POLAR RESOURCES




17 May 2004 Newsletter THIS ISSUE: Arctic Insects, Updates from Greenland, Alaska, and TREC

Arctic Insects Truly Are "Supercool"

Insects can be found just about anywhere in the world including the Arctic. But without the luxury of body fat or fur, how do insects survive the harsh, cold, arctic temperatures without freezing to death? Jack Duman, Gillen Professor and Chair of the Department of Biological Sciences at the University of Notre Dame, has been pursuing the answer to this question for more than 25 years, and he has uncovered some pretty fascinating answers.

Cucujus beetle

Just like we use antifreeze in our cars to prevent the engine from freezing up on cold winter days, Mother Nature has devised her own form of antifreeze through proteins that enable organisms as diverse as beetles and spiders, fish, plants, bacteria, and fungi to withstand freezing temperatures. Appropriately enough, these proteins are called antifreeze proteins (AFPs), and they function by lowering the freezing point of water so that the organisms that carry them can withstand temperatures well below 0°C. Insects carry the most active AFPs of all organisms, which make them ideal AFP subjects for study.

AFPs act to promote supercooling in two ways. In the first, they prevent external ice from forming across the tough, exterior insect cuticle by butting their way in between water molecules to prevent their interaction. This, in turn, protects the insect's internal fluids, or hemolymph, from freezing. By another mechanism, the AFPs glom on to certain molecules, called ice nucleating agents, to effectively shield their surfaces so that water molecules cannot attach to them, which is necessary for the formation of ice crystals.

Having long studied insects in his home state of Indiana, Duman began studying Alaskan and arctic insects in August 2001 in collaboration with Brian Barnes from the University of Alaska at Fairbanks. With the help of VECO Polar Resources, the Institute of Arctic Biology, and the Barrow Arctic Science Consortium, the research team ventures into the field at least three times a year for three weeks during September, January, and March. While in the field, they first identify where the insects of interest are residing, and they then place the insects in special enclosures to monitor them over the long winter season. They also search for new species to test for the presence of AFPs. Since beginning their studies in Fairbanks, Wiseman, Barrow, and Toolik Lake in Alaska, the researchers have identified 18 arctic insect species with AFPs; no arctic AFP-carrying insects had been characterized before this time.

Extending his studies of AFP proteins in the Indiana *Cucujus clavipes* beetle, Duman focuses part of his studies on AFPs in *Cucujus* found all the way up to the latitudinal tree line near Wiseman. Whereas the Indiana *Cucujus* larvae attain an average supercooling temperature of about -24°C before freezing in winter, the Alaska larvae achieve an average supercooling temperature of approximately -42°C. Based on their January 2004 findings, Duman stated that some beetles can supercool to temperatures below -80°C!

Project lead Jack Duman and grad student Kent Rogers, Notre Dame, search for Hypnoides beetles under rocks at Sag River in late September.

To achieve such incredibly low freezing points, the Alaska *Cucujus* employ some strategies that the Indiana beetles do not. First, the Alaska insects undergo extreme desiccation, dropping from about 63% water to roughly 35%. This results in less water within the insect that can freeze, and it also concentrates the AFPs and other freeze-preventing solutes, called polyols, within the insects to provide more freeze-protecting punch. The Alaska *Cucujus* also slow down their metabolisms during the winter through a process called diapause, which permits the production of fewer proteins for survival. This, in turn, may result in fewer ice nucleating agents within the insects and fewer opportunities for water molecules to stick to something to begin forming ice. ***(Continued on 2)***

Ph.D. student Todd Sformo, UAF, checks a temperature logger at Sag River, in early March. In the autumn boxes of collected insects are left buried on site for easy winter retrieval along with temperature logger data.

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Greenland

Who's in the Field?

UPCOMING GREENLAND EVENTS

ANG Flight Period
17 – 22 May
Ohmura Team In

Swiss Camp In
19 – 20 May

Greenland Holiday
30 – 31 May

Kangerlussuaq & Remote Sites
With no flights, the Kanger crew was able to catch their breath, clean up from the fray, and begin planning for the next flight period.

Joe McConnell's team finished their first of five sites, drilling 114m of 4" core. After being weathered in for 3+ days, they dug out and moved on. By Saturday they were already at 90 meters and three of the team members went on to the next drill site with the 2.5-inch drill where they hope to get to 60 meters.

On Thursday, the Cryosat UK1 team was pulled out of their camp outside Ilulissat via helicopter. They return to Copenhagen on Monday. The UK2 continues on their traverse and has so far covered is 1/3 of the distance to Summit. They have 16 more sites to visit before their arrival at the top of the ice cap around 14 June. For more on Cryosat visit: http://www.esa.int/export/esaLP/cryosat.html

Koni Steffen's field team on Petermann Glacier had excellent weather and a successful week of science studying the melting of the Petermann, the largest glacier in central northern Greenland. They placed instruments on the floating tongue of the glacier where it drains the ice sheet at a rate of 12 cubic kilometers per year. 67 meters of ice separated the research team from the water below them.

The drill hole at Petermann

Raven
It was a quiet week at Raven Camp. High winds kept camp activities to a minimum until Thursday when the crew got busy digging out and preparing the skiway for next week.

