

PALMER STATION MONTHLY SCIENCE REPORT

September 2019



Palmer Station was iced in for most of September, but the ice temporarily broke up with the high winds Palmer Station received late in the month, creating beautiful geometric designs around Arthur Harbor.

Image Credit: Hannah James

NEWS FROM THE LAB

Hannah James, Winter Laboratory Supervisor

It is hard to believe that the Winter 2019 season has come to a close. With September being the final month of only wintering-over science and staff on station, lots of projects wrapped up as preparations for the upcoming Summer 2019/20 ramped up. The B-459-P (Bernard) group completed their final Time Point experiments and prepared samples to ship back to Oregon State for further analysis. Dr. Kim Bernard was able to keep the wintering-over krill alive in the aquarium for the five and a half months her team was here. It was a pleasure having these three women on station for the season, and we look forward to their return in the winter of 2021. Some preliminary results of their experiment are discussed below.

The month of September brought a variety of weather to Palmer Station. We experienced everything from calm, sunny days to howling winds with blizzard conditions piling snow around station. The sea ice that was around for most of August was blown out, only to be replaced a few days later icing in the station for the majority of the month. The few days we did have local open water brought more wildlife to station. In Hero Inlet a Leopard and Wedell seal were spotted, and Elephant seals have been seen around Bonaparte Point. Kelp Gulls, Giant Petrels, and Sheathbills dominated bird sightings, but the occasional Cape Petrel and Snow Petrel were spotted flying around on windier days. Cormorants and Antarctic Terns were seen throughout the month as well.

SEPTEMBER 2019 WEATHER

W. Lance Roth, Research Associate

Temperature
Average: -5.7 °C / 21.8 °F
Maximum: 2.0 °C / 35.6 °F on 25 Sep 18:20
Minimum: -21.4 °C / -6.5 °F on 11 Sep 21:11
Air Pressure
Average: 986.3 mb
Maximum: 1018.2 mb on 3 Sep 03:03
Minimum: 952.4 mb on 11 Sep 03:54
Wind
Average: 16.7 knots / 19.2 mph
Peak (5 Sec Gust): 99 knots / 114 mph on 22 Sep 10:56 from NE (40 deg)
Prevailing Direction for Month: NNW
Surface
Total Rainfall: 25.1 mm / 0.99 in
Total Snowfall: 55 cm / 21.5 in
Greatest Depth at Snow Stake: 105.4 cm / 41.1 in
WMO Sea Ice Observation: 8/10 Nilas, ice rind, ice bergs, and young ice > 10cm thick
Average Sea Surface Temperature: -1.67 °C / 29 °F

September was cold with temperatures dropping down to -6.5° F and averaging 21.8° F. These colder air temperatures combined with an average sea surface temperature of 29° F allowed Arthur Harbor to completely freeze over. Think nilas ice covered the entire inlet for most of the month. On September 22nd high winds from the NE broke up the ice and blew it out with gusts up to 114 mph. We accumulated 21.5 more inches of snow raising our total snow accumulation to 41.1 inches.

B-459-P: CAREER: “THE OMNIVORE’S DILEMMA”: THE EFFECT OF AUTUMN DIET ON WINTER PHYSIOLOGY AND CONDITION OF JUVENILE ANTARCTIC KRILL

Dr. Kim Bernard, Principal Investigator, College of Earth, Ocean, and Atmospheric Sciences, Oregon State University

Personnel on Station: Kim Bernard, Kirsten Steinke and Julia Fontana

This month, we conducted our final Time Point (TP 4) of the long-term feeding experiment, concluding our winter field season. As a reminder, the treatments of our long-term feeding experiment were:

