Organismal physiological metrics from time series experiments on samples collected on R/V Atlantic Explorer cruise AE1910 in May 2019

Website: https://www.bco-dmo.org/dataset/829777
Data Type: Cruise Results
Version: 1
Version Date: 2021-01-19

Project
» Collaborative Research: Diel physiological rhythms in a tropical oceanic copepod (Zooplankton Diel Rhythm)

Contributors	Affiliation	Role
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Abstract
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Coverage

Spatial Extent: **N**:32.5868 **E**:-64.46173 **S**:32.1311 **W**:-64.7883
Temporal Extent: 2019-05-20 - 2019-05-23

Acquisition Description

Methods detailed in Tarrant, A. M., N. McNamara-Bordewick, L. Blanco-Bercial, A. Miccoli, and A. E. Maas. in review. Oceanic Copepods Fine-Tune Their Metabolism During Diel Vertical Migration.

Briefly, *Pleuromamma xiphias* were collected offshore from the Bermuda Institute of Ocean Sciences (BIOS) during a cruise aboard the R/V Atlantic Explorer from May 20-22, 2019. Net tows were conducted

at 12 time points, spaced 4-7 hours apart to target mid-day, early night, mid-night and morning. Nighttime tows (early- and mid-night) were conducted using a 1-m² Reeve net deployed to 200 m depth, with 150 µm mesh size, 20 L cod end, and a miniSTAR-ODDI pressure and depth sensor. Daytime tows (morning and afternoon) were conducted using a 1-m² MOCNESS with 150 µm mesh size and a custom thermally-insulated closing cod with one closing net sampling from 400-600 m. Because the cruise coincided with Tropical Storm Andrea, it was necessary to relocate the ship twice to avoid high winds and continue sampling. The latitude, longitude, date and time (local) for each tow details this relocation. After each tow, copepods were examined under a Leica M205 C stereo microscope to identify adult P. xiphias and determine their gender. Copepods were used immediately for respirometry and excretion measurements.

Water for physiological experiments was obtained daily from 200 m using the rosette on the CTD. It was gravity filtered past a 0.2 µm Supor filter in a Georig 142 mm filter holder and equilibrated to 20°C in an upright incubator. At each time point, up to six copepods were transferred into individual respiration chambers that consisted of 50 mL glass syringes containing an optically sensitive oxygen sensor (OXFOIL: PyroScience, Aachen Germany) and 30 mL of 0.2 µm filtered seawater. Oxygen concentration in each chamber was then measured non-invasively and continuously (every 60 seconds) for approximately 3 hours using two FireSting optical oxygen meters (PyroScience, Aachen Germany). At the end of the experiment, the chambers were visually inspected to ensure that the copepods were still swimming. A 15-mL subsample of water was filtered at a 30º upward angle (to avoid damaging copepods or fecal pellets) through 0.7 µm GFF filters into 15-mL conical vials that had been pre-treated with OPA working reagent (21 mM sodium tetraborate, 0.063 mM sodium sulfite, 50 mL L^1 o-phthalaldehyde in ethanol). This filtered water was refrigerated (4°C) for less than 24 h and then run for ammonium measurements at sea. Ammonium was measured using the OPA (o-phthalaldehyde) method (Holmes et al. 1999). The copepod and any fecal pellets from each chamber were rinsed into a petri dish. Any fecal pellets were counted and photographed under a stereomicroscope. Copepods were rinsed once in DI water and frozen at -80ºC. Frozen copepods were subsequently weighed on a Mettler-Toledo XPR microbalance, dried, and reweighed.

Processing Description

BCO-DMO Processing:
- converted latitude and longitude from degrees and decimal minutes to decimal degrees;
- added ISO8601 date/time field.