Summit
Camp staff worked in the cargo yard all week in preparation for the next flight week. Construction completed the tough task of rolling up all the power cables from satellite camp and pulling the poles that brought those cables from the shop to sat camp, giving camp a very different look!

Bob Hawley and Greg Lamorey had success with their sonic logging activities at GISP2 and report that due to improvements with their tool they are really happy with the data they are getting this year. They moved their setup to GRIP on Sunday, where they will conduct sonic logging upon their mid-June return to Summit. Next week Bob Hawley moves to Raven to begin his work on his newly funded project with Ed Waddington conducting firn density studies using optical logging.

The hot water drill at Petermann

Weather
Very windy conditions predominated southern Greenland weather early in the week and Raven recorded gusts over 50 kts. The McConnell team was tent-bound for 3 days due to high winds and blowing snow. Sunny, warm weather arrived mid-week. Summit winds have been mild with an average of 8kts and temperatures from –17c to –28c. The Kangerlussuaq crew is enjoying the absence of bugs.

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Studying AFPs and how they function could lead to some very useful applications. For example, AFPs could be engineered into certain plants or crops to make them more cold tolerant. Duman is in the process of exploring this possibility by inserting an AFP-coding gene into a small, model plant called *Arabidopsis thaliana.* As they hoped, they did see a depression in plant freezing of 1° to 3°C, and additional studies are underway. AFPs, even tiny amounts, also effectively prevent recrystalization. This is a process whereby, over time, small ice crystals reconfigure to form bigger crystals, because it's more energetically favorable for the water molecules to do so. (If you have ever pulled an old carton of ice cream out of the freezer and found the top covered in large ice crystals, then you have first-hand experience with recrystalization.) Recrystalization typically causes tissue damage in organisms, but AFPs may someday be utilized for biocryogenic applications, such as prolonging the storage of blood or preserving donated organs.

Many thanks to Jack Duman and Oivind Toien for text and photos. Visit these sites to read more about the Principal Investigators, Jack Duman: http://biology.nd.edu/JohnG.Duman.shtml and Brian Barnes: http://www.tedmed.com/barnes.html

More about this research can be found in the most recent edition of ARCUS' *Witness the Arctic* Newsletter: http://www.arcus.org/Witness_the_Arctic/Spring_04/Contents.html

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Alaska

Who's in the Field?

Martin Truffer's camp at Black Rapids

A BO-105 helicopter commuted to Barter Island on May 10th and spent the week moving 11 team members and 5,000lbs of gear to two separate camps on the McCall Glacier in the Arctic National Wildlife Refuge. Matt Nolan's team required 4 flights, while 6 were required for the team from Japan's National Institute of Polar Research (NIPR). Dr. Nolan is on the McCall as part of a project documenting changes in the storage of freshwater in the Arctic. The NIPR team is part of a large effort drilling ice cores around the Arctic for paleoclimate research. The two teams will remain on the glacier for three weeks. For more information go to: http://www.uaf.edu/water/faculty/nolan/glaciers/McCall/index.htm

Martin Truffer wrapped up a successful trip to Black Rapids glacier for his team's study of basal stress and motion at the glacier. For more information about the research go to: http://www.gi.alaska.edu/~truffer/research_main.html.

Next week, Martin Luthi and Ted Clark will begin fieldwork for their newly-funded Arctic Natural Sciences grant. They will join a Japanese team, led by Takayuri Shiraiwa of from Hokkaido University, who are conducting ice coring in the summit caldera for a trans-Pacific climate reconstruction project. Martin and Ted will carry out seismic work that will aid in the interpretation of the ice cores.

VPR staff pulled and shipped gear for Dr. Jim Dixon's archaeological survey work at On Your Knees Cave, Prince of Wales Island. For more information about research at On Your Knees Cave visit: http://www.usd.edu/esci/alaska/oykc.html

Toolik

At Toolik Field Station the VPR construction crew worked on building a deck roof for the BBQ area, put in the new screen doors on the Dining Facility, and placed the air conditioner into the Incubation Facility. The crew delivered the stanchion pieces for the boardwalk just before the big melt (as pictured to the left). For more information on Toolik please visit the Toolik website at: http://www.uaf.edu/toolik.

UPCOMING ALASKA EVENTS

5th International Congress of Arctic Social Sciences
Fairbanks, AK
19-23 May

LTR Program Toolik
Toolik Field Station, AK
21-25 June

Weather and Road Conditions

- ✓ For current weather conditions throughout Alaska go to: http://pafg.arh.noaa.gov
- ✓ For up to date road conditions visit http://511.Alaska.gov.

Helo Schedules Now Available

Summer helicopter schedules for Toolik and Barrow are now available for download on the web site. Go to http://www.vecopolar.com > Alaska > Calendars and Schedules

TREC Updates…

Greenland "TRECCER" Nikki Airaudi is back at home teaching 8th grade science after spending 3 weeks in Greenland. Nikki and her class were featured in a local newspaper: http://www.gmtoday.com/news/local_stories/2004/May_04/05122004_01.asp

8th grade teacher Patty Cie from Yelm, Washington arrived in Nome, Alaska on May 14th to embark the US Coast Guard Cutter Healy and participate in a cruise studying Shelf-Basin Interactions in the Chukchi and Beaufort Seas. Find out more about Patty's trip and the research project she is participating in at http://www.arcus.org/TREC/phpbb/portal_healy.php.