Vol. 10, Spring 2000

NEWSLETTER FOR THE

Canadian Antarctic Research Network

INSIDE

Reckoning Lake Vostok

Eddy Carmack[1] and John Wüest[2]

Much like a fictional "Lost World" of childhood movies, Lake Vostok has until recently escaped man's detection. Located in East Antarctica (Fig. 1), the 10- to 20-million-year-old freshwater body is covered by a 3.7- to 4.2-km-thick layer of glacial ice. Lake Vostok is big: it has an area (~14,000 km^2) near that of Lake Ladoga, a volume (~1,800 km^3) near that of Lake Ontario, and a maximum depth (> 500 m) near that of Lake Tahoe. While the lake has yet to be penetrated, remote survey methods suggest that it is filled with fresh water and that its floor is covered with thick sediments (Kapitsa et al., 1996). New analyses of Vostok ice core data reveal that microbes that have been isolated for millions of years still live in its waters and sediments (Vincent, 1999; Priscu et al., 1999; Karl et al., 1999). This combination of thick ice cover and the extreme isolation of its microbes makes Vostok an excellent analog for planetary exploration (F. Carsey, pers. comm.). However, these extreme conditions call for the use of *in situ* micro-robotics specially designed to address an anticipated range of physical and geochemical conditions within the lake. To spur discussion on water circulation to be expected within Vostok, we applied thermodynamic and hydrodynamic principles to ask: "How fast is the water moving?" (see Wüest and Carmack, 2000).

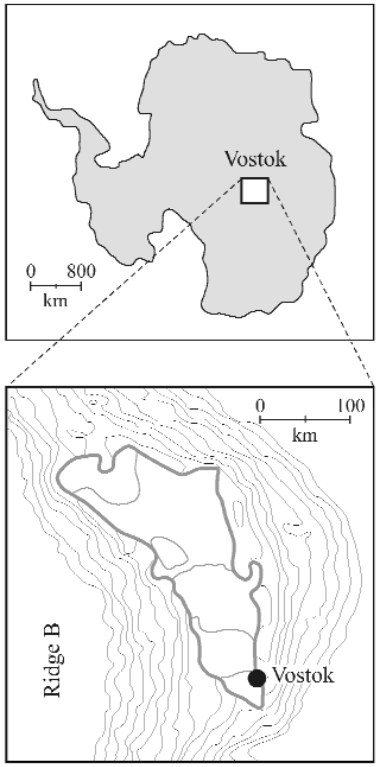

Figure 1: Location and map of Lake Vostok, adapted from Kapitsa et al., 1996.

Density-driven flows are likely to dominate water motion within Lake Vostok; and thus thought must be given to (1) the joint effects of high pressure on both the density and the freezing point of fresh water; and (2) the role of geothermal heating (perhaps 50 mWm-2). The depression of temperature of maximum density with pressure is TMD ~ 4°C - 0.021p, where p is pressure in bars, while the depression of the freezing temperature with pressure is TFP ~ 0°C - 0.00759p (Chen and Millero, 1986; Fujino et al., 1975). These two lines cross at a critical pressure (pcrit) near 305 bars, which corresponds to an overlying ice thickness of about 3350 m (Fig. 2). Above pcrit TMD > TFP, and the system is stable when temperature increases with depth; that is, it behaves as a lake (think of a normal ice-covered lake in which the warmest water is found at the bottom). Below pcrit TMD < TFP, and the system is stable when temperature decreases with depth; that is, it behaves like an ocean, such that water would rise when heated from below.

