PALMER STATION MONTHLY SCIENCE REPORT

July 2017

Laurence M. Gould **marine laboratory technician (MLT) Jess Ackerman inspecting a trawl net during one of B-029-P (Postlethwait)'s fishing cruises.** *Image Credit: John Postlethwait*

NEWS FROM THE LAB
Emily Olson, Winter Laboratory Supervisor

Activity ramped up in the Palmer Labs in mid-July when B-029-P (Postlethwait), A-109 (Moore), and a representative from the Comprehensive Nuclear-Test-Ban Treaty Organization (CTBTO) for project T-998-P joined B-036-P (O'Brien) on station. We had two fishing cruises depart from and return to station with a haul of nototheniods to be used in thermotolerance experiments conducted by B-029-P (Postlethwait). B-036-P (O'Brien) was joined by the project PI, Kristin O'Brien, and the final portion of the group's project, the sampling of heat-acclimated fish, was conducted. Terra Lab was abuzz with grantees calibrating instruments and collecting data. After over three active months on station, B-036-P departed on LMG17-06NB. It was a short port call, but great work got done and the grantees remaining on station through the end of LMG17-07 are well positioned to have a successful and productive field season.

Outside the scenery has changed notably over the past month. Much to the joy of the skiers on station, we finally have some solid snowpack and haven't seen rain since the beginning of July. We have also noticed sea ice forming in Arthur Harbor and Hero Inlet every time the winds let up, but while the rest of the continent has become enshrouded in pack ice, satellite imagery confirms that the area around Anvers Island remains ice (and iceberg) free. During the first week

of July, we finally saw the sun peak up over the glacier after a near month-long absence. Mother nature treated us by giving us a foggy shroud that let us look directly at the half-orb, with a chorus of winterover cheers to accompany the sight. Unfortunately, the return of the sun didn't last long; towards the end of the month strong storms buffeted the area, giving us winds from all compass directions and leaving the horizon murky and gray. Every once in a while, though, a glimpse to the east would catch you by surprise with the sudden emergence of the mountains of the continent, pink and orange from winter's perennial sunrise/sunset, and remind you of the beauty hiding just behind that steel veil.

Our first glimpse of the sun peaking over the Marr Ice Piedmont on July 6th.
Image Credit: Shaun Bonneau

Palmer Monthly meteorological summary for July, 2017

Temperature
Average: -4.4 °C / 24.2 °F
Maximum: 3 °C / 37.4 °F on 1 Jul 20:38
Minimum: -10.8 °C / 12.56 °F on 31 Jul 13:33
Air Pressure
Average: 979.7 mb

Maximum: 1013.2 mb on 21 Jul 19:40
Minimum: 949.3 mb on 30 Jul 22:20
Wind
Average: 14.3 knots / 16.4 mph
Peak (5 Sec Gust): 67 knots / 77 mph on 9 Jul 23:48 from N (6 deg)
Prevailing Direction for Month: NNE
Surface
Total Rainfall: 117.9 mm / 4.64 in
Total Snowfall: 47 cm / 18.3 in
Greatest Depth at Snow Stake: 54.2 cm / 21.1 in
WMO Sea Ice Observation: Sea ice present <3/10, nilas or ice rinds, 1-5 bergs, with growlers and bergy bits.
Average Sea Surface Temperature: -1.52 °C / 29.3 °F

July was a really windy month with wind speeds up to 77 mph on the 9th and an average speed of 16.4 mph. Temperatures dropped down to 13 °F with an average of 24 °F. These warm temperatures combined with moist, high wind systems brought 18 inches of snow this month bringing our total up to 21 inches. Arthur Harbor and Hero Inlet have been developing some sea ice in the form of nilas and ice rinds. Less than 3/10 of the ice is present, but there are plenty of bergs, growlers, and bergy bits in the area.

