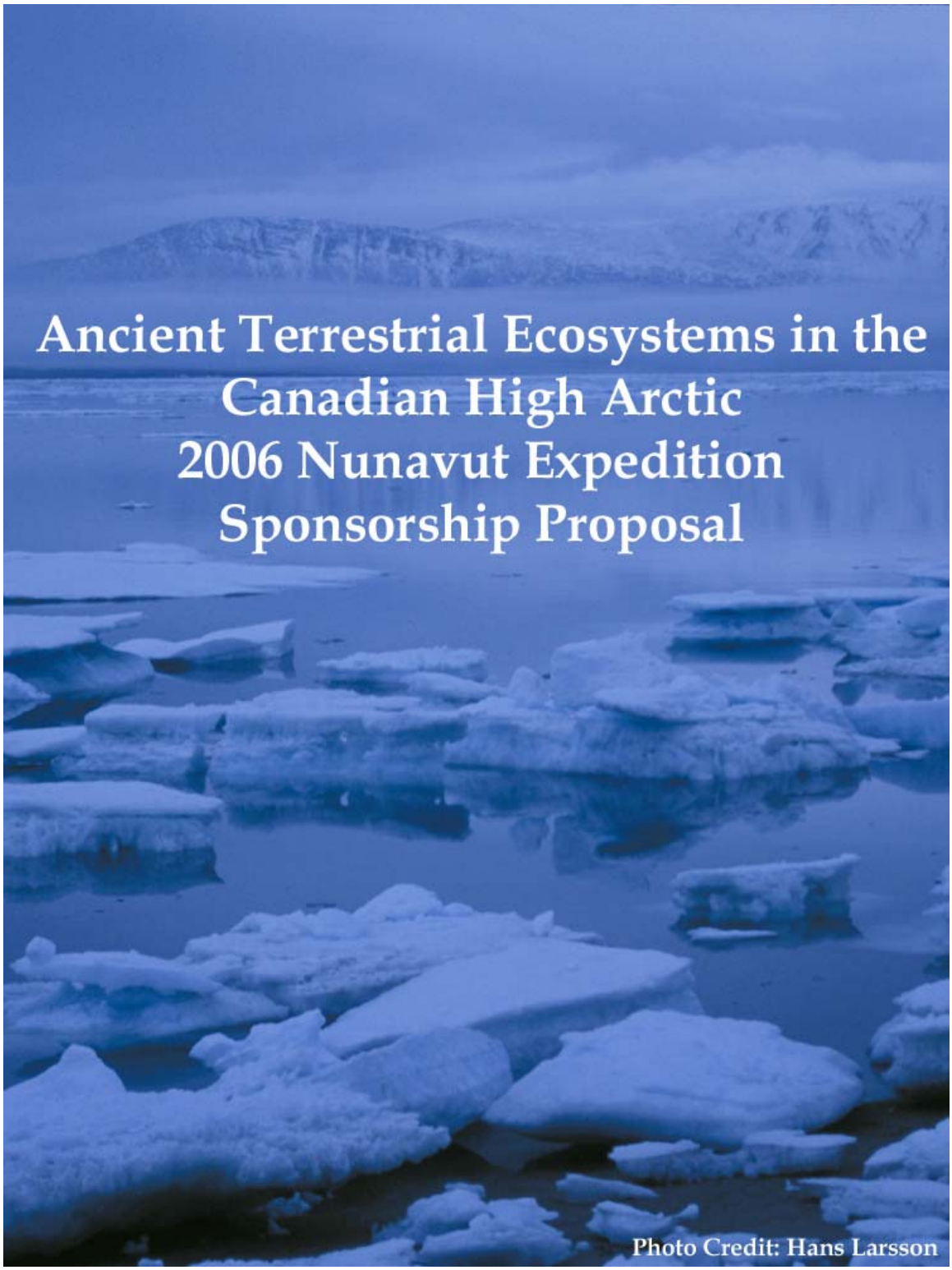
Ancient Terrestrial Ecosystems in the Canadian High Arctic
2006 Nunavut Expedition
Sponsorship Proposal
Photo Credit: Hans Larsson

