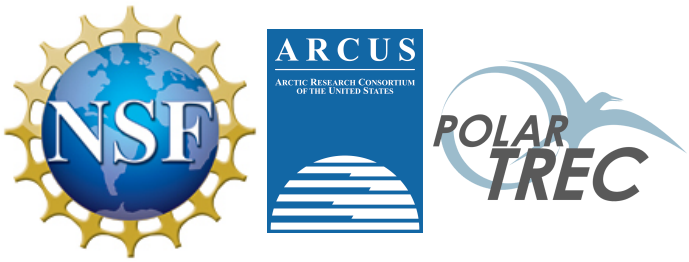
TEACHERS AND RESEARCHERS EXPLORING AND COLLABORATING

# PolarTREC STEM Experience Report

## Chemical Ecology of Shallow Water Marine Communities

PolarTREC Expedition Page
https://www.polartrec.com/expeditions/chemical-ecology-of-shallow-water-marine-communities

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## The PolarTREC Field Experience

A simple Google search changed my life. I always knew I wanted to go to Antarctica, but getting the opportunity to visit the continent as part of a research team was something I never imagined. A year ago, I was looking for a way to become more involved and connected to the research science world. I am an AP Environmental Science teacher and a table leader at the AP grading in June, so I felt connected to a wider group of high school and college educators, but was missing how research really brings science as a process alive. It has been over twenty years since I finished my masters' thesis, researching red wolves at Alligator River National Wildlife Refuge in eastern North Carolina and I had an itch that needed to be scratched. With that Google search, I discovered PolarTREC and began completing the lengthy application process. After a long waiting period I received a email saying a research group from University of Alabama at Birmingham (UAB) would like to interview me. The interview was very successful and within hours I had accepted the position with Principal Investigator (PI) Dr. Chuck Amsler and the UAB research team at Palmer Station.

*The UAB team and University of South Florida PhD. student*

The field experience would begin and end with a four-day boat ride across the Southern Ocean and the much talked about Drake Passage. There was not a lot of science on this voyage of the Laurence M. Gould (LMG), but I was able to get involved in the XBT data collection that looks at temperature and depth across the Drake Passage. The LMG is the smaller of the two US ships stationed out of Punta Arenas Chile.

*The LMG and Palmer vessels dock in Punta Arenas, Chile*

There have been nightmare stories from the crossing of the Drake Passage and just this year, there was a major accident when one of the scientists was thrown from his bunk and broke numerous bones. Luckily, I did not experience anything of that magnitude, although we had a day or two of rough seas on the way back to Punta Arenas. During this expedition, I would spend 24 days on the Western Antarctic Peninsula at Palmer Station, the smallest of the US stations which can hold a maximum of 44 persons, but during my stay was at 90% capacity.

## Summary of the Science

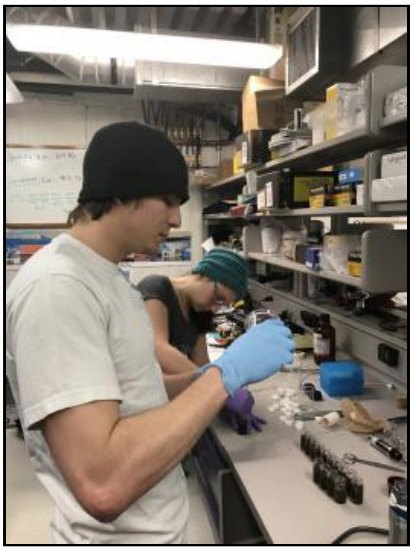
The Principle Investigator I worked with was Dr. Chuck Amsler from the University of Alabama at Birmingham and his team of Maggie Amsler, Sabrina Heiser, Michelle Curtis, CJ Brothers and the chemist and diver Andrew Shilling, a Doctoral student from the University of South Florida. The research consisted of three main parts: first, collecting algae and invertebrates from the shallow

*Launching the XPT to measure temperature and depth while crossing the drake passage.*

water marine environments. Second, the extraction and isolation of specific chemical compounds called chemotypes from these organisms that were then used in bioassays. And finally, Sabrina's research into the life cycle and chemical defenses of the alga *Plocamium cartilagineum*.

