

# Austral Extremities



Murray Field Team (Right to left): Dr. Alison Murray, Brandon Carter, and AK.

the ice, although beautiful, was not cooperating, and had blown in tight to the coast. Not to be discouraged, we began setting up our laboratory, and took advantage of the Laurence M. Gould's 3-day layover at Station to collect our first samples...



Launching the CTD off the Laurence M. Gould, in Arthur Harbor, Anvers Island.

On September 25<sup>th</sup>, we finally arrived at Palmer Station, Anvers Island, Antarctica, via the Laurence M. Gould. Our passage was relatively calm, as conditions in the Drake Passage can be unforgiving (an understatement). In fact, the crew who left Station on the very same ship experienced, in the words of the Chief Mate "our worst crossing ever." In addition to our delayed arrival,



The view west from Palmer Station.

## Searching small, to see the big picture...

### 1. Darkfield microscopy-

microscope slides prepared on a dark background, on which the organisms of interest appear light.

2. Extremophiles- organisms that thrive in extreme environments, e.g. very salty (halophilic), extremely hot (thermophilic).

3. Genomics- the study of the entire DNA sequence (all of the genes) of an organism or group of organisms.

4. Psychrophilic- (cold loving) organisms that are adapted to extreme cold environments.

5. Phylogenetic - organisms that are grouped together based on their degree of genetic similarity.

6. PCR - a method of amplifying genetic material that uses polymerization (making many units). PCR is also used to make plastics (long-chain polymers).

7. Diurnal- an event that occurs every day, and occurs during daylight and stops at night. By collecting day and night samples, we can compare for differences.

As I scan the night sky (an inverted sky, to my boreal frame of reference) eyeing the Southern Cross, I am filled with awe at its resemblance to the microscopic world depicted on the slides we've prepared from Arthur Harbor seawater. We're using **dark field microscopy**<sup>1</sup>, with a fluorescent dye (DAPI), to locate Archaea and other microbes that we've recovered from our samples. Too many hours at the scope convince me I've seen Ursa Major in its field of view...



On the sea ice, in search of seawater.

Life in extreme environments comes easier to some organisms than others. Archaea are unique and unusual microscopic life forms in that they are prokaryotes (bacteria) that share some characteristics of eukaryotes (plants, algae, mammals). Most Archaea are **extremophiles**<sup>2</sup>, and they're an important part of our work here in Antarctica. Dr. Murray is a specialist in microbial **genomics**<sup>3</sup>, and is studying which genes are expressed in **psychrophilic**<sup>4</sup> Archaea and other cold-adapted marine microbes. While a species of organisms is genetically identical (in terms of the genome sequence), the actual genes that are expressed in individual

organisms at a given time can vary greatly. Gene expression has been shown to change rapidly in some microbes under varying environmental conditions, even within hours. We will be collecting Archaea and other marine microbes to determine which genes are expressed depending upon their environment. We'll look at

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how Archaea and bacteria that reside in light (shallow) water differ from those in dark (deep) water. We will also try to induce changes in their gene expression, by exposing them to warmer or colder temperatures, different photoperiods, variations in pressure, different nutrients, etc. This information helps us understand the organism's adaptability.

Are the resident Archaea in Arthur Harbor's waters really extremophiles? While the Antarctic waters are indeed colder than most ( $\sim -1.8^{\circ}\text{C}$ ), that's not *extremely* cold. However, the length and variation in photoperiod here *is* extreme. Still, deep water resident Archaea aren't likely to be affected by photoperiod. Maybe these Archaea aren't extremophiles at all, which would make their **phylogenetic**<sup>5</sup> link to other Archaea (those who reside in deep thermal vents, extremely saline environments, etc.) all the more intriguing. As more than 20% of the local ocean microbial population, there is something truly special about Archaea.

## The process...

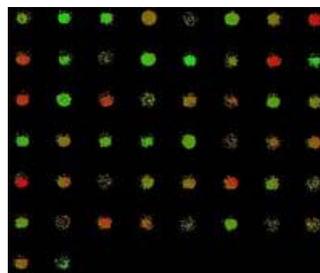


**Step 1 - Collect Archaea and marine bacteria!!!** Arthur Harbor is our intended source for seawater and ice, where the microbes live.