B-036- P: THE PHYSIOLOGICAL AND BIOCHEMICAL UNDERPINNINGS OF THERMAL TOLERANCE IN ANTARCTIC NOTOTHENIOID FISHES

Kristin O'Brien, Principal Investigator, University of Alaska Fairbanks; Elizabeth Crockett, Co-Principal Investigator, Ohio University
Personnel on station: Amanda Biederman, William Joyce, Anna Rix, Kristin O'Brien

The *Laurence M. Gould* arrived on station the evening of July 16th. We are grateful to the support staff at Palmer Station for handling lines under cold, dark, and windy conditions, permitting us to begin work early on Monday, July 17th, harvesting *Notothenia coriiceps* from our warm acclimation experiments. Animals were acclimated to 5 °C; one set for 6 weeks and a second set for 10 weeks, while control animals were held for the same lengths of time at ambient temperature. We began by harvesting animals and preparing membranes and mitochondria from 10-week acclimated animals and then proceeded to process the 6-week acclimated animals.

Several tissues (heart, glycolytic muscle, oxidative skeletal muscle, spleen, liver, brain, gills) and blood plasma were harvested from acclimated and control animals and will be shipped to our home institutions for experiments investigating the capacity of notothenioids to adjust metabolism, activity of membrane-bound enzymes, and membrane fluidity to elevations in temperature.

Dr. Elizabeth Crockett and graduate student Amanda Biederman are investigating the capacity of *N. coriiceps* to adjust membrane fluidity in response to warm acclimation. Synaptosomal, myelin

and mitochondrial membranes were prepared from brains of *N. coriiceps* by Amanda Biederman and mitochondrial membranes from heart ventricles were prepared by Kristin O'Brien and Anna Rix. Membranes will be shipped to Ohio University where membrane fluidity will be quantified. Results from these studies will elucidate if Antarctic fishes are able to adjust membrane fluidity in response to elevated temperatures or if the capacity to remodel membranes has been lost during their long evolution in a stable, cold environment.

Mitochondria were isolated and cardiac mitochondrial function quantified by Kristin O'Brien from warm-acclimated and control animals. While a detailed analysis of the data has not yet been completed, a preliminary evaluation of the data suggests that mitochondrial function is not altered in response to 6 or 10 weeks of warm acclimation in *N. coriiceps*. Further analyses of heart ventricle tissues at our home institution will reveal if alterations in metabolism at the tissue-level (ie; changes in mitochondrial quantity rather than quality) improve cardiac performance at elevated temperature in *N. coriiceps*.

William Joyce completed studies of the effects of warm acclimation on the cardiovascular system of *N. coriiceps*. His results indicate that *N. coriiceps* has the capacity to enhance cardiac performance in response to warm acclimation to 5 °C. While the hearts of warm-acclimated *N. coriiceps* become arrhythmic at the same temperature as animals held at ambient temperature, hearts of warm-acclimated *N. coriiceps* continue to function at higher temperatures and maintain a higher cardiac output compared to those held at ambient temperature. These results suggest that the capacity to maintain ATP levels at high temperatures is improved by warm acclimation. Measurements of metabolic enzyme activities at our home institutions will provide further insight.

Studies of cardiac function and thermal sensitivity of cardiac function in hemoglobinless icefishes were also completed by William Joyce this month. William and Michael Axelsson (on station during LMG17-04) measured central venous pressure in icefishes for the first time ever, allowing them to accurately calculate cardiac output and cardiac work in icefishes. Their results show that resting cardiac output is lower than previously measured for the icefish *Chaenocephalus aceratus* and increases considerably in response to acute warming. Therefore, contrary to previous thought, *C. aceratus* is capable of enhancing cardiac output in response to elevations in temperature, supporting an increase in oxygen demand. William and Michael also determined that cardiac work is similar between icefishes and red-blooded fishes, supporting the hypothesis that the loss of hemoglobin is not a beneficial mutation. Although the loss of hemoglobin reduces blood viscosity, it does not reduce work of the heart because of the large blood volume of icefishes. Bruce Sidell would have been quite pleased to know that he was correct in his "back of the envelope" calculations of cardiac work in icefishes (J. Exp. Biol. 2006 209:1791-802).

Unfortunately, our experiments were cut short by one day due to a potential medevac situation. We were unable to prepare membranes and isolate mitochondria from one additional set of animals from the 6-week acclimation experiment, leaving us with a sample size of 5 rather than 6 for this group. We were, however, able to harvest tissues from all 6-week acclimated and control animals (in addition to the 10-week acclimated and control animals) for experiments at our home institutions.