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2006 Nunavut Expedition
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Summary

Our trip is primarily scientific in nature, and will be exploring various regions in the High Arctic for fossil remains of plants and animals. Our primary research goal is to learn more about global climate change and how it has changed in the past and may change in the future. Our party is made up of 11 members, all of whom have previous palaeontological field experience, and several of whom have previous Arctic experience. Our expedition will last for approximately one month, with most of the time spent actively hiking and searching for new fossil bearing localities. From June 24th to July 27th 2006, we will be traveling to Ellesmere, Cameron and Melville Islands in Nunavut, Canada, all of which are several hundred kilometres away from the nearest permanent structures. These locations are also near or above the Arctic Circle, and so we will be experiencing close to 24-hour daylight.

Introduction and Background

The Canadian Arctic is an extremely vast and relatively unexplored region in general, and especially in reference to paleontology. The existence of fossils in the region was first discovered in 1853, yet since this time, very little palaeontological exploration has been conducted (Tozer 1963; Ash and Basinger 1991). One of the most obvious reasons for this is the inaccessibility of the region and the short time period available each summer for expeditions. The Arctic holds great potential to increase our knowledge and understanding of the ancient world, in several respects. To date, much palaeontological work has been conducted in northern temperate regions, specifically southern Canada, the USA, and Europe. While the exploration of these regions has provided vital information about extinct ecosystems, little is known about extreme northern locations. Exploration of this region has the possibility for discovery of many new species unknown to science, as well as better understanding extinct ecosystems.

In the Mesozoic era (244 to 65 million years ago), the High Arctic was a very different place. At the beginning of the Triassic (248 to 206 million years ago) all the