Scuba Diving in Antarctica takes a lot of experience, preparation, and stamina. You need to be completely covered in a dry suit with only a small area of your face exposed. The divers would stay submerged up to 45 minutes at a time and would sometimes complete up to 3 dives in one boating session. My job during this part of the research was a dive tender, I would help the divers get into their gloves and get their tanks on before the entered the water.

While the divers were in the water, we kept a constant lookout for leopard seals and kept the communications center at Palmer aware of the progress of the boating trip. When the divers came up with the seaweed, invertebrates, or experimental substrates the dive tenders would bring the specimens, equipment and tanks onboard the boat.



*Andrew Shilling and Michelle Curtis isolating chemotypes in the lab*

Once chemotypes were isolated, research was conducted through bioassays that consist of using a dried krill or algae based pie mixed with the specific isolated chemical compound from algae or an invertebrate species and testing it against a control pie of krill or algae with only the chemical used to extract the tested compound. Researcher CJ Bothers describes the experiments his way:

"The seafloor along the western Antarctic Peninsula is covered with macroalgae and small invertebrates living on the macroalgae. Most macroalgal species, such as the red alga *Plocamium cartilagineum*, produce chemical compounds that discourage invertebrate grazing. However, the amphipod, *Paradexamine fissicauda*, is a "cheater" and can consume *P. cartilagineum* and sequester the chemicals to protect itself against fish and other predators. Research conducted by the Amsler/Baker/McClintock group has determined that *P. cartilagineum* produces multiple "chemotypes" or multiple sets of chemical defensive compounds. However, we do not understand why the alga needs to produce multiple chemotypes, and what effects different chemotypes have on amphipods consuming the alga."

"The purpose of this experiment was to determine how different chemotypes of P. cartilagineum affect the growth and reproduction of the amphipod Paradexamine fissicauda. To answer this question, we held juvenile amphipods in containers for 60 days while being limited to a single food source – either a non-chemically defended macroalga (control group) or one of seven different chemotypes of P. cartilagineum (experimental groups). We measured the length and

*Helping Maggie Amsler getting her gloves on before a dive*

weight of the amphipods at the beginning of the experiment and after 30 and 60 days. We also conducted the same experiment with adult amphipods, to determine the effects of macroalgal chemical defenses on reproduction. In addition to measuring growth, at the end of the experiment we determined how many adult amphipods were carrying eggs, and the clutch size. These data will help us determine why macroalgae produce a variety of chemical defenses, and what effects these chemical defenses have on amphipods living on the macroalgae."

*Feeding Sea Stars as part of a bioassay*

Sabrina's Heiser's PhD work entails a lot different aspects of study with *Plocamium* and the shallow water marine environment, but her work this Antarctic season dealt mainly with trying to discover whether the chemical defenses of the *Plocamium* are dependent on the location where the red algae is growing. Last year, Sabrina took individual plants with specific chemotypes from one area of the Palmer Station dive area and transplanted them to other areas and depths using concrete blocks as substrate to grow the algae. This year she harvested those *Plocamium* specimens and will wait for Andrew and the lab at the University of South Florida to isolate the chemotypes. These data will allow Sabrina to determine if location has an influence on the chemotypes produced by the algae.

## The Importance of Teacher/Researcher Collaboration

The teacher and researcher have different expertise and approach the knowledge of science from different perspectives. The highest goal of a high school teacher in the classroom is to produce students who are scientifically literate and on occasion to graduate students who go into a field of science and add to the academic knowledge of a scientific subject. Researchers pursue the knowledge that is at the base of being scientifically literate, but without new students to take up and expand that knowledge a great deal will be lost to the ether. By allowing teachers to join in and work on experiments through the PolarTREC program researchers are ensuring a future of study in science. Teachers are great at outreach, that is basically what I do everyday in the classroom, we can often reach a wider and more varied audience than most researchers can teaching in a university or presenting at a conference of scientists already interested in the subject matter. For example, during my live PolarConnect event we had over 150 computers signed in for the event. If 100 of those computers were

*UAB student Sabrina Heiser identifying Plocamium specimens in the wet lab at Palmer Station*

teacher's classrooms we had over 2,500 people listening in on the event. These are students and adults that may never have even heard of *Plocamium*, amphipods or thought of how chemical defenses in algae or sponges might be used in human medicines. The ways the teacher is impacted are limitless, I learned and was reminded of so much science during my expedition that my teaching will be forever changed. Instead of using cookie-cutter experiments that teach students how to follow directions, I will begin to add more labs that teach science as a process and labs that have impact in the real world.