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Related Publications

Holmes, R. M., Aminot, A., Kérouel, R., Hooker, B. A., & Peterson, B. J. (1999). A simple and precise method for measuring ammonium in marine and freshwater ecosystems. Canadian Journal of Fisheries and Aquatic Sciences, 56(10), 1801–1808. doi:10.1139/f99-128
Methods

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Parameters

Parameter	Description	Units
Sample_ID	Sample ID	unitless
net_recovery_date	Net recovery date; format: MM/DD/YYYY (in the local time zone, Atlantic Standard Time)	unitless
net_recovery_time	Net recovery time; format: hh:mm (in the local time zone, Atlantic Standard Time)	unitless
lat	Latitude	degrees North
long	Longitude	degrees East
Setup_time	Setup time; format: hh:mm (in the local time zone, Atlantic Standard Time)	unitless
Gender	Gender (M or F)	unitless
mL	Sample volume	milliliters (mL)
duration	Duration	hours
Wet_weight	Wet weight	milligrams (mg)
Dry_weight	Dry weight	milligrams (mg)
O2	Respiration rate	micromoles O2 per hour per liter (umol O2 h-1 L-1)
mO2	Mass specific respiration rate	micromoles O2 per hour per milligram (umol O2 h-1 mg-1)
NH4	Ammonium excretion rate	micromoles NH4 per liter (umol NH4 L-1)
mNH4	Mass specific ammonium excretion rate	micromoles NH4 per hour per milligram (umol NH4 h-1 mg-1)
O_N	O:N ratio	unitless
FP	Fecal Pellet production	pellets
net_recovery_ISO_DateTime_UTC	Net recovery date and time (UTC) in ISO8601 format: YYYY-MM-DDThh:mmZ	unitless

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Instruments

Dataset-specific Instrument Name	
Generic Instrument Name	Niskin bottle
Dataset-specific Description	Water for physiological experiments was obtained daily from 200 m using the rosette on the CTD.
Generic Instrument Description	A Niskin bottle (a next generation water sampler based on the Nansen bottle) is a cylindrical, non-metallic water collection device with stoppers at both ends. The bottles can be attached individually on a hydrowire or deployed in 12, 24, or 36 bottle Rosette systems mounted on a frame and combined with a CTD. Niskin bottles are used to collect discrete water samples for a range of measurements including pigments, nutrients, plankton, etc.

Dataset-specific Instrument Name	Reeve net
Generic Instrument Name	Reeve Net
Dataset-specific Description	Nighttime tows (early- and mid-night) were conducted using a 1-m² Reeve net deployed to 200 m depth, with 150 µm mesh size, 20 L cod end, and a miniSTAR-ODDI pressure and depth sensor.
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	Turner fluorometer with Amonium module
Generic Instrument Name	Fluorometer
Generic Instrument Description	A fluorometer or fluorimeter is a device used to measure parameters of fluorescence: its intensity and wavelength distribution of emission spectrum after excitation by a certain spectrum of light. The instrument is designed to measure the amount of stimulated electromagnetic radiation produced by pulses of electromagnetic radiation emitted into a water sample or in situ.

Dataset-specific Instrument Name	1-m2 MOCNESS
Generic Instrument Name	MOCNESS
Dataset-specific Description	Daytime tows (morning and afternoon) were conducted using a 1-m² MOCNESS with 150 um mesh size and a custom thermally-insulated closing cod with one closing net sampling from 400-600 m.
Generic Instrument Description	The Multiple Opening/Closing Net and Environmental Sensing System or MOCNESS is a family of net systems based on the Tucker Trawl principle. There are currently 8 different sizes of MOCNESS in existence which are designed for capture of different size ranges of zooplankton and micro-nekton Each system is designated according to the size of the net mouth opening and in two cases, the number of nets it carries. The original MOCNESS (Wiebe et al, 1976) was a redesigned and improved version of a system described by Frost and McCrone (1974).(from MOCNESS manual) This designation is used when the specific type of MOCNESS (number and size of nets) was not specified by the contributing investigator.

Dataset-specific Instrument Name	miniSTAR-ODDI
Generic Instrument Name	Pressure Sensor
Dataset-specific Description	Nighttime tows (early- and mid-night) were conducted using a 1-m² Reeve net deployed to 200 m depth, with 150 um mesh size, 20 L cod end, and a miniSTAR-ODDI pressure and depth sensor.
Generic Instrument Description	A pressure sensor is a device used to measure absolute, differential, or gauge pressures. It is used only when detailed instrument documentation is not available.