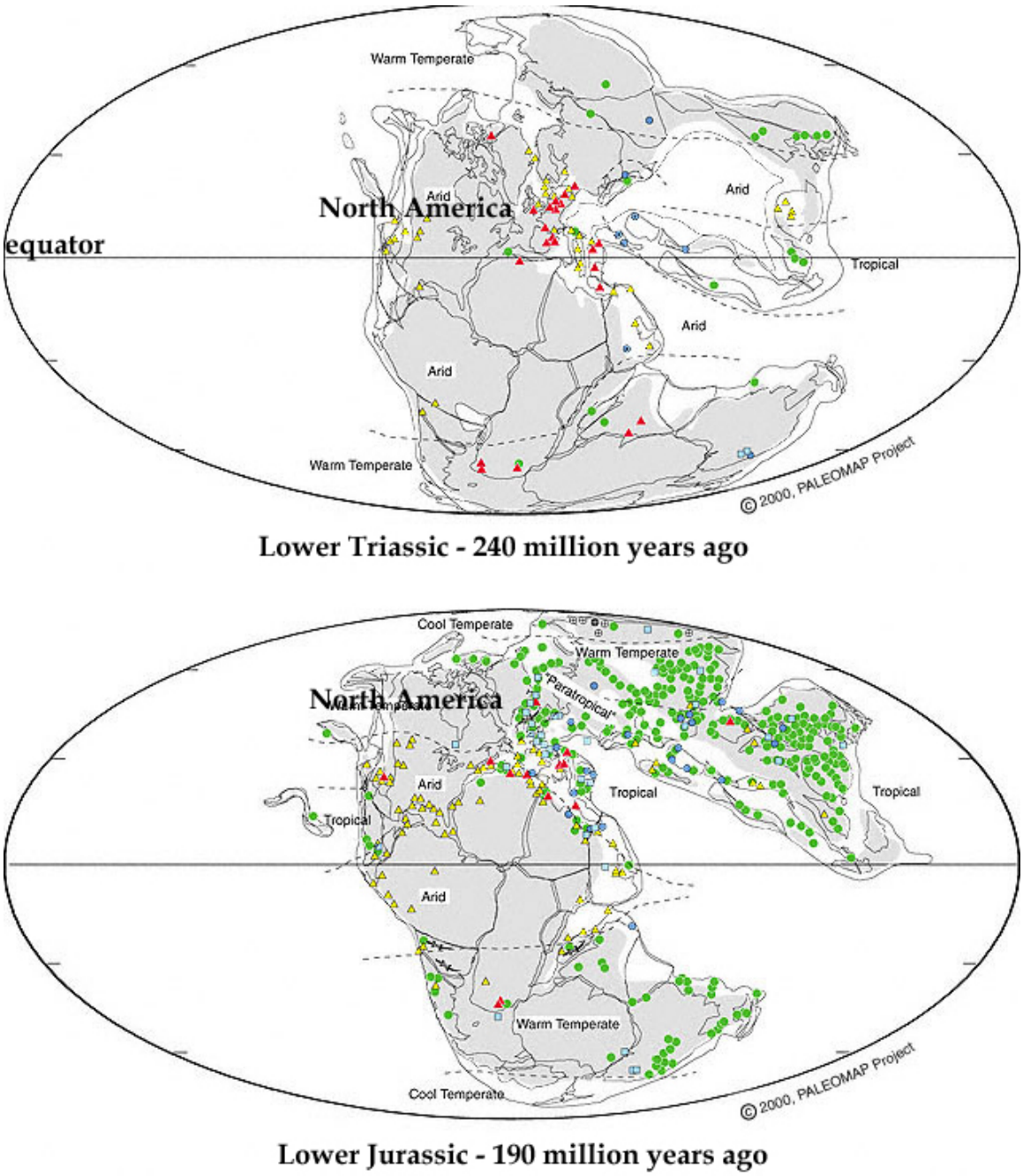
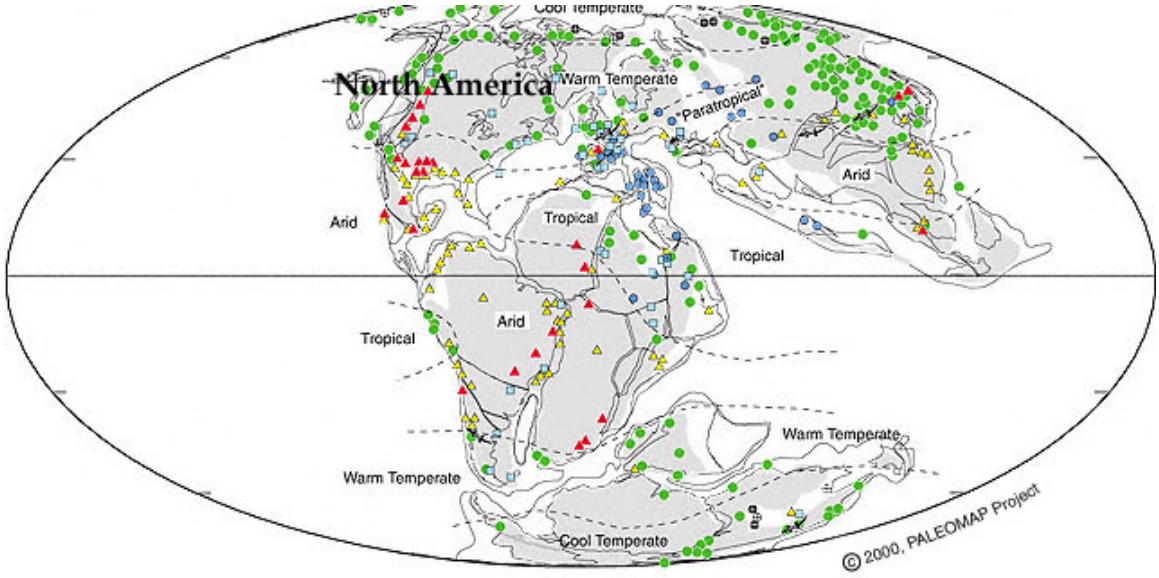
