Neocalanus body and lipid sac morphometrics from zooplankton samples collected during Seward Line cruises in the Northern Gulf of Alaska from 2018 to 2020

Website: https://www.bco-dmo.org/dataset/936158
Data Type: Cruise Results
Version: 1
Version Date: 2024-08-23

Project
» Collaborative Research: Molecular profiling of the ecophysiology of dormancy induction in calanid copepods of the Northern Gulf of Alaska LTER site (Diapause preparation)

Contributors	Affiliation	Role
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Abstract
We examined the variability of lipid sac content in three species of Neocalanus copepod collected in the Northern Gulf of Alaska over spring, summer, and fall during 2018-2020. Neocalanus were sorted and imaged from zooplankton samples collected along the Seward Line and within the Prince William Sound during 2018-2020. Lipid sac area, lipid sac volume and percent lipid were used to assess lipid content and variability among the metrics. For all species, lipid content increased with increasing stage and concurrently, prosome length.

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Coverage

Location: North Gulf of Alaska , 59N 148W - 0-4400m
Spatial Extent: **N**:60.6 **E**:-147.6 **S**:57.75 **W**:-149.5
Temporal Extent: 2018-04-20 - 2018-09-30

Methods & Sampling

Zooplankton samples were collected on NGA-LTER cruises along the Seward Line and within PWS during the summer, spring, and fall of 2018-20 aboard the R/V *Sikuliaq*, R/V *Tiglax* or the R/V *Woldstad*. During spring and summer cruises copepods were collected using a Quad net, a modified CalVet net (0.25 m mouth diameter, 1 m cylinder and 1.5 m cone), of 150-µm mesh hauled vertically from 100 m during the day, then live sorted and imaged. During summer 2019, animals were also collected during the night in the drogue net (0-200 m) of a towed Midi Multinet (0.25 m^2) (Hydro-Bios, Germany), equipped with 500-µm mesh nets, and live sorted and imaged the following morning. The towed Multinet fished five discrete depth layers including: 0-20, 20-40, 40-60, 60-100, and 100-200 m. During summer 2020, we employed a vertically-hauled Midi Multinet of 150-µm mesh (fished during the day) for these same strata that were live-sorted and imaged immediately after collection to improve specimen quality. During summer and fall of all years at one or two deep-water Seward Line stations, and one or two PWS stations, we also fished the vertically-hauled Multinet at four additional depths: 200-300, 300-400, 400-600 and 600-1200 m (or 600-720 for PWS). A flowmeter installed in each net quantified the volume of water filtered. We targeted *Neocalanus flemingeri*, *Neocalanus plumchrus* and *Neocalanus cristatus* for sorting, staging, and imaging from each of these strata.

Up to 60 individuals of each stage for each species were analyzed, if present. The *Neocalanus* specimens were selected individually from homogenized temperature-regulated subsamples using a ladle or wide-bore plastic pipette. Only living, apparently undamaged individuals with intact lipid sacs were sorted and imaged using a Leica MZ16 microscope with either a Spot 4Mpx, Jenoptik 8Mpx, or Spot 12Mpx digital camera. Depending on stage and species, just prior to imaging three to fifteen animals were placed in a chilled embryo dish then water was reduced so animals shifted onto their sides (with gentle manipulation as needed). For every magnification setting, a calibration scale bar was added to the images. In cases where availability of animals was limited, animals with compromised lipid sacs were imaged to establish prosome length only. The calibrated images were later analyzed using Spot Software (V4.7 or 5.3) for determination of the prosome length (measured as maximum) and prosome width (measured from top of prosome to base of maxillipeds), the lipid sac length (measured from most anterior point to most posterior point), and lipid sac width (measured starting at the point closest to the base of the maxillipeds (ventral point) to most dorsal point). Animals that showed signs of compromised lipid sacs upon image inspection were only measured for prosome length. Adobe Photoshop (version CS6) was utilized to measure lipid sac area using the quick select tool to help demarcate the perimeter of the lipid sac. The number of pixels within the perimeter of the lipid sac was converted to area (mm^2) using the pixel-to-µm calibration associated with each image.

