Report	http://bcodata.whoi.edu/GoME_Pteropods/cruise_reports/Tioga746_Cruise_Report_V3.pdf
Start Date	2014-04-25
End Date	2014-04-27
Description	The central goal of this cruise was to document the abundance and vertical distribution of the pteropod species Limacina retroversa, to capture live individuals for experimentation, and to sample the carbonate chemistry profile of two sites in the GoME.

TI777

Website	https://www.bco-dmo.org/deployment/539885
Platform	R/V Tioga
Report	http://bcodata.whoi.edu/GoME_Pteropods/cruise_reports/Tioga777_Cruise_Report.pdf
Start Date	2014-08-19
End Date	2014-08-20
Description	Live capture of pteropod Limacina retroversa for experiments and water sampling for carbonate chemistry profile.

TI787

Website	https://www.bco-dmo.org/deployment/562792
Platform	R/V Tioga
Report	http://bcodata.whoi.edu/GoME_Pteropods/cruise_reports/Tioga787_Cruise_Report.pdf
Start Date	2014-11-04
End Date	2014-11-06
Description	Live capture of pteropod Limacina retroversa for experiments and water sampling for carbonate chemistry profile and MOCNESS tow for later analysis of pteropod community. [underway data not available at this time: 2015-07-28]

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Project Information

Seasonal and Ontogenetic Effects of Ocean Acidification on Pteropods in the Gulf of Maine (Gulf of Maine Pteropods)

Website: http://www.whoi.edu/people/glawson/

Coverage: Gulf of Maine

This project will involve a series of five short cruises in 2013 and 2014, during which a variety of hydrographic, chemical, and biological data and samples will be collected, as well as a number of laboratory experiments examining pteropod physiology and gene expression.

From NSF proposal abstract:

Dissolution of excess anthropogenic CO2 into the ocean is causing the marine environment to decrease in pH. This "ocean acidification" is predicted to threaten a broad variety of marine organisms, particularly calcifying animals such as the thecosome (i.e., shelled) pteropods. These pelagic gastropods form an aragonite shell, are prey for a number of commercially important fish, and are significant contributors to carbon biogeochemistry. Their ecosystem importance, abundance, and sensitivity to dissolution position them as an important group for investigating the impacts of acidification. Our understanding of the effect of high CO2 on pteropods and the pelagic ecosystem, however, is limited primarily to short-term studies of adult calcification and respiration response in the polar ecosystems. There have been no seasonal studies of sensitivity and our understanding of the effect of CO2 on pteropod early life stages is limited. Limacina retroversa is a particularly abundant thecosome pteropod in the North Atlantic, where it is prey for a number of fisheries species and other top predators. This species is also the most common pteropod in the Gulf of Maine (GoM) where it is present year round. L. retroversa thus offers the prospect of a useful model pteropod species, given both its ecological importance and its abundance in readily accessible waters. The investigators will conduct a series of short cruises to sample L. retroversa on a seasonal basis from local waters of the GoM near Cape Cod. The carbonate chemistry of the GoM fluctuates seasonally, providing the opportunity to assess the response of wild caught pteropods to natural changes in CO2. By characterizing the carbonate chemistry of the water column and measuring the metabolic rate, shell quality, and gene expression of pteropods throughout the year, the researchers will achieve a time series of pteropod sensitivity to CO2. Subsequently, using experimental manipulations the investigators will explore the effect of seasonal acclimation on pteropod response to short- and medium-term exposure to enhanced CO2. Pteropods frequently lay eggs in captivity, and at WHOI there is institutional expertise in maintaining these individuals in the laboratory. Building on these strengths, the researchers will also study the effect of CO2 on embryonic and larval development in L. retroversa. These earliest life-stages of marine calcifiers are thought to be especially sensitive since initial shell precipitation and the highly energetic processes of growth and development are impeded by CO2 exposure. They will also document mortality, shell production, abnormality, and developmental rate of clutches of pteropod embryos exposed to increased CO2.

Intellectual Merit: Thecosome pteropods are an abundant group of calcifying zooplankters that have been chronically understudied, particularly in temperate regions. Due to its accessibility and ecological importance, L. retroversa can be developed as a valuable model, interesting both as the dominant pteropod in the commercially-important GoM region and also an abundant pteropod in the temperate waters of the North Atlantic. The goal of this research is to augment our knowledge of the distribution of L. retroversa, to attain an understanding of their seasonal sensitivity to natural variability in CO2, and to see how this exposure impacts responses to both short- and medium-term CO2 exposure. Using powerful transcriptomic technologies, the research will transform our understanding of this group by investigating the molecular mechanisms of response in L. retroversa to both seasonality and varying durations and intensities of acidification, contextualized by ecosystem- and organism-level metrics. Furthermore the study will examine the effect of CO2 on the eggs of pteropods for the first time, providing insight into their sensitivity to an acidifying environment.