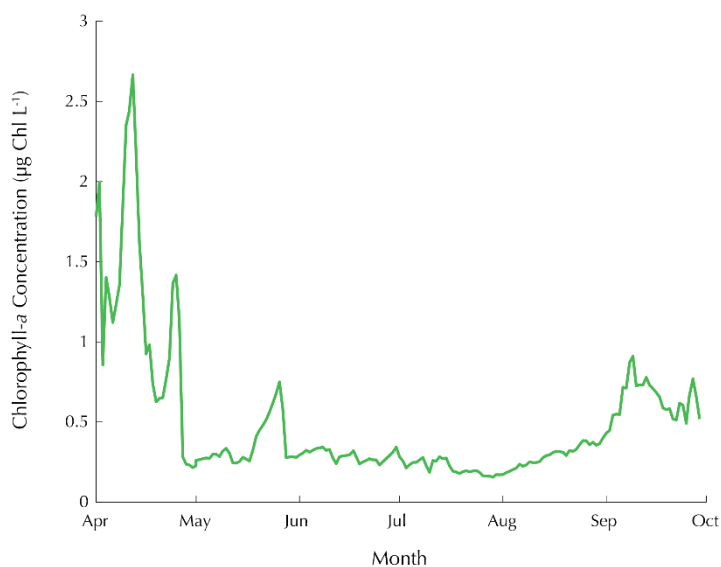
Treatment	Phase 1 Diet	Phase 2 Diet	Name
1	Freeze-dried mixed zooplankton	Natural seawater	MZA-NAT
2	Freeze-dried mixed zooplankton	Freeze-dried mixed zooplankton	MZA-MZA
3	Diatom culture	Natural seawater	DIA-NAT
4	Diatom culture	Diatom culture	DIA-DIA

Phase 1 diets were given during Time Points (TP) 1 and 2, while phase 2 diets were given during TP3 and TP4. Time points corresponded to the following dates:

Time Point	Date
0	04/29 – 05/03
1	06/03 – 06/08
2	07/08 – 07/13
3	08/07 – 08/16
4	09/11 – 09/20

Preliminary Results

1. Ambient Chlorophyll-*a* Concentrations



This month, we noticed a marked increase in ambient chlorophyll-*a* concentrations from the seawater intake in Arthur Harbor (Figure 1). This would have resulted in greater phytoplankton biomass in the experimental tanks and we anticipated that this might be expressed as elevated mean respiration rates in krill across all treatments. However, we did not find this.

Figure 1. Daily chlorophyll-a concentrations ($\mu\text{g Chl L}^{-1}$) from seawater intake (waterwall) showing ambient conditions in Arthur Harbor and in our experimental

2. Respiration Rates

During the five months of our long-term feeding experiment, we observed an increase in mean respiration rates (standardized by dry weight) between TP0 (late April, early May) and TP2 (July) for all treatments (Figure 1), suggesting that late autumn and early winter respiration rates might respond to food availability in juvenile krill. By TP3 (August), respiration rates of all treatments had continued to increase except the DIA-NAT treatment, which had decreased (Figure 1), suggesting that feeding on copepods in the autumn allows juvenile krill to cope with reduced food in the winter, whereas feeding primarily on diatoms in the autumn does not.