Our experiments could not have been completed this season without the outstanding support of the staff at Palmer Station. We are especially grateful for the excellent assistance of the Lab

Manager, Emily Olson, Instrument Technician, Matt Boyer, and the folks in FMC who kept the seawater system running and our tank heaters operational. It was truly a joint effort and a pleasure working with everyone.

B-029 – ICEmiRs: CONTROL OF DEVELOPMENT AND PHYSIOLOGY IN ANTARCTIC FISH BY microRNAS

John Postlethwait, Principal Investigator, University of Oregon, H. William Detrich, Principal Investigator, Northeastern University, Thomas Desvignes, University of Oregon

Personnel on Station: John Postlethwait, H. William Detrich, Thomas Desvignes, Kristin Alligood, Rachael Cunningham, Isaac Miller, and Natalie Mosqueda

Icefish live in frigid Antarctic seas and have unique traits, such as the absence of red blood cells and the inability to adapt to changes in environmental temperatures- a trait that would be harmful to animals in fluctuating environments. In mammals and fish inhabiting temperate waters, development and physiology is regulated by genes that encode specific proteins, but the rate of protein production is often modulated by short RNA molecules called microRNAs (miRNAs). MiRNAs, which have not been studied in Antarctic fish, regulate the amount of protein that cells make by binding to the intermediate messenger RNA (mRNA), thus interrupting protein production. The B-029-P (Postlethwait) project aims to compare miRNA regulation in 1) Antarctic fish vs. warm-water fish to learn how miRNAs regulate gene expression in constant cold and how their expression varies with elevation of temperature; and in 2) Antarctic icefish with no red blood cells, enlarged hearts, and reduced bone density vs. closely related Antarctic fish containing red blood cells, normal hearts, and dense bones. The project will study the importance of miRNA gene regulation in Antarctic fish and will shed light on how these fish might respond to the warming of Antarctic waters.

On Wednesday, July 12th, PIs Postlethwait, Detrich, and Desvignes, and team members Alligood, Cunningham, Miller and Mosqueda sailed on the *Laurence M. Gould* from Punta Arenas, Chile, and arrived at Palmer Station on July 16th. After a two day port call (extended by one day due to inclement weather forecast for the fishing grounds), on the morning of July 19th, Detrich, Desvignes, Alligood, Cunningham, and Mosqueda, sailed back on the *LMG* to conduct three days of fishing operations at ASPAs 153 (Eastern Dallmann Bay) and 152 (Western Bransfield Strait). The goals of this trip were to set baited traps targeting specimens of the red-blooded Bullhead notothen, *Notothenia coriiceps* and the Humphead notothen, *Gobionotothen gibberifrons*, near Astrolabe Needle (ASPA 153) during the afternoon of July 19th (and recover after 24 hours) and to trawl at night in the area southwest of Low Island (ASPA 152) to capture specimens of the white-blooded Blackfin icefish, *Chaenocephalus aceratus*, and the Mackerel icefish, *Champsocephalus gunnari*. During the first night of trawling on July 19th, on the southwest bank of Low Island, under moderate winds (20-35 knots), the team made five trawl sets at depths between 160 and 190m. These trawls yielded a good number of specimens of all four targeted species, as well as other species of Antarctic fish. In the early morning of July 20th, the team returned to the Dallmann Bay site and retrieved the traps, which produced modest but diverse numbers of Bullhead notothen and Humphead notothen. Following trap recovery, they decided to sail for Palmer Station after performing three additional trawls North of Dallmann Bay. These trawls yielded additional specimens of three of the four targeted species and a

diversity of other fish species but no Bullhead notothen. The *LMG* tied up at the Palmer Station pier at 10:30AM on July 21st, after a successful two day fishing trip instead of the three days originally planned. With the excellent assistance of *LMG* and ASC personnel, the fish were offloaded and transferred to the Palmer Station aquaria. We greatly appreciate the professionalism and help of the *LMG* and Palmer Station staff in support of our project.