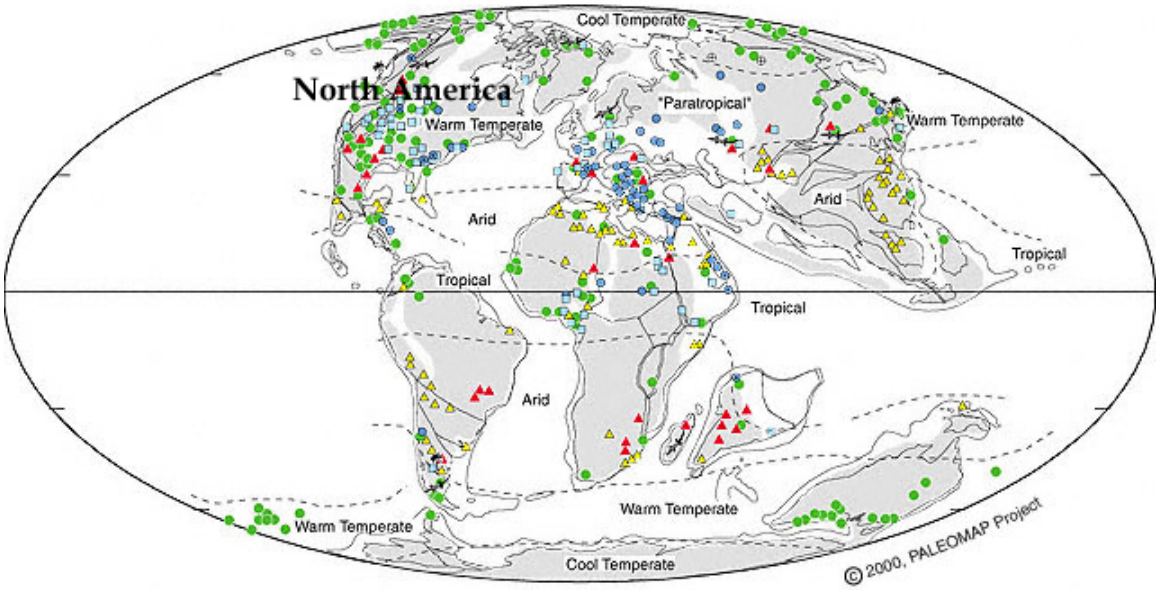