Acidification of the Coastal Ocean: Are deep waters of the Gulf of Maine already corrosive to pteropods? (GoME OA Pteropods)

Coverage: Gulf of Maine

ABSTRACT

As a result of increases in atmospheric carbon dioxide (CO2), the ocean is taking up extra CO2 and becoming more acidic, in a process referred to as ocean acidification (OA). Certain coastal regions, such as the upwelling system along the U.S. West Coast, are more susceptible to the effects of ocean acidification than others, because their waters are naturally low in pH and saturation of aragonite (a calcium carbonate mineral), but higher CO2 concentration, at least at some times of year. In such OA ‘hot-spots’, continued anthropogenic perturbations to the carbonate chemistry will quickly push the system towards a more corrosive (aragonite under-saturated, OA < 1) environment that many calcium carbonate shell-forming organisms may not tolerate. Coastal acidification in the Gulf of Maine (GoME) has generally not been considered to be a pressing concern, but new data collected by our group and collaborators suggest that in the deep waters of the GoME low seawater pH may cause aragonite saturation states (OA) to be close to a chemical and ecological threshold (i.e. OA = 1). Currently, there are no year-round CO2 system measurements to assess conclusively whether the deep waters in the GoME are already experiencing seasonal OA under-saturation. If seasonal undersaturation is present, however, this may have detrimental consequences to thecosome pteropods, a group of aragonite

shell-forming zooplankton that are important members of the pelagic food web and key contributors to biogeochemical cycles.

We propose an interdisciplinary project aiming to assess seasonal variations of the CO2 system in the deep GoME and the associated impacts on thecosome pteropods. The main objectives of this project are to: (1) investigate if deep waters of the GoME are already seasonally under-saturated with respect to aragonite saturation state, and if these waters are more susceptible to acidification pressures; (2) quantify seasonal patterns in the abundance of the most common thecosome pteropod in the GoME, Limacina retroversa, and examine the impacts of potential under-saturation of aragonite on its vertical distribution; (3) investigate the physiological response of the animal to its chemical environment. Demonstration that the deep waters of the GoME are already seasonally undersaturated with respect to aragonite would be an important development. If the GoME does indeed qualify as a coastal acidification 'hot spot,' the proposed study would undoubtedly have significant implications for future funding of coastal acidification research in the GoME.

OBJECTIVES

The long-term goal of this research is to understand forcing by climate, enhanced atmospheric CO2 levels, and coastal eutrophication, on seasonal and inter-annual variability in carbonate chemistry of the Gulf of Maine and the associated implications to planktonic calcifiers, notably pteropods. The specific goals of this project are to:

1. Quantify seasonal variations of carbonate system parameters and buffer intensity in deep waters of the Gulf of Maine in order to evaluate the sensitivity of these waters in response to acidification due to anthropogenic forcing, such as increase in atmospheric CO2, freshening of the GoME (decrease in total alkalinity) and increases in water-column respiration due to eutrophication. We will test the hypotheses that deep waters of the GoME are already seasonally under-saturated with respect to aragonite saturation state, and that these waters have low buffer intensity compared to overlying water, which would cause them to be more susceptible to acidification pressures and to reach critical ecological thresholds (OA < 1) more readily.

2. Quantify seasonal patterns in the abundance of the pteropod Limacina retroversa and its vertical distribution relative to concurrent measurements of water column chemical properties, testing the hypothesis that this species is absent in the acidic waters of the near-bottom nepheloid layer.

3. Measure variations in L retroversa metabolic rate as a function of local microenvironments of the Gulf of Maine, controlling temperature and carbonate chemistry in the lab to recreate conditions naturally experienced by the pteropods at shallow and deep depths in the water column, testing whether there is a physiological response of the animals to their chemical environment.

PROPOSED RESEARCH

We propose three 2-day research cruises on the R/V Tioga to the deep portions of Wilkinson Basin (~300m) in the GoME, targeting the time periods of late spring/early summer, late summer/early fall, and late fall/early winter when aragonite under-saturation is most likely. During each cruise, full water-column CTD casts will be taken at two or more stations near the deepest part of the basin, along with in-situ measurements of O2 and particle backscatter (to identify the bottom nepheloid layer). We will make bottle measurements of DIC, TA, and pH. This will allow us to fully define the seawater CO2 system for calculation of OA and various buffer factors (Egleston et al. 2010), which characterize the sensitivity of seawater against changes in acidity (pH), and OA under acidification. Underway measurements of pCO2, DIC, pH, fluorescence, and CTD will also be made along the cruise track to identify productive waters.