During this first fishing trip the B-029-P (Postlethwait) members on station, Postlethwait and Miller, cleaned aquarium tanks, readied heaters, installed software for temperature data loggers, prepared oxygen sensor probes, and organized the laboratory. With the help of the Resident Marine Technicians at Palmer Station they also setup two baited fish traps west of Bonaparte Point near Palmer Station. They recovered the traps 24 hours later but did not capture any fish. Whether the fish were experiencing a period of winter dormancy (hibernation), had moved away for the winter, or the traps were set in inappropriate locations is not known. If weather permits, we hope to set more traps during the month of August to acquire more knowledge on fish around Palmer Station.

On the morning of July 23rd, Postlethwait, Desvignes, Miller and Alligood departed Palmer Station on board the *LMG* to conduct the second fishing trip of LMG17-06. The decision was made to not deploy traps at Dallmann Bay due to the few fish captured there on the previous fishing trip and to proceed directly to trawling at Low Island, which had been quite productive in the first fishing trip. With the skillful assistance of the *LMG* captain and marine technicians and good weather, the team ran six trawls at about 180 m depth, with the first net in the water around 11PM. Fishing continued until 8:30AM the next day. During that night, we managed to capture a large amount of specimens of all the four targeted species ("corries", "gibbies", "blackfin", and "gunnars"). The *LMG* then steamed back to Palmer Station performing en route two Blake trawls in the Gerlache Strait at about 360-400 m depth, capturing fish species representing a somewhat different fish community. The catch included several deeper water species absent from Low Island that are important for the analysis of miRNA genetic evolution. In addition, we recovered a few individuals of the two other main lineages of fish inhabiting the frigid waters of the Southern Ocean: the eelpouts and snailfishes. These species evolved adaptations to Antarctic cold independently of the Notothenioid fish that are our main targets and thus provide insight into common and diverse mechanisms for cold adaptation. During both fishing cruises, we marked each individual fish with a fin punch to indicate the location of capture (dorsal caudal fin, Dallman Bay; ventral caudal fin, Gerlache Strait; no punch, Low Island) because we want to be able to parse out putative effects from potentially genetically different populations of the same species due to the lack of knowledge about the population biology of most Antarctic fish. Animals showed no evidence of pain from the hole-punching procedure and videos were shot to document the process.

While steaming back to Palmer Station, the team began to process some of the collected specimens. We were disappointed by the number of fish that had died overnight, possibly due to particularly low temperatures on the back deck and in the *LMG* aquaria, but these fish still provided samples for DNA analyses and we collected tissue samples for transcriptomic analyses and for gene expression studies by in situ hybridization. We have since thought out contingency plans to avoid this situation happening again and will be ready to implement them on the fishing trips scheduled for LMG17-07. Upon arrival at Palmer Station, around 8:30 AM on July 25th (again, a successful two day fishing trip instead of the three days allocated), the crew of the *LMG* coordinated with personnel at Palmer Station the offload of fish into the cascade tanks and the

experimental Xactic tanks for holding until the large aquarium tanks became available from B-036-P (O'Brien) the following day.

Fish from the first fishing trip were by then acclimated to aquarium conditions and the team had tested the temperature ramps in the Xactic tanks, so on July 25th we began our first warming experiments, starting with the fragile icefish species and moving to the more robust red-blooded species in the next weeks. While the temperature experiments were happening, the team also proceeded on sampling control fish.

On 29 July, despite an extremely bad weather forecast for the northbound crossing of the Drake Passage, the *LMG* departed Palmer Station to Punta Arenas, Chile, with project members Postlethwait, Detrich, and Miller on board. Desvignes, Alligood, Cunningham and Mosqueda remain at Palmer Station to continue the experiments and await the arrival of a new team member on LMG17-07.

As of today, August 1st, the *LMG* is awaiting better weather sheltered east of Brabant Island in the Crocker Passage and will initiate the crossing of the Drake Passage on August 4th. Meanwhile the team on station has already made substantial progress on the proposed experiments, having run half of the fish of two of the four species through the warming protocol. We are confident that with the additional fish to be captured on fishing trips during LMG17-07, we will succeed in performing all experiments needed for testing the hypotheses of both the implication of miRNAs in thermal adaptation in Antarctic notothenioids, as well as their involvement in the peculiar icefish physiology.

We express our sincere gratitude to the USAP staff in the US and Punta Arenas, and to the *LMG* and Palmer Station personnel for their exceptional help in making the month of July so far a scientific success for the B-029-P (Postlethwait) group despite many changes of plan.