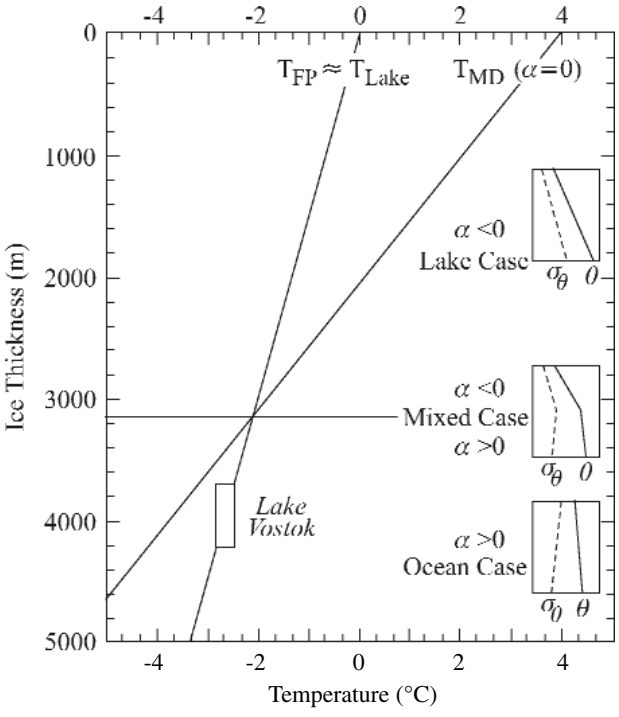

Figure 2 : Plot of the freezing temperature (TFP) and the temperature of maximum density (TMD) as a function of ice thickness. Three types of lakes under ice can be expected in Antarctica, depending on whether the ice thickness is larger, less, or about equal the critical depth (~3170 m depth for rIce ~913 kg m-3), where TFP and TMD are equal. In Lake Vostok TFP (~ - 2.7°C) is warmer than TMD (~ -4°C) so the thermal expansion coefficient α is positive ("Ocean case"); subsequently, potential density σθ increases when the potential temperature decreases with depth

Lake Vostok falls in the "ocean" category. Other Antarctic subglacial lakes (for example the one at South Pole) fall into the "lake" category. To make things (even) more complicated, the ice-water (ceiling) and water-sediment (floor) interfaces of the lake are sloped.

Using scaling arguments for fluid motion, we predict two types of internal motions: (a) vertical convective plumes with velocity scales of ~0.3 mm s-1 and (b) horizontal convections of about the same magnitude. Vertical convection is due to the geothermal heat flux, while horizontal circulation is tied to latent heat fluxes (melting and freezing) along the tilted ice ceiling. Vertical mixing is very fast, a time scale of days. Melting and re-freezing associated with the horizontal flow is predicted to flatten the ice cover to a remarkably smooth terrain as the glacier moves over the lake on a time scale of ~20,000 years. We also note that field experiments could be carried out to see if flow can be detected in similar (but less extreme) high pressure and low temperature situations (e.g. beneath the Ward Hunt Ice Shelf in the Canadian High Arctic; Jeffries, 1992).

Eddy Carmack is a research scientist with the Institute of Ocean Sciences, DFO, in Sidney, B.C. John Wüest is a specialist in aquatic ecology with the Swiss Federal Institute for Environmental Science and Technology.

Footnotes:

[1]Institute of Ocean Sciences, 9860 West Saanich Road, Sidney, BC V8L 4B2, Canada
E-mail: Carmack@pac.dfo-mpo.gc.ca

[2]EAWAG and ETH, CH-8600 Dübendorf, Switzerland

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Skating on Thick Ice: An MP in Antarctica

Peter Adams

In January 1999, the Hon. David Anderson, then federal Minister of Fisheries and Oceans, now Minister of Environment, attended the "Ministerial on Ice" at New Zealand's Scott Base in the Ross Sea region of Antarctica. He represented Canada at a meeting of ministers and officials from 23 countries.

In January 2000, at the invitation of Antarctica New Zealand, I visited the same region in the company of the Chief of the NZ Defence Force, the Chair of the Foundation of Research, Science and Technology, NZ, the Deputy Secretary, Foreign Affairs and Trade, NZ, and representatives of Antarctica New Zealand. My purpose was to further explore Canada's involvement in Antarctica, with particular reference to co-operation with New Zealand. I was thoroughly briefed before leaving for Antarctica, and I particularly thank Prof. Warwick Vincent (CCAR) and Dr. Clive Howard-Williams (New Zealand) for facilitating the visit.

I met Canadians wherever I went. For example, Valerie Villeneuve, of Université Laval, was doing research from Bratina Island on the McMurdo Ice Shelf, Yannick Huot of Dalhousie, was taking a course at the Crary Lab, McMurdo, Phil Holme, a graduate student at Victoria University of Wellington, was doing geological fieldwork, and Ian Hogg, now on the faculty at Waikato, was studying freshwater invertebrates. In addition, I met Twin Otter pilots of First Air, Yellowknife, on their way home after completing a contract. Various non-Canadian researchers spoke to me about Canadian colleagues who had been there or who were due to arrive.