At each station, pteropods will be sampled with a ¼-m2 Multiple Opening/Closing Net and Environmental Sensing System (MOCNESS) with six 150-µm mesh nets. MOCNESS tows will be performed immediately after CTD casts and will target depth layers chosen based on examination of the CTD's dissolved oxygen, and transmissometry data as indices of chemical conditions, such that some nets will sample exclusively within the nepheloid layer, as well as at shallower intervals. A subset of captured pteropods will be picked out of the samples and transported alive in 1-L jars to WHOI. The remainder of each sample will be preserved in 95% ethanol for later quantification of abundance and size.

Profiles will be made with a Video Plankton Recorder to further quantify pteropod abundance and vertical distribution, and to quantify particle abundance for our collaborator C. Pilskaln. Prof. Pilskaln or one of her graduate students will participate in the cruises at no-cost to this project, and will collect large-volume (5-10 L) filtered particle samples from Niskin bottles triggered in the nearbottom particle resuspension (i.e., nepheloid) layer. Prof. Pilskaln's measurements will thus target the particulate fraction and help constrain the overall water column carbonate budget. Water will also be collected for use in later metabolic lab studies.

Pteropods transported to WHOI will be used in laboratory studies of acute metabolic effects of high CO2/low pH. After an 8 hour acclimation period to clear their guts, individual animals will be exposed in respiration chambers for 48 hours to conditions recreating the temperature and carbonate chemistry of deep and shallow portions of the water column (created starting with water collected at the point of capture). Rates of respiration and ammonia excretion in manipulated and control animals will be measured following standard techniques (see Maas et al., 2012).

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Program Information

Science, Engineering and Education for Sustainability NSF-Wide Investment (SEES): Ocean Acidification (formerly CRI-OA) (SEES-OA)

Website: https://www.nsf.gov/funding/pgm_summ.jsp?pims_id=503477

Coverage: global

NSF Climate Research Investment (CRI) activities that were initiated in 2010 are now included under Science, Engineering and Education for Sustainability NSF-Wide Investment (SEES). SEES is a portfolio of activities that highlights NSF's unique role in helping society address the challenge(s) of achieving sustainability. Detailed information about the SEES program is available from NSF (https://www.nsf.gov/funding/pgm_summ.jsp?pims_id=504707).

In recognition of the need for basic research concerning the nature, extent and impact of ocean acidification on oceanic environments in the past, present and future, the goal of the SEES: OA program is to understand (a) the chemistry and physical chemistry of ocean acidification; (b) how ocean acidification interacts with processes at the organismal level; and (c) how the earth system history informs our understanding of the effects of ocean acidification on the present day and future ocean.

Solicitations issued under this program:
NSF 10-530, FY 2010-FY2011
NSF 12-500, FY 2012
NSF 12-600, FY 2013
NSF 13-586, FY 2014
NSF 13-586 was the final solicitation that will be released for this program.

PI Meetings:
1st U.S. Ocean Acidification PI Meeting(March 22-24, 2011, Woods Hole, MA)
2nd U.S. Ocean Acidification PI Meeting(Sept. 18-20, 2013, Washington, DC)
3rd U.S. Ocean Acidification PI Meeting (June 9-11, 2015, Woods Hole, MA – Tentative)

NSF media releases for the Ocean Acidification Program:

Press Release 10-186 NSF Awards Grants to Study Effects of Ocean Acidification

Discovery Blue Mussels "Hang On" Along Rocky Shores: For How Long?

Discovery nsf.gov - National Science Foundation (NSF) Discoveries - Trouble in Paradise: Ocean Acidification This Way Comes - US National Science Foundation (NSF)

Press Release 12-179 nsf.gov - National Science Foundation (NSF) News - Ocean Acidification: Finding New Answers Through National Science Foundation Research Grants - US National Science Foundation (NSF)

Press Release 13-102 World Oceans Month Brings Mixed News for Oysters

Press Release 13-108 nsf.gov - National Science Foundation (NSF) News - Natural Underwater Springs Show How Coral Reefs Respond to Ocean Acidification - US National Science Foundation (NSF)

Press Release 13-148 Ocean acidification: Making new discoveries through National Science Foundation

research grants

Press Release 13-148 - Video nsf.gov - News - Video - NSF Ocean Sciences Division Director David Conover answers questions about ocean acidification. - US National Science Foundation (NSF)

Press Release 14-010 nsf.gov - National Science Foundation (NSF) News - Palau's coral reefs surprisingly resistant to ocean acidification - US National Science Foundation (NSF)

Press Release 14-116 nsf.gov - National Science Foundation (NSF) News - Ocean Acidification: NSF awards $11.4 million in new grants to study effects on marine ecosystems - US National Science Foundation (NSF)

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Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-1316040
WHOI (WHOI - internal)	COI-2012: Wang,Lawson,Maas

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