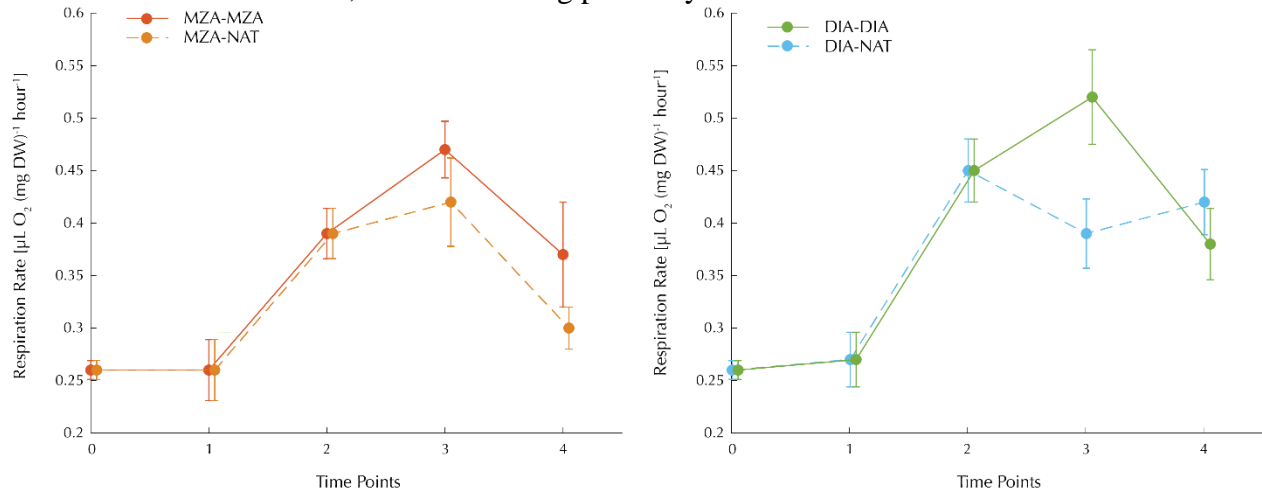


Figure 2. Mean respiration rates standardized by dry weight for krill measured at Time Point Zero (May), Time Point 1 (June), Time Point 2 (July), Time Point 3 (August) and Time Point 4 (September) in each of the four treatments (MZA-NAT, MZA-MZA, DIA-NAT, and DIA-DIA). Note that values at each Time Point are offset for each treatment for clarity. Error bars are standard error.

However, by TP4 (September), these trends did not continue. The mean respiration rates of krill from MZA-MZA, MZA-NAT and DIA-DIA all decreased, while those from DIA-NAT remained relatively constant, yielding final values that were not significantly different between treatments (Figure 1). This was a surprising finding given that ambient chlorophyll-*a* concentrations had risen. One possible reason for decreased respiration rates could be related to a reduction in feeding. However, this would be unusual given the relatively high ambient phytoplankton biomass, and our ingestion rate experiments indicated that feeding remained high in September. An alternative cause for the reduced respiration rates may have to do with the move from previtellogenesis to vitellogenesis in maturing female krill. It is possible that maturing female krill reduce their metabolic processes in order to store the energy required for egg production.

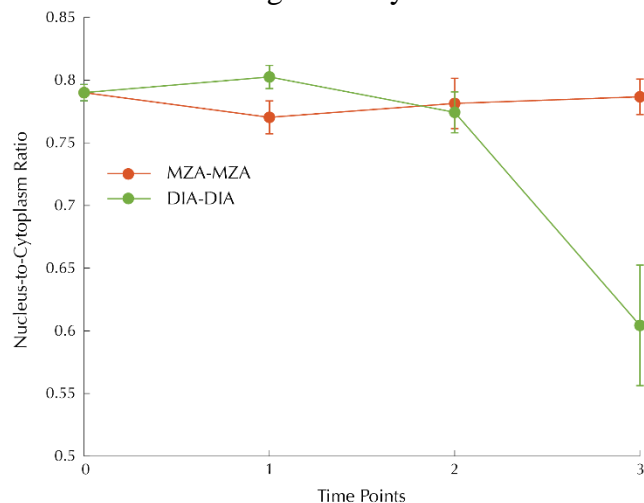


Figure 3. Mean nucleus-to-cytoplasm ratio in ovarian cells of female krill for Time Points 0-3.

3. Reproductive Development

PhD student Kirsten Steinke has been analyzing the reproductive development in female krill from each of our experimental treatments. Specifically, she has been dissecting out the ovaries and using the squash technique to examine oogenesis (i.e. egg development). By determining the ratio of the nucleus to the cytoplasm in each cell, one can assess the stage of development. The smaller the nucleus-to-cytoplasm (N:C) ratio, the more advanced the ovarian development. Kirsten's preliminary results suggest that, by TP3, development was more advanced (i.e. smaller N:C ratio) in female krill in the DIA-DIA treatment than in the MZA-MZA treatment (Figure 3), highlighting the importance of diatoms in the timing of reproductive development in krill. These are preliminary data and she has not yet measured N:C ratios in all krill collected, including those from MZA-NAT and DIA-NAT.

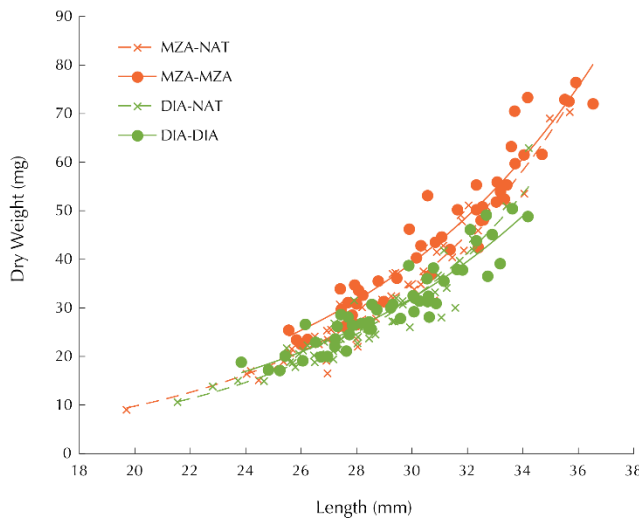


Figure 4. Relationships between length (mm) and final dry weight (mg) at TP4 of juvenile krill used in our long-term feeding experiment.

suggesting that they had greater lipid storage. Interestingly, there was no significant difference in dry weight to length relationships between krill in either MZA-MZA and MZA-NAT or DIA-DIA and DIA-NAT, implying that autumn diet may be more important than a sustained winter diet for determining end of winter condition.