This sample, from a short visit to one sector of Antarctica, suggests that the scale of Canadian activity on the continent is very considerable.

Yet, as readers of this newsletter well know, Canada is not a full participant in the Antarctic Treaty system. We participate in a variety of Treaty activities but as a second class-member. To be a full member, among other things, we need to support an expedition or base, or engage in some equivalent activity in Antarctica.

Canada's limited involvement in Antarctica has become an item of international gossip. We are said to be the only country that makes a profit there. The reason for this is that our pilots, aircraft, and engineers are in great demand in and around the continent because of their cold environment capabilities. Our snowmobiles, parkas, *mukluks,* boots, huts, tents, and remote sensing technology are prominent down here. The two largest Antarctic tourism companies are based in Canada. So, business is good for us in Antarctica.

At the same time, our researchers and students, who are spread throughout the continent, like those whom I met, all piggyback with other nations. They are attractive to their hosts because they tend to bring cold weather as well as scientific expertise. This is a cheap way to do research in that remote region.

I think that it is admirable that our people can work so effectively with all 27 Antarctic Treaty nations. We should continue to do so. I suspect that our contribution to science in Antarctica, even taking into account the piggybacking, is likely already as substantial as that of several minor Antarctic Treaty nations. However, I also believe that the time has come for us to move to full status in the Treaty. We have a moral duty to do so, and it makes good sense as a means of strengthening science in Canada. In my report, I make the case that we can achieve full Treaty status by taking a few simple steps, including more formal co-operation with New Zealand. Copies of the report are available on request. My main recommendations are as follows:

- that the existing Canadian Arctic/Antarctic Exchange Program be strengthened;
- that Canada establish a formal agreement for co-operation in polar matters with New Zealand;
- that Canada ratify the Protocol on Environmental Protection to the Antarctic Treaty, passing the appropriate domestic legislation; and
- that Canada become a Consultative Member of the Antarctic Treaty.

Peter Adams is MP for Peterborough (Adamsp@parl.gc.ca), and a former research scientist with Trent University.

Letter from the Chair of CCAR

Warwick Vincent

This year marks the beginning of the second term of office for the Canadian Committee for Antarctic Research (CCAR), Canada's national Antarctic committee under the auspices of the Scientific Committee for Antarctic Research (SCAR). It's time, therefore, to take stock of CCAR's accomplishments over the first two-year term, and to set priorities for the immediate future.

CCAR was established concurrently with Canada's successful application for full membership, in SCAR. Much of our work has therefore revolved around the formal requirements for membership, such as appointing and liaising with Canadian representatives to SCAR working groups and responding to various requests for information and reporting. CCAR also inherited responsibilities for the Canadian Arctic–Antarctic Exchange Program, which it co-administers with the Polar Continental Shelf Project (PCSP). In CCAR's second year of operation a new Board was appointed to the Canadian Polar Commission (CPC). CCAR devoted considerable efforts to briefing the new CPC members about the significance of Antarctic and bipolar research for Canada. Over the first two-year period we have been operating under interim Terms of Reference, and these have now been finalized in consultation with CPC.

CCAR has been active on various fronts in raising general awareness of Antarctic issues. Most of the CCAR members and advisers have been involved in interviews with the media on a myriad of Antarctic and bipolar subjects, ranging from global climate change to RADARSAT to life at the bottom of the Ross Sea. The production of this newsletter remains an important part of our awareness and education mandate, but we have also been involved in other related activities. For example, CCAR has facilitated the visit of senior Canadian officials to the Ross Sea sector of Antarctica via the New Zealand Antarctic Programme. Minister David Anderson and John Davis (Assistant Deputy Minister, Fisheries and Oceans Canada) took up the invitation in 1999, and Dr. Peter Adams, MP, was similarly hosted by Antarctica New Zealand in January 2000 (see his article in this issue).