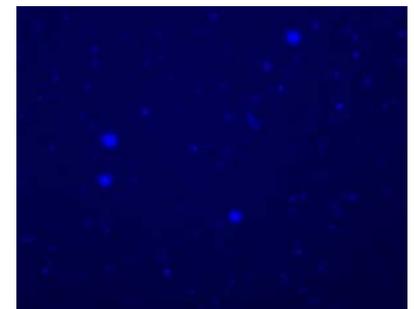
**Step 2 - Concentrate the sweater to get biomass.** We use a tangential flow filtration system to maximize our recovery without damaging the cells.



**Step 3 - Quality control - we make slides of the concentrated samples to quantify the number of cells in the samples, and to see "who's there."** We're interested in the tiny bright dots, which are bacteria and Archaea.



**Step 4 - Isolate DNA and identify genes!** This micro-array helps us see which genes are turned "on" (expressed) or turned "off" (not expressed).



## Some challenges...

In addition to the ever-fickle whims of the weather, collecting enough Archaea poses a few challenges. The Archaea in this region experience a surge in abundance tied to the austral winter (June-August), which begins to increase in late fall (May) and drops off significantly in mid-spring (October). These early- and late-season surges don't correspond to guaranteed open water, which we need to boat to our stations. So we wait...and we wait - for stable sea ice (that we can walk out on to sample through ice cores) or for open water. In addition, we need biomass, and lots of it. While many microbes can be cultivated in the lab, Archaea have yet to be cultivated successfully. This is part of the effort while we're here - can we culture

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the organisms, or must we obtain them from the sea? We use PCR (**polymerase chain reaction**<sup>6</sup>), a breakthrough biotechnology tool of the 90's, to verify if the cultures contain Archaea. Though we can detect the Archaea, much work remains to be done back in the States, to determine the cold-adapted gene expression.



Brandon cultivating microbes in the "cold room," which is kept at 2°C to approximately mimic their natural ocean environment (-1.8°C).

## Outside the science world...



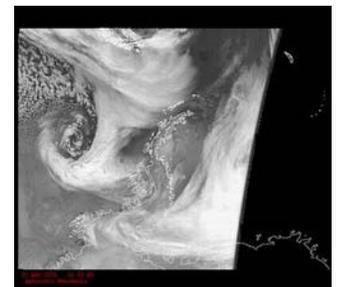
Alison Murray holds fast to the only thing keeping her on the ground, during our diurnal collection.

In other news, neighboring Antarctic station Rothera, operated by the Brits, suffered a great loss when its entire biology lab was lost to a fire last week. All anyone could do was stand by and watch as it burned to the ground. In spite of this devastating loss, no one was hurt, and the winds directed the flames away from other structures. This tragedy was a somber reminder to all of us of the importance of drills, and just how tentative is our existence here.

Whirling winds and white out conditions kept us holding fast to the handrails and blinded in the wee A.M. hours during our first **diurnal**<sup>7</sup> sample collection. We collected seawater from the pump house, a comfortable 20-feet from station, from midnight to 2 A.M. to give us an idea of the gene expression patterns during the dark hours of the day. A state of near calm, moments later became winds gusting to 72 knots, leaving a frosty blanket on every window in the building. Just as quickly, the winds calmed, and all was quiet before our Station compadres rose to greet

the day.

We continue to wait for the strong east winds to blow the sea ice pack offshore, and open the waters to our efforts. Other options include the ever-risky attempt to access seawater through holes we cut in the ice - but the ice pack stability must be ensured each day by our resident experts, the GSAR (Glacier Search & Rescue) team. Nearly as eagerly, we anticipate the arrival of the Adelie penguins, who should appear en masse any day now... Already, the great Southern Elephant Seals have begun to haul out near station, bringing their late-night serenades and stale aroma with them. Early this morning Alison Murray spied a group of blue-eyed shags (cormorants), the first she'd seen this trip. Summer is indeed trying to make its presence known.



Satellite image of a storm over Palmer Station

We are heavily insulated against the tenuous political situation in the states, and have many questions unanswered. While we can read news briefs during our limited (and Draconian) Internet availability, it's difficult to gauge what passes at home. At times, this seems the best place to be, while at others, we yearn to be among our friends and engage in deep discussion regarding our country's predicament. Know, all, that we are thinking of you and hoping you are with friends and family as the wind moves in Afghanistan.