To calculate lipid sac volume, we first assumed the lipid sac to be a cylinder. We used the measured lipid sac length and the measured lipid sac area to find the average diameter of the cylinder (i.e. area divided by length) in order to account for the varying height and shape of the lipid sac. We then used this average diameter to estimate the volume of the lipid sac. Body volume wa calcualted at a oblate spheroid from prosome length and prosome height.

Species List:

Scientfic_Name, Lifesciences Identifier (LSID)
Neocalanus flemingeri, urn:lsid:marinespecies.org:taxname:353708
Neocalanus plumchrus, urn:lsid:marinespecies.org:taxname:196772
Neocalanus cristatus, urn:lsid:marinespecies.org:taxname:104470

BCO-DMO Processing Description

BCO-DMO Data Manager Processing Notes:
* Data from source file lipid.data.final 2024.csv were imported into the BCO-DMO data system. csv downloads of these data will have the name "936158_v1_neocalanus-lipids-and-morphometrics.csv."
* Parameters (column names) renamed to comply with BCO-DMO naming conventions. See https://www.bco-dmo.org/page/bco-dmo-data-processing-conventions

* ISO_DateTime_UTC column added. Converted from DateTime (Alaska local time AKST/AKDT in excel numeric format) to human readable date in ISO 8601 format timestamp with timezone (UTC as Z).

* decimals in columns (LipidArea, AdjustedHeight, LipidVolume, BodyVolume, Lipid_percent_BodyVolume) greater than 4 decimal places were rounded to 4 decimal places.

* Missing data in the BCO-DMO system displays as a blank (null values) by default and will vary depending upon the file format downloaded (blank in csv files, NaN in .mat matlab files, etc).

Problem Description

Overall design is unbalanced with unequal effort across years, depth and species. Imbalance is a consequence of both animal availability, scientific bandwidth and stations sampled. It is likely that some of the data still includes animals with lipid sacs that had lost some of their contents during collection and handling, but did not appear anomalous visually (resulting in underestimate of lipid stored by such specimens).

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Parameters

Parameter	Description	Units
OrgSequence	Internal reference (numeric sequential identifier)	unitless
Year	Year of sample	unitless
Season	Seasons of sample (spring, summer, fall)	unitless
station	NGA-LRTER station name	unitless
DateTime_local	Date and time of samples (Alaska local time AKST/AKDT). The format is excel default time base.	unitless
ISO_DateTime_UTC	Date and time of samples in ISO 8601 format with timezone (UTC).	unitless
Latitude	Latitude	decimal degrees
Longitude	Longitude	decimal degrees
DephMax	Maximum depth of sample in meters	meters (m)
DepthMin	Minimum depth of samples in meters	meters (m)
species	Species of Neocalanus (see Methodology for taxon ids)	unitless
LifeStage	Copepodite life stage	unitless
ProsomeLength	Prosome length	micrometers (um)
ProsomeHeight	Prosome height (at maxillipeds)	micrometers (um)
LipidLength	Lipid sac length	micrometers (um)
LipidHeight	Lipid sac height (at maxillipeds)	micrometers (um)
LipidArea	Lipid sac area in lateral view	square millimeters (mm^2)

AdjustedHeight	Lipid sac average height	micrometers (um)
LipidVolume	Lipid sac volume	cubic millimeters (mm^3)
BodyVolume	Body volume	cubic millimeters (mm^3)
Lipid_percent_BodyVolume	Percentage Lipids of total body volume	percent (%)