CCAR's most important contribution to date has been to initiate a strategic plan for Canadian Antarctic and bipolar science. Our discussion document was released in 1999 and prompted excellent feedback from many quarters, including government departments, politicians, university personnel, and private enterprise. CCAR organized a workshop on this subject in Calgary in October 1999, and a bilingual report of the proceedings has been published by the Canadian Polar Commission. This report lists more than 75 scientific publications since mid-1997 with a Canadian bipolar or Antarctic component — a timely reminder that we have a significant base of polar expertise in Canada on which to build.

Our next step is to incorporate suggestions and to begin to implement the plan and workshop recommendations. An idea that was enthusiastically endorsed at the workshop was to set up a Canadian foundation for Antarctic and bipolar research that would seek private as well as public sponsorship for supplemental support (e.g., for travel) to Canadian scientists, including students, wanting to conduct research in Antarctica or to undertake bipolar studies. This organization would be separate from CCAR and CPC, and planning for such a foundation is now well underway. A Foundation Steering Committee has been established, with members Olav Loken (CCAR), Wayne Pollard (McGill University), Pat Shaw (Marine Expeditions), and myself (Universitè Laval).

Another important news item for Canada's high-latitude science community is that CCAR is joining forces with an Ontario-based company in an exciting new Antarctic/bipolar educational venture called "Students on Ice" (see "News in Brief" for more details). You'll be hearing much more about this, the Foundation, and other new CCAR activities over the course of the year ahead.

Warwick F. Vincent is Chair of the Canadian Committee for Antarctic Research.

Antarctic Ice Mass Change and Crustal Motion

Thomas James

During the last ice age the weight of the Laurentide ice sheet depressed the Earth's crust in northern Canada, and, with the disappearance of the ice, the crust rebounded. This is not an instantaneous process, but extends over thousands of years. For example, the port of Churchill on Hudson Bay is still rising at a rate of approximately 1 cm/year. Studies of ice marginal features and raised beaches dated by radiocarbon methods have made it possible to develop a comprehensive picture of the rebound patterns. I use estimates of ice sheet advance and retreat as input to computer models, or simulations, of how the Earth's crust responds to a changing surface load to explain the observed rebound patterns.

Antarctica presents some special difficulties in trying to determine its past mass balance because it is still largely ice covered, and there are relatively few ice marginal features and raised beaches to establish ice sheet history and uplift patterns. Other methods must be found, and I have focused on developing models of ice sheet history and crustal movements based on similar work in Canada, and incorporating our current state of knowledge about the history of the Antarctic ice sheet. Figure 1 shows uplift rates from Antarctica predicted by a particular model of Antarctic ice mass change. The largest rates, nearing 15 mm/year, are expected at the base of the Antarctic Peninsula. A broad region extending from the Transantarctic Mountains (TAM) across the Ross Ice Shelf to Marie Byrd Land features smaller, but still significant, uplift rates. Other plausible histories produce different uplift patterns.

Modern satellite technology has made it possible to verify parts of the model by measuring the current rate of crustal movement. The method depends on making precise observations of vertical and horizontal crustal motion using Global Positioning System (GPS) technology. This research was initially assisted in the early 1990s by a Global Change Program grant from the National Oceanic and Atmospheric Administration (NOAA), and has proceeded in close collaboration with Erik Ivins of NASA's Jet Propulsion Laboratory (JPL). There is now a fairly even distribution of some 20 permanent GPS sites along the coast, operated by various nations. The longest-established of these sites (e.g., McMurdo Station) have already been operating for several years and have measured vertical displacement rates with a precision better than 1 mm/yr.

GPS installation at Mt. Coates, located in the Dry Valleys. Photograph Courtesy C. Raymond, JPL/NASA.