We emphasize that the results presented here are all preliminary and we will be processing and analyzing most of our collected samples when we get back to Oregon. We look forward to learning more about how diet affected our experimental krill in the coming months.

Final Remarks

We would like to thank the entire ASC winter crew at Palmer Station for all of their hard work and support throughout the field season. We have had a successful and productive research season, and this would not have been possible without them.

4. Body Size

One of our hypotheses was that juvenile krill fed a carnivorous diet (i.e. MZA) would store more lipids, while those fed an herbivorous diet (i.e. DIA) would use energy consumed for growth rather than lipid storage. We would expect, therefore, that krill from the MZA treatments would be heavier per unit length than those from the DIA treatments. Once we are back in Oregon, we will analyze total lipid contents, but until then we can assess dry weight to length relationships as a proxy. By TP4 (September), krill from both the MZA-MZA and MZA-NAT treatments were heavier than those from the DIA-DIA and DIA-NAT treatments (Figure 4),

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G-090-P: GLOBAL SEISMOGRAPH NETWORK (GSN) SITE AT PALMER STATION.
Kent Anderson, Principal Investigator, Incorporated Research Institutions for Seismology (IRIS)

Station PMSA is one of more than 150+ sites in the GSN, monitoring seismic waves produced by events worldwide. Real-time telemetry data is sent to the U.S. Geological Survey (USGS). The Research Associate operates and maintains on-site equipment for the project.

The system operated normally throughout the month.

A-111-P: THE NEXT GENERATION OF GEOSPACE RESEARCH FACILITIES AT PALMER STATION

Andrew Gerrard, Principal Investigator, New Jersey Institute of Technology

The ionosphere-thermosphere-magnetosphere (ITM) region of Earth's atmosphere, which is part of the larger geospace environment, is the portal through which the solar wind can enter and impact our planetary system. Though space weather research over the past decades has greatly increased our understanding of a wide variety of phenomena associated with ITM physics, the sum of these individual processes occurring in the geospace environment does not replicate the rich diversity and scope of this complex region. Thus, a more holistic approach to ITM research is necessary, one that integrates clustered instrumentation at multiple locations to simultaneously look at the interactions within the entire system. Using coordinated and collaborative instrumentation currently installed in Antarctica, researchers will study interrelated ITM phenomena observed at high latitudes. The goal of this research effort is a better understanding of the energy transfer and modulation of the geospace system.

Both the ELF/VLF operated normally through the month.

A-119-P: CONTINENTAL-SCALE STUDIES OF MESOSPHERIC DYNAMICS USING THE ANTARCTIC GRAVITY WAVE INSTRUMENT NETWORK (ANGWIN)

Michael Taylor, Principal Investigator, Utah State University

The Antarctic Gravity Wave Imaging Network (ANGWIN) is a cooperative effort of six international Antarctic programs to collect continent-wide gravity wave measurements. This network capitalizes on existing optical and radar measurement capabilities at McMurdo, Palmer, South Pole, and six other research stations: Halley (UK), Syowa (Japan), Davis (Australia), Rothera (UK), and Ferraz (Brazil). Infrared (IR) all-sky mesospheric OH (hydroxyl) imagers are installed at Davis, McMurdo, and Halley stations. The network quantifies the properties, variability, and momentum fluxes of short-period (less than one hour) mesospheric gravity waves and their dominant sources and effects over the Antarctic continent. An all-sky near-IR imager is also installed at Palmer Station to augment the existing instrumentation and create a capability for studying gravity wave properties at each site.

The camera and laptop have been taken down and packaged for shipment to Logan, Utah.

O-264-P: A STUDY OF ATMOSPHERIC OXYGEN VARIABILITY IN RELATION TO ANNUAL DECADAL VARIATIONS IN TERRESTRIAL AND MARINE ECOSYSTEMS.