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Instruments

Dataset-specific Instrument Name	Hydrobios Multinet-midi both 150um and 500um mesh
Generic Instrument Name	MultiNet
Generic Instrument Description	The MultiNet© Multiple Plankton Sampler is designed as a sampling system for horizontal and vertical collections in successive water layers. Equipped with 5 or 9 net bags, the MultiNet© can be delivered in 3 sizes (apertures) : Mini (0.125 m2), Midi (0.25 m2) and Maxi (0.5 m2). The system consists of a shipboard Deck Command Unit and a stainless steel frame to which 5 (or 9) net bags are attached by means of zippers to canvas. The net bags are opened and closed by means of an arrangement of levers that are triggered by a battery powered Motor Unit. The commands for actuation of the net bags are given via single or multi-conductor cable between the Underwater Unit and the Deck Command Unit. Although horizontal collections typically use a mesh size of 300 microns, mesh sizes from 100 to 500 may also be used. Vertical collections are also common. The shipboard Deck Command Unit displays all relevant system data, including the actual operating depth of the net system.

Dataset-specific Instrument Name	
Generic Instrument Name	Plankton Net
Dataset-specific Description	Quad net, a modified CalVet net (0.25 m mouth diameter, 1 m cylinder and 1.5 m cone), of 150-µm mesh
Generic Instrument Description	A Plankton Net is a generic term for a sampling net that is used to collect plankton. It is used only when detailed instrument documentation is not available.

Dataset-specific Instrument Name	Digital cameras
Generic Instrument Name	Underwater Camera
Generic Instrument Description	All types of photographic equipment that may be deployed underwater including stills, video, film and digital systems.

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Deployments

SKQ201810S

Website	https://www.bco-dmo.org/deployment/922368
Platform	R/V Sikuliaq
Report	https://nga.lternet.edu/wp-content/uploads/2019/04/Cruise-Report-SKQ201810S.pdf
Start Date	2018-04-18
End Date	2018-05-05
Description	Coordinates for this deployment can be found in R2R: https://www.rvdata.us/search/cruise/SKQ201810S

SKQ201915S

Website	https://www.bco-dmo.org/deployment/910757
Platform	R/V Sikuliaq
Report	https://nga.lternet.edu/wp-content/uploads/2020/03/Cruise-Report-SKQ201915S_v3.pdf
Start Date	2019-06-29
End Date	2019-07-18
Description	Northern Gulf of Alaska Long-Term Ecological Research (NGA-LTER) See more cruise details on R2R https://www.rvdata.us/search/cruise/SKQ201915S

SKQ202006S

Website	https://www.bco-dmo.org/deployment/922372
Platform	R/V Sikuliaq
Report	https://nga.lternet.edu/wp-content/uploads/2020/07/Cruise-Report-SKQ202006S_v2.pdf
Start Date	2020-05-04
End Date	2020-05-11
Description	Coordinates for this deployment can be found in R2R: https://www.rvdata.us/search/cruise/SKQ202006S

SKQ202010S

Website	https://www.bco-dmo.org/deployment/936170
Platform	R/V Sikuliaq
Report	https://nga.lternet.edu/wp-content/uploads/2020/12/Cruise-Report-SKQ202010S.pdf
Start Date	2020-07-02
End Date	2020-07-16

SKQ202012S

Website	https://www.bco-dmo.org/deployment/936172
Platform	R/V Sikuliaq
Report	https://nga.lternet.edu/wp-content/uploads/2020/11/Cruise-Report-SKQ202012S.pdf
Start Date	2020-09-01
End Date	2020-09-09

WSD201807

Website	https://www.bco-dmo.org/deployment/936189
Platform	R/V Woldstad
Report	https://nga.lternet.edu/wp-content/uploads/2019/04/Cruise-Report-WOL18J.pdf
Start Date	2018-07-03
End Date	2018-07-18

TXS19

Website	https://www.bco-dmo.org/deployment/910688
Platform	R/V Tiglax
Report	https://nga.lternet.edu/wp-content/uploads/2019/10/Cruise-Report-TXS19.pdf
Start Date	2019-04-26
End Date	2019-05-08
Description	NGA LTER Summer cruise