In the interior of West Antarctica, however, where the highest rates are predicted and the largest differences are seen between

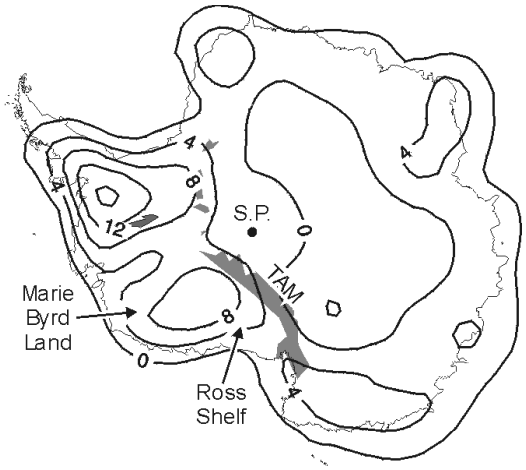

Figure 1. Predicted present-day uplift rates, in millimeters per year, for the D91 deglaciation model [James and Ivins, 1998].

different histories of Antarctic ice mass change, there are as yet almost no observations. But good progress has been made in developing semi-autonomous GPS stations for deployment at unattended sites (see photo). A team from JPL led by Carol Raymond has established two stations near McMurdo that have operated for several years and collected 40 to 100 days of observations per year during the Antarctic summer and fall (http://geodynamics.jpl.nasa.gov/antarctica/tam.html). The data quality is similar to that from continuous sites, but as the observations are only seasonal it will take longer to get comparable precision in uplift rates. Eventually it is hoped to have stations along the length of the TAM operating throughout most of the year. Other groups, using this or similar instrumentation, have established a limited number of sites at different locations.

GPS is not the only technique that gives information on present-day crustal deformation. Repeated gravity observations, either ground-based or satellite-derived, are sensitive both to present-day ice mass change and the internal mass redistribution causing crustal uplift. Owing to the differing sensitivities of different techniques to ice mass change and crustal response, it is important to integrate observations from as many techniques as possible. In this way we obtain a more detailed picture of the past history of the Antarctic ice sheet and make better predictions about its future behaviour and potential impact on global sea level changes.

In 1998, the Scientific Committee on Antarctic Research (SCAR) established a Group of Specialists on Antarctic Neotectonics (ANTEC) to guide future studies of the Antarctic neotectonics regime, including seismicity, volcanism, crustal deformation arising from plate boundary processes, and postglacial rebound. The group met during the European Geophysical Society conference in late April 2000, to review the current status of neotectonic research in Antarctica and to start developing a science plan identifying key research priorities.

These studies are in their infancy, but hold real promise for untangling the details of Antarctic ice-sheet mass balance. This is important for understanding the role of ice sheets in the climate system, and to put some limits on ice sheet changes and how these have affected sea level changes during the last few thousand years. Improved knowledge of the past will also help us predict future changes.

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Web site: http://www.pgc.nrcan.gc.ca/geodyn/ant_ice.htm

Tom James is a research scientist with the Geological Survey of Canada, Natural Resources Canada. E-mail: tjames@nrcan.gc.ca

Canadian Arctic–Antarctic Exchange Program

Bonnie Hrycyk

In the short time that the Canadian Arctic–Antarctic Exchange Program has been in operation, the benefits to participating Canadian research scientists have been notable.

Proposals to the program, which is designed to encourage exchanges between Arctic and Antarctic researchers, are reviewed by the Canadian Committee on Antarctic Research and Polar Continental Shelf Project's Science Screening Committee. PCSP delivers logistics support to projects involving Antarctic collaborators working with their Canadian colleagues in the Arctic each year.

Through the program, scientists from a number of Canadian universities — McGill, Laval, Saskatchewan, Ottawa,

Toronto — and government researchers have invited Antarctic colleagues from the U.S., U.K., Japan, Italy, and New Zealand to work in the Arctic with them; in turn, the Canadian research scientists and students have been hosted by their colleagues in Antarctica.

In 1998, Dr. Don McEwen (University of Saskatchewan) noted that his collaborations with Antarctic scientists enhanced the value of his Arctic research activities through interaction with key scientists in the Antarctic atmospheric program and allowed him full access to complementary Antarctic data, leading to joint publications.

Dr. Warwick Vincent (Laval) has noted that these exchanges provide benefits beyond simply allowing Canadian researchers and their students access to Antarctica. For example, he pointed out that the involvement of a scientist, Dr. Clive Howard-Williams, from the New Zealand Antarctic Program, was extremely valuable in the knowledge he contributed to students and other researchers involved in a recent Laval Arctic field program.