Figure 1: Climate and continent positions during the Lower (Early) Triassic and Lower (Early) Jurassic. Note that during the Triassic North America was much closer to the equator than today, and that it was slowly drifting northwards during this time. Also, much of North America experienced hot, dry conditions during the Triassic, and the climate became gradually cooler and wetter by the Jurassic. Images adapted from www.scotese.com.

continents were assembled into a large super-continent near the equator called Pangaea. During this period, North America was moving from a position approximately 30 degrees further south than present to its current location (Fig. 1), leading to a major difference, especially in the northern latitudes, in both temperature and photoperiod (Ash and



Lower Cretaceous - 140 million years ago



Upper Cretaceous - 65 million years ago

Figure 2: Climate and continental position during the Cretaceous. Note that by the Lower (Early) Cretaceous North America was near its present day position, but that the climate was much warmer than today, especially at high latitudes. The temperature increased slightly into the Upper (Late) Cretaceous. Images adapted from www.scotese.com.

Basinger 1991). Much of the continent was experiencing very warm, dry conditions, much like those of the American southwest today. As time progressed, North America began to move further and further north. The Jurassic (200 to 144 million years ago; Fig. 1) saw the climate become cooler and wetter, especially in the Arctic. However, while it was cooling, the average temperatures were much higher than today, and regions that are year-round permafrost today probably never dipped below freezing during this time. We

know from some fragmentary evidence that at this time much of the Arctic Islands were part of a large, temperate rainforest, which probably supported a host of animals like lizards, amphibians and dinosaurs. During the Cretaceous (144 to 65 million years ago; fig 2) global temperatures probably reached a maximum, with regions in the Arctic possibly 20 to 30 degrees warmer on average compared to today, with abundant precipitation and very little frost (Wolfe and Upchurch 1987).

These warm temperatures gradually cooled off during most of the Tertiary (65 to 1.5 million years ago), yet still remained higher than today. During the Pliocene (5.3 to 1.8 million years ago) the temperatures were cooler than they had been 60 million years previous, but were still roughly 15°C warmer in Arctic regions than currently (Ballantyne et al. submitted).

Intended Study Sites

Our expedition seeks to expand our knowledge of ancient terrestrial ecosystems at times of dramatic climatic change. The research will explore rocks that record terrestrial fossils that lived at times preceding the climate changes. This data is vital to begin to assess how these terrestrial ecosystems changed in response to climatic changes, and how they may change in the future as the Earth experiences much warmer conditions due to human induced greenhouse gas production.

Our team will be focusing its efforts in three different regions. The first locality we will be visiting is the most recent, and is located in Strathcona Fiord on Ellesmere Island, Nunavut (Fig. 3). This site, known as the Beaver Pond site, is 4 to 5 million years old and is unique among Arctic fossil localities because it preserves the remains of plants (mosses, leaves, and tree trunks), along with vertebrates (fish, birds, mammals) and invertebrates (insects, mollusks). Early work on the site has yielded important insights into animal migration and dispersal during this time. The warm temperatures of the Beaver Pond site might correspond with a thermal maximum during the Pliocene, a period in Earth's history when climatic boundary conditions were largely similar to today (Dowsett et al. 2004; Elias and Matthews 2002). Thus, the Beaver Pond locality may provide insight into the biotic impacts of current Arctic warming. The habitat represented by the Beaver Pond deposit was a boreal forest margin dominated by an extinct larch, and associated with at least 34 other species of vascular plant (ex. birch, alder, grasses) and 10 species of mosses (Harington 2001). Research on the vertebrate component of the Beaver Pond assemblage has yielded unexpected findings. For example, most of the mammals (e.g. horse, deerlet, shrew, and badger) are more closely related to Asian groups than North American forms (Tedford and Harington 2003).

The Beaver Pond is also important because it represents a period of significant warming. Recent estimates suggest that the mean annual temperature was roughly 15°C warmer than it is in that region currently (Ballantyne et al. submitted). The warm temperatures of the Beaver Pond site might correspond with a thermal maximum during the Pliocene, a period in Earth's history when climatic boundary conditions were largely similar to today (Dowsett et al.2004; Elias and Matthews 2002). Thus, the Beaver Pond locality may provide insight into the biotic impacts of current Arctic warming.