TXF19

Website	https://www.bco-dmo.org/deployment/910759
Platform	R/V Tiglax
Report	https://nga.lternet.edu/wp-content/uploads/2020/02/Cruise-Report-TXF19.pdf
Start Date	2019-09-11
End Date	2019-09-26
Description	Northern Gulf of Alaska Long-Term Ecological Research (NGA-LTER) Fall cruise

TXF18

Website	https://www.bco-dmo.org/deployment/910684
Platform	R/V Tiglax
Report	https://nga.lternet.edu/wp-content/uploads/2019/04/Cruise-Report-TXF18.pdf
Start Date	2018-09-11
End Date	2018-09-25
Description	NGA LTER Fall cruise

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Project Information

Collaborative Research: Molecular profiling of the ecophysiology of dormancy induction in calanid copepods of the Northern Gulf of Alaska LTER site (Diapause preparation)

Coverage: Northern Gulf of Alaska LTER

NSF Award Abstract:
The sub-arctic Pacific sustains major fisheries with nearly all commercially important species depending either directly or indirectly on lipid-rich copepods (Neocalanus flemingeri, Neocalanus plumchrus, Neocalanus cristatus and Calanus marshallae). In turn, these species depend on a short-lived spring algal bloom for growth and the accumulation of lipid stores in order to complete an annual life cycle that includes a period of dormancy. The intellectual thrust of this project measures how the timing and magnitude of algal blooms affect preparation for dormancy using a combination of field and experimental observations. The Northern Gulf of Alaska - with four calanid species that experience dormancy, steep environmental gradients, well-described phytoplankton bloom dynamics, and a concurrent NSF-LTER program - provides an unusual opportunity to identify the factors that affect dormancy preparation. Education and outreach plans are integrated with the research. Educational efforts focus on interdisciplinary opportunities for undergraduate, graduate and post-doctoral trainees. The project will generate content for existing graduate and undergraduate courses. U. of Alaska Fairbanks and U. Hawaii at Manoa are Alaska Native and Native Hawaiian Serving Institutions, and students from these groups will be recruited to participate in the project. Because fishing is a major industry in the Gulf of Alaska, outreach will communicate the role copepods play in marine ecosystems using the concept of a dynamic food web tied to production cycles.

Diapause (dormancy) and the accompanying accumulation of lipids in copepods have been identified as key drivers in high latitude ecosystems that support economically important fisheries, including those of the Gulf of Alaska. While the disappearance of lipid-rich copepods has been linked to severe declines in fish stocks, little is known about the environmental conditions that are required for the successful completion of the copepod's life cycle. A physiological profiling approach that measures relative gene expression will be used to test two alternative hypotheses: the lipid accumulation window hypothesis, which holds that individuals enter diapause only after they have accumulated sufficient lipid stores, and the developmental program hypothesis, which holds that once the diapause program is activated, progression occurs independent of lipid accumulation. The specific objectives are: 1) determine the effect of food levels during N. flemingeri copepodite stages on progression towards diapause using multiple physiological and developmental markers; 2) characterize the seasonal changes in the physiological profile of N. flemingeri across environmental gradients and across years; 3) compare physiological profiles across co-occurring calanid species (N. flemingeri, Neocalanus plumchrus, Neocalanus cristatus and Calanus marshallae); and 4) estimate the reproductive potential of the overwintering populations of N. flemingeri. The broader scientific significance includes the acquisition of new genomic data and molecular resources that will be made publicly available through established data repositories, and the development of new tools for routinely obtaining physiological profiles of copepods.

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.

NOTE: Petra Lenz is a former Principal Investigator (PI) and Andrew Christie is a former Co-Principal Investigator (Co-PI) on this project (award #1756767). Daniel Hartline is the PI listed for the award #1756767 and is now a former Co-PI on this project.

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Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-1756859