Dr. Wayne Pollard (McGill), who has invited U.S. colleagues to work with him in the Arctic and, with graduate students, subsequently worked at the U.S. McMurdo Dry Valleys Long-term Ecological Research site, indicated that he has gained a better understanding of systems operating in the Arctic through his work in the south polar region. In addition, he notes, the exchange has allowed him to establish a series of professional associations that will be beneficial over the long term. "There are benefits on many levels: as a teacher, a researcher, and member of the Canadian northern science community."

Dr. Hugh French, (Ottawa) who has worked with Italian colleagues on bipolar comparisons of high-latitute permafrost conditions, expects other faculty at his university to become involved in scientific exchanges in future. The collaborations supported through the exchange program, he notes, "...demonstrate a Canadian commitment to SCAR."

Bonni Hrycyk is Director of the Polar Continental Shelf Project.
E-mail: bhrycyk@nrcan.gc.ca

Some Recent Canadian Contributions to Antarctic and Bipolar Science

(Names of Canadian co-authors are underlined, except where all are Canadians)

De Mora, S., S. Demers and M. Vernet , 2000: *The Effects of UV Radiation in the Marine Environment*. Cambridge University Press. 320 p.

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NEWS IN BRIEF

Antarctic Treaty Consultative Meeting (ATCM) – XXIV ATCM was to be held in Poland in 2000, but last June, Poland announced that for economic reasons this would not be feasible. Recently, the Netherlands offered to host a Special Consultative Meeting in the Hague, September 11-15, 2000 to consider the report of the Committee on Environmental Protection which will meet at that time. There will also be informal discussions of other issues.

"Students on Ice" Expedition, December 27, 2000 to January 8, 2001, to Antarctica is an historic opportunity for 100 high school students from across Canada to explore and experience the mysteries and wonders of Antarctica. The Canadian Committee for Antarctic Research is assisting in the development of the expedition's educational program. Other partners of Students on Ice include *Canadian Geographic*, the Canadian Museum of Nature, and Marine Expeditions Inc.

Expedition leader Geoff Green, a veteran of 50 expeditions to Antarctica, is the director of Students on Ice. One of his goals is to have at least one student participating from every province and territory. The expedition will also have a live interactive website, allowing students from around the world to participate vicariously in the journey. Students on Ice is planning to run a similar program to the Arctic in the Summer of 2001. For more information contact: Tel.: (613) 392-2207 E-mail: studentsonice@reach.net Website: www.studentsonice.com

Valèrie Villeneuve, **MSc candidate at Laval University**, participated in an international research project on the McMurdo Ice Shelf in January – February 2000. She was hosted by New Zealand under the terms of the Canadian Arctic–Antarctic Exchange Program. Her research has been on the microbial ecology of lakes and ice shelf meltwaters in the Canadian High Arctic, and the trip to Antarctica allowed her to make comparative measurements on analogous "cryo-ecosystems" in the south polar region. Her Antarctic research was funded by NSERC (Dr. Warwick Vincent), National Institute of Atmosphere and Water Research (Dr. Ian Hawes), and Antarctica New Zealand.

Yannick Huot, **MSc. candidate in oceanography at Dalhousie University**, was among 24 students who participated in the Antarctic Marine Biology course at McMurdo station last January run by the National Science Foundation (United States). Students from anywhere in the world can apply for this all-expenses-paid course, and applicants from six countries were selected for the January 2000 course.

Prof. Peter Suedfeld, **University of British Columbia**, was the Senior Editor for the special Issue on "International Research in Antarctic Psychology" recently published by the journal *Environment and Behavior* (Vol. 32.1, Jan. 2000). The issue contains eight papers, three of them reporting results of studies within three national Antarctic programs, the others with more general aspects of psychological adjustments within isolated groups.

Prof. Louis Legendre, **Laval University**, was co-convenor of a special session on biological, chemical, physical, and sedimentological interactions in polynyas held during the Conference of the American Society of Limnologists and Oceanographers in Copenhagen, June 5-9, 2000.

Bonni Hrycyk, is stepping down from CCAR this year but will be remaining as Canada's member to COMNAP (Council of Managers of National Antarctic Programs). Her participation in COMNAP is proving to be an excellent opportunity for exchanging expertise in science logistics between Canada and operators in the south polar region.