B-029-P (Postlethwait) team members Miller and Postlethwait dissecting an Antarctic icefish. *Image Credit: John Postlethwait*

PALMER STATION
RESEARCH ASSOCIATE MONTHLY REPORT
July 2017
W. Lance Roth

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 new UPS was installed replacing the old system.

A-109-P: ANTARCTIC EXTREMELY LOW FREQUENCY/VERY LOW FREQUENCY (ELF/VLF) OBSERVATIONS OF LIGHTNING AND LIGHTNING-INDUCED ELECTRON PRECIPITATION (LEP).
Robert Moore, Principal Investigator, University of Florida

ELF/VLF radio wave observations at Palmer Station are used to provide a deeper understanding of lightning and its effects on the Earth's inner radiation belt. The Research Associate operates and maintains on-site equipment for the project.

The VLF/ELF system has operated well throughout the month. The system was calibrated and all the data was duplicated on station by the grantee.

A-119-P: DEVELOPMENT OF ANTARCTIC GRAVITY WAVE IMAGER.
Michael Taylor, Principal Investigator, Utah State University

The Gravity Wave Imager takes images of the night sky in the near infrared, observing the dynamics of the upper atmosphere. The camera takes one 20-s exposure image every 30s of a very faint emission originating from a layer located at ~55 miles of altitude. .

The IR camera has operated well throughout the month.

A-357-P: EXTENDING THE SOUTH AMERICAN MERIDIONAL B-FIELD ARRAY (SAMBA) TO AURORAL LATITUDES IN ANTARCTICA
Eftyhia Zesta, Principal Investigator, University of California Los Angeles

The three-axis fluxgate magnetometer is one in a chain of longitudinal, ground-based magnetometers extending down though South America and into Antarctica. The primary scientific goals are the study of ULF (Ultra Low Frequency) waves and the remote sensing of mass density in the inner magnetosphere during geomagnetically active periods. The Research Associate maintains the on-site system.

The magnetometer was operational all month. It is still not on the Network and awaiting a new RSP.

A-373-P: TROPOSPHERE-IONOSPHERE COUPLING VIA ATMOSPHERIC GRAVITY WAVES
Vadym Paznukhov, Principal Investigator, Boston College

The goal of this project is to enhance the comprehensive research understanding of troposphere-ionosphere coupling via Atmospheric Gravity Waves(AGWs) in the Antarctic region. Both experimental and modeling efforts will be used on the Antarctic Peninsula to investigate the efficiency and main characteristics of such coupling and will address several questions remaining in the current understanding of this coupling process.

The system operated well throughout the month. The Matlab license expired and had to be reinstalled on both computers.

O-202-P: ANTARCTIC METEOROLOGICAL RESEARCH CENTER (AMRC) SATELLITE DATA INGESTOR.
Mathew Lazzara, Principal Investigator, University of Wisconsin

The AMRC computer processes satellite telemetry received by the Palmer Station TeraScan system, extracting Automated Weather Station information and low-resolution infrared imagery and sending the results to AMRC headquarters in Madison, WI. The Research Associate operates and maintains on-site equipment for the project.

The data ingestor computer system has been operating normally all month.

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 interannual variations in atmospheric O_2 (detected through changes in O_2/N_2 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 CO_2 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 when the winds were favorable and HATS Air samples were taken twice this month.

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 throughout the month. The aspirating fan on the PSP is no longer working.

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 well throughout the month.

T-312-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 Orbital Elements were updated on the Terascan system. More maintenance was done on the antenna. Photos of the computer system were taking to compare it with a possible replacement system from the NBP.

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. The grantee was on station maintaining the system.

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 and the tidegauge worked well throughout the month. The observations and tide data are archived on the AMRC website: ftp://amrc.ssec.wisc.edu/pub/palmer/

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. The Joubin and Wauwerman sites are beginning to come back online as the sun get higher in the sky. Some data was lost due to a loose connection on the Communications side of the system. The solar shield on the temp/humidity sensor blew off during high winds, but has been replaced.

A classic Palmer sunset from atop the glacier in the Backyard. *Image Credit: Ken Keenan*