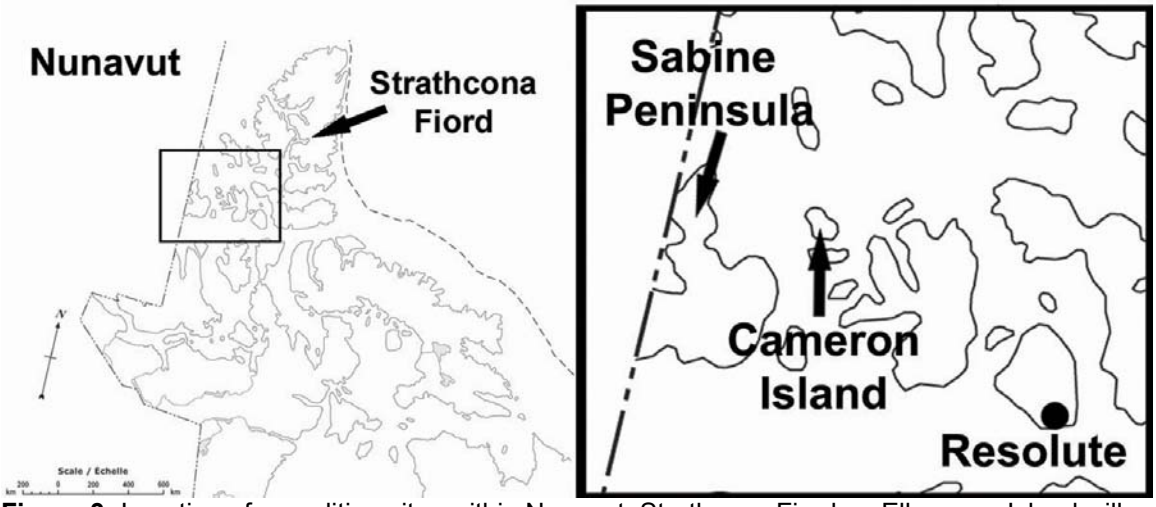


Figure 3: Location of expedition sites within Nunavut. Strathcona Fiord on Ellesmere Island will be our first destination, but we will spend the majority of our time backpacking across Sabine Peninsula on Melville Island. The closest settlement of any kind to these sites is Resolute, a small town with weather, military and research facilities on Cornwallis Island.

After excavating portions of the Beaver Pond site Rybczynski's team will prospect similar deposits in the Bay Fiord region for evidence of plant and animal fauna. Concurrently, a group lead by Hans Larsson will travel to the Sabine Peninsula of Melville Island to explore Triassic rock formations (~ 240 million years old; fig. 3). Triassic fossils from the High Arctic will provide evidence for early high-latitude communities, setting the stage for subsequent evolution of terrestrial ecosystems. Previous work in 2004 on Axel Heiberg Island yielded a locality with a remarkably high diversity of plant fossils (Vavrek et al., in review).

Only one terrestrial vertebrate fossil from Triassic-aged rocks has been found, to date, in the Canadian High Arctic. A neck vertebra of a reptile closely related to birds and crocodiles was collected from Rendezvous Point on the northwestern shore of Cameron Island by a crewmember of a ship captained by Sherman Osborn during a search for the lost Franklin expedition from 1852 to 1854. The fossil was eventually described by in 1875 and is currently housed in the National Museum of Ireland, Dublin. Rendezvous Point, Cameron Island and the southern region of the Sabine Peninsula of Melville Island will be prospected for 3 weeks. Triassic outcrops in these regions offer a chance to investigate not only western High Arctic plants to compare with those from Axel Heiberg, but to also prospect the rocks that have historically yielded the only terrestrial animal fossil from Triassic times. Finds in these rocks would significantly improve our understanding of the terrestrial ecosystems during the Triassic Period, the beginning of the Mesozoic Era.

Our ongoing group project is investigating in detail the biodiversity, productivity and provinciality in the Canadian Arctic during this time. Most of the data we have for the Arctic during this period comes from Alaska, Siberia and Greenland, while the number of fossils recovered from the Canada is extremely small. The main reason for this is not the lack of fossils in the area, but rather a lack of search effort, and so our goal is to change this.

By combining the data from productivity and diversity we hope to gain a more precise understanding of the ecological trends occurring across North America in the plant community at this time, such as provinciality and the floral response to long-term climatic changes on the order of millions of years. As well, questions about long-term changes in global temperatures at high latitudes can be examined.

Expedition Details

Group members – our group will be made up of 11 members:

Trip Leaders

Dr. Hans Larsson – Canada Research Chair in Vertebrate Palaeontology, McGill University, Montreal, Quebec
Dr. Larsson is an Associate Professor at McGill University, specializing in evolution of archosaurs (birds, crocodiles and dinosaurs). His research utilizes several different approaches, using developmental data from modern animals and using the fossil record to search for patterns in how these groups have evolved into their present state. He has participated in two previous expeditions to the Arctic, gaining valuable experience for operating in the region.