NEWS IN BRIEF (CONTINUED)

FARO Looking at Links with COMNAP — At the third annual meeting of the Forum of Arctic Research Operators (FARO), held in Cambridge, U.K., during Arctic Science Summit Week in April 2000, a number of ideas were discussed in terms of establishing links with COMNAP.

Among the ideas raised were a system to exchange information between FARO and COMNAP on a regular basis, and the possibility of the chairs of FARO and COMNAP attending each other's annual meetings and reporting on their respective activities.

At its most recent meeting, FARO established two working groups — one, with Dr. Tom Pyle, U.S.A., in the lead, to examine the feasibility of establishing a circum-Arctic environmental monitoring network, and second group, to be chaired by Dr. Mario Zuchelli, Italy, co-ordinating a technology seminar, possibly jointly with COMNAP, to be held during a future Arctic Science Summit Week.

FARO's next meeting will be held during the 2001 Arctic Science Summit Week in Iqaluit, Canada, in the week of 22 April 2001.

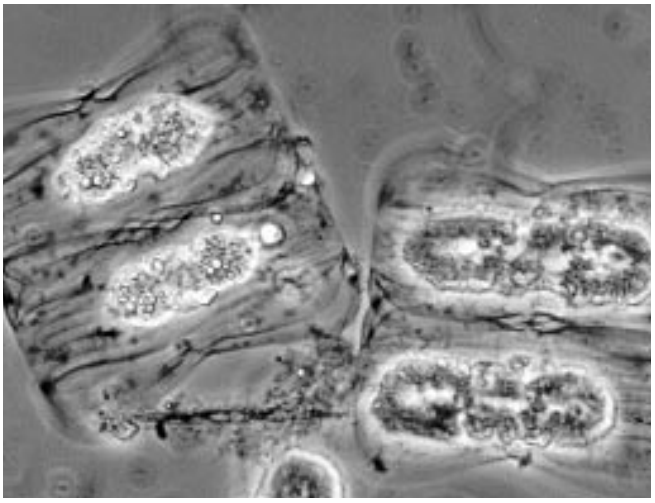
The report on the Calgary Workshop, held to exchange viewpoints regarding the report "Antarctic and Bipolar Science: A Strategic Plan for Canada" is now available. It includes a bibliography of Canadian contributions to Antarctic and bipolar science since mid-1997 as an appendix. Please contact the Canadian Polar Commission to obtain a copy.

Studying Antarctic Diatoms

Michel Poulin

At the invitation of Catherine Riaux-Gobin of Laboratoire Arago in Banyuls-sur-mer, France, Michel Poulin of the Canadian Museum of Nature in Ottawa took part in a scientific mission to Adélie Land. He spent two and a half months at the French base Dumont d'Urville (66° 40'S, 140° 01'E). The invitation was the result of fruitful co-operation that has now been going on for four years between the Museum and Laboratoire Arago.

The purpose of the project was to study the role of high concentrations of sea ice diatoms in the dissociation of the nitrogen and silica cycles in Antarctic coastal zones and their development at break-up. The mission began in early November and ended in December 1999. Daily samples were taken at a fixed station located 0.5 from the base, and the following parameters were measured: ammonium, nitrites, nitrates, phosphates, silicates, light intensity, salinity, temperature, pigments, and cell count. The time study will be based on a near-perfect sequence of 28 days, with interruptions



Amphirprora kufferathii

caused by extreme weather conditions. For each visit, the sampling consisted of extracting three sea ice cores and taking from the bottom 10 cm the free ice crystals that rise in the drilling well and the water beneath to a depth of 5 m.

Observation of microalgae *in vivo* with an optical microscope improved our knowledge of the communities both

in the ice and in the waters beneath. The first impression is that the assemblages of micro-algae are dominated by diatoms such as *Nitzschia stellata Manguin, Amphiprora kufferathii Manguin* and *Berkeleya adeliensis Medlin*. An abundance of small chlorophyl cells (coccolithophores, euglena, cryptophycea, choanoflagellates) was also observed, to be identified later. These preliminary optical microscope observations enabled some forty species of microalgae to be recognized, but there is no doubt that a number of other species will be added as analysis proceeds.