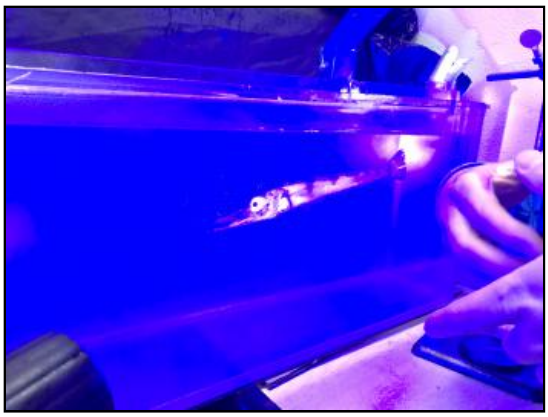
## Bringing it All Back Home (Students, Community and Polar Research)

My main hope from this expedition was to improve my knowledge of polar research and to become reacquainted with experimental science. Through this experience I will improve the way I teach and I now have new knowledge of experimental design. The research with the UAB team will be helpful when setting up experiments in my AP Environmental Science classes, especially when it comes to biological stimulus, climate change, resource partitioning, and even LD and ED 50 lessons. My PI, Dr. Amsler, allowed me to take part in much of the other research going on at Palmer Station. Through the three research teams at Palmer Station, including my UAB team, I gained invaluable knowledge to help me combat what I believe is our biggest environmental problem, that of climate change. A Duke team, who was represented by KC Bierlich, and Michelle Shero was researching how humpback whales put on weight during their Antarctic feeding season.

*Dr. Thomas Desvignes shows the clear blood of the icefish...no hemoglobin*

Climate change has a huge impact on the future of these whales. The whales and really most of the food web of Antarctica are dependent on krill and krill is dependent on sea ice which is drastically shrinking due to climate change. Another research team was studying the icefish, a very interesting fish that does not have hemoglobin in its blood. It carries dissolved oxygen in its blood that supplies the organs with the oxygen they need. The icefish carries dissolved oxygen in its blood at 21%, but as ocean temperatures warm they will not be able to carry as much dissolved oxygen and that will impact all their organs especially their eyes.

Water temperature also effects the rate at which their eggs develop, speeding it up. Meaning the eggs will hatch at very different times than the needed food supply. In fact the whole shallow water marine environment around Antarctica may be heading towards disaster from a very unlikely source. Benthic king crabs are now amassing on the continental slope of Antarctica. Once confined to the deep ocean where temperatures are actually warmer than the shallows, they were unable to move into waters below -0.4 degrees Celsius. The salt in the oceans allow waters in Antarctica to reach -1.8 degrees Celsius. As global temperatures raise, ocean temperatures will as well, which will allow the king crabs to migrate into the shallow water marine environments. For millions of years the shallow water marine environment around



*The translucence of the icefish glows under a black light*

Antarctica has evolved without a skeleton crushing organisms like the king crab, and the native organisms located in this environment do not have any defenses against the king crab. My students from last year, my future students and the community at large have already shown a huge interest in my expedition and I cannot wait to share my experience with all of them.

## Community Outreach

One of the most delightfully surprising aspects of my return to North Carolina was all the interest I have received in my expedition. Students, friends, colleagues, acquaintances, and people I don't even know have approached me to ask questions about my experience or ask if I could do a presentation to their classroom, association, or group. I already have been asked to give presentations in classroom in two counties other than my own. Teachers at my school are asking when I plan on presenting to the faculty and staff. Elementary and middle school teachers have asked me to present to their classrooms. I already have plans to present to two organizations in our county and two breweries. The local paper will write a follow up article about my expedition. I plan on creating a group of students who will visit local elementary and middle schools to share lessons on polar science. One of the outreach plans I am most excited about is creating an Arctic/Antarctic presentation with fellow PolarTREC grantee Wendy Pillars that we can give at scientific conferences in the future. My PolarTREC experience peaks interest in almost every person I meet regardless of age and gives me an opening to talk about polar science and climate change to people and groups I never imagined I would have a chance to. I am excited about the opportunity that PolarTREC has allowed me to have and will spread the science I have been exposed to at every opportunity.

*Duke researchers use drones to monitor weight gain over the feeding season*

*LMG rolling through 20ft waves, this splash soaked me way up on the bridge.*