Dr. Natalia Rybczynski – Research Scientist, Canadian Museum of Nature, Ottawa, Ontario
Dr. Rybczynski is an expert on fossil mammals, especially rodents and their relatives. Much of her research has focused on the chewing apparatus of terrestrial herbivores, and comparisons between fossil mammals and reptiles. Interesting outcomes of her research has led to a new understanding of the functions and origins of woodcutting in beavers. Her interests also include evolution of Mesozoic and Cenozoic terrestrial communities in the Canadian Arctic. She has also participated in five previous Arctic expeditions, including four to the High Arctic, bringing a great deal of experience in organizing and coordinating our efforts in this harsh environment.

Team Members

Ashley Ballantyne – Duke University, Durham, North Carolina, USA
As a PhD student at Duke University, Ashley is interested in interactions between the Earth's atmosphere and biosphere and how these interactions have changed through geologic time. He is currently working on sediments obtained from Lake Titicaca, South America, to determine the record of climatological, biological and geological processes that have occurred in the lake over the last million years. As well, he has recently submitted a paper along with Dr. Rybczynski on the temperatures in the High Arctic 5 million years ago. He has participated in expeditions to South America and California, and is an avid skier and climber.

Carter Cox – Crowsnest Pass, Alberta
Carter is a high school teacher and science educator in Alberta. He has a great deal of prospecting experience in the southern Alberta Badlands. During the summer he gives guided canoe and hiking tours through the region, educating both the young and old on

the geology and evolution of the area. He has a great deal of outdoor experience from hiking and camping around his home town of Crowsnest Pass.

Maria de Boef – McGill University, Montreal, Quebec
Maria is interested in bone histology and microstructure. By examining the bones of ancient animals, we can gain important insights into their behaviour and ecology. An important aspect of this trip for her is finding possible evidence for or against the theory that dinosaurs migrated, much as modern caribou in the region do today. This can be investigated by examining the growth patterns in ancient bones. She spent several weeks last summer in southern Alberta doing a course in field palaeontology.

Alex Dececchi – McGill University, Montreal, Quebec
Alex is an MSc student studying changes in dinosaur limbs and how they evolved into bird wings. Work in this region is important for him as the areas we are traveling to are dated from the same time as the origin of flight in vertebrates, and so may yield important fossils for his studies. He has participated in previous fieldwork in Alberta and Newfoundland, and is an active athlete in wrestling and rugby.

Dara Finney – Canadian Museum of Nature, Ottawa, Ontario
Dara is an experienced environment and health scientist and educator currently working with Environment Canada. She has coordinated and led a number of multi-month community development projects and expeditions in North America, Australia and the South Pacific, and will be the team logistic and communications expert. Dara will be using the research obtained from the Artic to develop educational components for schools and community organizations across Canada.

Erin Maxwell – McGill University, Montreal, Quebec
Erin is a Ph.D. student who is interested in the evolution and diversity of ancient aquatic reptiles. She has recently co-published a paper describing a new species of ichthyosaur, a type of reptile which looks very similar to modern dolphins. As well as naming this new species, she showed evidence that the animal was pregnant at the time that it died, with embryos preserved inside it. She has spent summers in the High Arctic, Saskatchewan and Alberta doing field research.

Dr. Francois Therrien – Royal Tyrrell Museum of Palaeontology, Drumheller, Alberta
Dr. Therrien is an expert in the reconstruction of ancient ecosystems, combining various aspects of geology and paleontology to reconstruct the habitats and climate in which dinosaurs lived. Dr. Therrien Master's degree involved the reconstruction of a Late Triassic palaeoenvironment of early carnivorous dinosaurs, and his PhD in consisted of a reconstruction of the Late Cretaceous palaeoenvironments of dinosaurs in Romania. He is currently employed as a postdoctoral fellow at the Royal Tyrrell Museum where he studies environmental and climatic changes at the end of the Age of Dinosaurs. During his career, Dr. Therrien has led several field expeditions in the forested mountains of Romania and in the arid badlands of the American southwest and Alberta, and is experienced with fieldwork in isolated and inhospitable regions.