Interestingly, the assemblages in Antarctic sea ice are totally different from those observed in the Canadian Arctic. Although in both cases diatoms with a raphe are dominant, the composition of species is very different. Almost the same genera of diatoms are found, but the biological diversity is greater in sea ice in the Canadian North, with three times as many species. It would be most interesting to compare the two types of environment.

Michel Poulin's participation in this Antarctic mission was made possible mainly by the support offered by the Institut Français pour la Recherche et la Technologie Polaires, but also by the Canadian Museum of Nature.

Michel Poulin is a scientist with the Canadian Museum of Nature's Research Division, P.O. Box 3443, Stn. D, Ottawa, Ontario K1P 6P4; Tel.: (613) 566-4788 Fax: (613) 364-4027 E-mail: mpoulin@mus-nature.ca

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Symposium of the Association des diatomistes de langue française, Centre Universitaire, Luxembourg. September 8-11.

Letter from the CPC

The terms of members of the Canadian Committee on Antarctic Research (CCAR) expired March 31, 2000. As one of the Committee's final actions, they prepared a list of nominees for membership on the next CCAR. The list of nominees was reviewed by the Board of Directors of the Canadian Polar Commission at the May 7, 2000 meeting in Quebec City at which time six individuals were approved to lead CCAR into the new millenium. Their appointments will be staggered to ensure continuity on the committee.

On behalf of the Commission, I would like to extend a special thanks to all the members of CCAR for their dedication and hard work in dealing with Antarctic issues. Sincere thanks to Ms. Bonni Hrycyk, Director, Polar Continental Shelf Project, Natural Resources Canada; Dr. Kathleen Conlan, Research Scientist, Canadian Museum of Nature; Dr. Eddy Carmack, Research Scientist, Fisheries and Oceans Canada; and Prof. Peter Suedfeld, Department of Psychology, University of British Columbia. Thanks also to CCAR's special advisers, Prof. Wayne Pollard, Department of Geography, McGill University, and Dr. Fred Roots, Science Advisor Emeritus, Environment Canada, for their support and commitment. I would also like to acknowledge and thank the Chairman of CCAR, Prof. Warwick Vincent, Department of Biology, Laval University, for his dedication and leadership, as well as the Secretary of CCAR, Dr. Olav H. Loken, Consultant, Ottawa, Ontario, for his commitment and hard work.

For the year 2000, CCAR will consist of Prof. Warwick Vincent returning as Chairman, Dr. Kathleen Conlan, Dr. Eddy Carmack, Prof. Peter Suedfeld, Prof. Wayne Pollard, and Dr. Olav H. Loken who will also remain as Secretary. Dr. Fred Roots will also remain as a special adviser.

The Canadian Polar Commission looks forward to working with CCAR in the advancement of scientific knowledge and in the facilitation of Antarctic and bipolar research.

Steven C. Bigras
Executive Director, Canadian Polar Commission

Information Update

Please assist us in updating your information on the CCAR mailing list and the CPC's Directory of Polar Researchers. Fill in the form below and return to:

Alan Saunders
Manager, Communications and Information
Canadian Polar Commission
Suite 1710, Constitution Square
360 Albert Street
Ottawa, Ontario
K1R 7X7

Last name: _____

First name: _____

Title: _____

Institution: _____

Department: _____

Web URL: _____

Street: _____

City: _____

Province/State: _____

Country: _____

Postal code: _____

Telephone: _____

Fax: _____

E-mail: _____

Have you conducted research in Antarctica?

_____

Main field of research: _____

_____

_____

_____

Related fields: _____

_____

Years worked in Antarctica: _____

First year: _____

Will you be returning to Antarctic to conduct research in the near future?

List titles of four recent papers, books, articles, etc. dealing with Antarctic:

Questions/Comments:

CCAR/CCRA Members and Advisers

CARN Newsletter

CANADIAN POLAR COMMISSION
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Please send editorial correspondence to:
Alan Saunders
Editor, *CARN Newsletter*
Canadian Polar Commission
Suite 1710, 360 Albert Street
Ottawa, ON K1R 7X7
Tel.: (613) 943-8605, Fax: (613) 943-8607
E-mail: saunders@polarcom.gc.ca
www.polarcom.gc.ca/ccarhome.htm