Dataset-specific Instrument Name	FireSting optical oxygen meters
Generic Instrument Name	Dissolved Oxygen Sensor
Dataset-specific Description	Oxygen concentration in each chamber was then measured non-invasively and continuously (every 60 seconds) for approximately 3 hours using two FireSting optical oxygen meters (PyroScience, Aachen Germany).
Generic Instrument Description	An electronic device that measures the proportion of oxygen (O2) in the gas or liquid being analyzed

Dataset-specific Instrument Name	Mettler-Toledo XPR microbalance
Generic Instrument Name	Scale
Dataset-specific Description	Frozen copepods were weighed on a Mettler-Toledo XPR microbalance.
Generic Instrument Description	An instrument used to measure weight or mass.

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Deployments

AE1910

Website	https://www.bco-dmo.org/deployment/772516
Platform	R/V Atlantic Explorer
Report	http://datadocs.bco-dmo.org/docs/Zooplankton_Diel_Rhythm/data_docs/AE1910_Cruise_report_ZDR.pdf
Start Date	2019-05-20
End Date	2019-05-23
Description	Additional cruise data may be available from the Rolling Deck to Repository (R2R): https://www.rvdata.us/search/cruise/AE1910

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Project Information

Collaborative Research: Diel physiological rhythms in a tropical oceanic copepod (Zooplankton Diel Rhythm)

Coverage: Bermuda

NSF Award Abstract:
The daily vertical migration (DMV) of zooplankton and fish across hundreds of meters between shallow and deep waters is a predominant pattern in pelagic ecosystems. This migration has consequences for biogeochemical cycling as it moves a substantial portion of fixed carbon and nitrogen (an estimated 15 to 40 % of the total global organic export) from the surface directly to depth where it feeds the midwater food chain and sequesters nutrients away from atmospheric mixing. Estimates and predictions of these fluxes are, however, poorly understood at present. New observations have shown that one source of uncertainty is due to the assumption that metabolic rates and processes do not vary over the course of the day, except based on changes in temperature and oxygen availability. Rates are, however, also driven by differences in feeding, swimming behavior, and underlying circadian cycles. The objective of this project is to improve the ability of scientists to understand and predict zooplankton contributions to the movement of carbon and nitrogen in the ocean by detailing daily changes in physiological processes of these organisms. By producing a set of respiration and excretion measurements over a daily time series, paired with simultaneously collected gene and protein expression patterns for an abundant vertically migratory species, the investigators will provide unprecedented and predictive insight into how changes in the environment affect the contribution of zooplankton to biogeochemical fluxes. The sampling design of the project will advance discovery and understanding by providing hands-on training opportunities to at least

two undergraduate researchers. The project will broaden dissemination of the research via development of an educational module, focusing on rhythms in the ocean. The module will initially be piloted with the Bermuda Institute of Ocean Sciences (BIOS) summer camp students and then disseminated through the BIOS Explorer program, the Teacher Resources Page on the BIOS website, and published in a peer-reviewed educational journal.

This project will characterize the metabolic consequences of daily physiological rhythms and DVM for a model zooplankton species, the abundant subtropical copepod Pleuromamma xiphias. Flux processes (oxygen consumption, carbon dioxide production, production of ammonium and fecal pellet production) will be interrogated using directed experiments testing the effects of temperature, feeding and circadian cycle. Circadian cycling will further be examined using transcriptomic and proteomic profiling. These experiments will be related to field samples taken at 6-h intervals over the course of the diel migration using an integrated suite of molecular and organismal metrics. Combined organismal, transcriptomic and proteomic profiles will provide an understanding of which metabolic pathways and associated flux products vary in relation to particular environmental variables (food, light cycle, temperature). Diel variation in metabolic rates will also be assessed across seasons and species using other important migratory groups (pteropod, euphausiid, and another copepod). The metabolic data will then be contextualized with abundance estimates from archived depth-stratified tows to allow scaling to community-level patterns and will be used to improve calculations of zooplankton contribution to particulate organic carbon, nitrogen and respiratory active flux. The results of this study will both improve our flux estimates and provide predictive insight into how various environmental variables influence the underlying physiological pathways generating carbon and nitrogen flux.

Cruise reports are available from the completed cruises:
SD031019
AE1910
AE1918

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Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-1829318
NSF Division of Ocean Sciences (NSF OCE)	OCE-1829378

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