Ralph Keeling, Principal Investigator, Scripps Institution of Oceanography

The goal of this project is to resolve seasonal and inter-annual variations in atmospheric O₂ (detected through changes in O₂/N₂ ratio), which can help to determine rates of marine biological productivity and ocean mixing as well as terrestrial and oceanic distribution of the global anthropogenic CO₂ sink. The program involves air sampling at a network of sites in both the Northern and Southern Hemispheres. The Research Associate collects samples fortnightly from Terra Lab.

Air samples were taken twice this month.

O-264-P: COLLECTION OF ATMOSPHERIC AIR FOR THE NOAA/GMD WORLDWIDE FLASK SAMPLING NETWORK

Don Neff and Steve Montzka, Principal Investigators, National Oceanic and Atmospheric Administration / Global Monitoring Division; Boulder, CO

The NOAA ESRL Carbon Cycle Greenhouse Gases (CCGG) group makes ongoing discrete measurements to document the spatial and temporal distributions of carbon-cycle gases and provide essential constraints to our understanding of the global carbon cycle. The Halocarbons and other Atmospheric Trace Species (HATS) group quantifies the distributions and magnitudes of the sources and sinks for atmospheric nitrous oxide (N₂O) and halogen containing compounds. The Research Associate collects weekly air samples for the CCGG group and fortnightly samples for the HATS group.

CCGG samples were taken once a week during favorable winds and HATS Air samples were taken every other week.

O-264-P: ULTRAVIOLET (UV) SPECTRAL IRRADIANCE MONITORING NETWORK

James Butler, Principal Investigator, National Oceanic and Atmospheric Administration / Global Monitoring Division; Boulder, CO

A Biospherical Instruments (BSI) SUV-100 UV spectroradiometer produces full sky irradiance spectra ranging from the atmospheric UV cutoff near 290nm up to 605nm, four times per hour. A BSI GUV-511 filter radiometer, an Eppley PSP Pyranometer, and an Eppley TUVR radiometer also continuously measure hemispheric solar flux within various spectral ranges. The Research Associate operates and maintains on-site equipment for the project.

The system operated normally with the occasional gap in data due to issues with the wavelength definition. Bi-weekly absolute scans were completed as necessary.

R-938-P: TERASCAN SATELLITE IMAGING SYSTEM

The TeraScan system collects, processes, and archives DMSP and NOAA satellite telemetry, capturing approximately 25-30 passes per day. The Research Associate operates and maintains

on-site equipment for the project. The TeraScan weather and ice imagery is used for both research and station operations.

The system operated normally throughout the month.

T-295-P: GPS CONTINUOUSLY OPERATING REFERENCE STATION.

Joe Pettit, Principal Investigator, UNAVCO

Continuous 15-second epoch interval GPS data files are collected at station PALM, compressed, and transmitted to the NASA-JPL in Pasadena, CA. The Research Associate operates and maintains on-site equipment for the project.

The system operated normally throughout the month. UNAVCO sent a current version of Trimble Business Center which our IT department has installed on the Windows 10 Research Associate computer. We should now be able to process the glacier terminus surveyed this past austral summer.

T-998-P: INTERNATIONAL MONITORING STATION (IMS) FOR THE COMPREHENSIVE NUCLEAR TEST BAN TREATY ORGANIZATION. (CTBTO)

Managed by General Dynamics

The IMS Radionuclide Aerosol Sampler and Analyzer (RASA) is part of the CTBTO verification regime. The automated RASA continually filters ambient air and tests for particulates with radioisotope signatures indicative of a nuclear weapons test. The Research Associate operates and maintains the instrument.

The system operated normally throughout the month.

OCEANOGRAPHY

Daily observations of sea ice extent and growth stage are also recorded, along with continuous tidal height, ocean temperature, and conductivity at Palmer's pier.

Observations of sea ice around station were made daily.

METEOROLOGY

The Research Associate acts as chief weather observer, and compiles and distributes meteorological data. Weather data collected using the automated electronic system is archived locally and forwarded once per month to the University of Wisconsin for archiving and further distribution. Synoptic reports are automatically generated every three hours by the Palmer Meteorological Observing System and emailed to the National Weather Service for entry into the Global Telecommunications System.

The local weather station (PAWS) is working well. Observations are archived on the AMRC website: <ftp://amrc.ssec.wisc.edu/pub/palmer/>.