Sylvie Tissandier – McGill University, Montreal, Quebec

Sylvie is completing a MSc in changes in morphology of fish fins. This trip may lead to the discovery of important new fossils for her research. As well as taking a course in field palaeontology, she has spent several summers coordinating a public field research program at the Royal Tyrrell Museum of Palaeontology in Drumheller, Alberta. She grew up in the Rocky Mountains, and has a great deal of experience in outdoor pursuits.

Matthew Vavrek – McGill University, Montreal, Quebec
Matthew is a Ph.D. student at McGill University, specializing in biodiversity and productivity of ancient ecosystems. He is the team's plant expert, and is most interested in discovering the fossil flora of the area. He has spent several summers doing field research in British Columbia, Saskatchewan, Alberta and Lebanon. He spends spare time canoeing, kayaking and mountain biking.

Travel Itinerary

We will be traveling by commercial aircraft from Montreal, Quebec and Ottawa, Ontario through Iqaluit, Nunavut on our way to our final destination of Resolute, Nunavut. From Resolute we will be flying by Twin Otter bush plane to Strathcona Fiord, Ellesmere Island (approximately 80 degrees North) where we will be excavating the Beaver Pond locality. We will be at this site for approximately one week, weather permitting. Once this work is completed, our group will split in two, with one group led by Natalia Rybczynski and the other by Hans Larsson. The Rybczynski team will remain in the Bay Fiord region to prospect similar deposits for plant and animal remains. This will be accomplished by establishing a series of fly camps. The Larsson team will return to Resolute, resupply and take a Twin Otter to Sabine Peninsula on Melville Island. While here they will be backpack camping across the peninsula, prospecting for new fossil producing sites. Expectations are to cover 10 to 20 kilometres a day, so as to search as much ground as possible in the short time available. This portion of the trip on Melville Island will take approximately two and a half weeks. After this, the Larsson team will travel back to Resolute and most of the group will remain there to prepare the gear and specimens collected for transport back to Montreal and Ottawa. However, Hans Larsson and Matthew Vavrek will be travelling by helicopter to Cameron Island. While on Cameron they will be spending three days prospecting several localities where fossils have been found by previous 19th Century expeditions. At that point, Larsson and Vavrek as well as the Rybczynski team will return to Resolute for a final debriefing before returning to Montreal and Ottawa.

Trip Preparation

Current preparations are underway for the summer. Funding for logistical support has been secured from the Polar Continental Shelf Project (PCSP), McGill University, Canadian Museum of Nature, and National Geographic. As well, several individuals have applied to the Northern Scientific Training program to support transport to the Arctic. Transport while we are in the Arctic has been arranged through the PCSP, and they will be providing us with communication support as well. Also, we have our own satellite phone should an emergency arise.

All necessary permits (Nunavut Palaeontologist Permit, Land Use Permit (Indian and Northern Affairs)) are in the final stages of approval. As well, all of the members on the team have at least a basic level of First Aid, and four members have training in Wilderness First Aid, with a special emphasis on Arctic and cold regions. As we will be in regions with polar bears, several members do have their firearms licenses to carry a shotgun, and two more will be completing a course before we leave to obtain one.

Environmental Impact

The Arctic may seem to some like a harsh, rugged place, but the ecosystems found there can be fragile. Our expedition will be sensitive to the local flora and fauna, as we will be concentrating our efforts and time on exposed rock surfaces. This is primarily because any attempt to prospect for fossils in areas covered by soil or vegetation is far too time consuming, as well as respecting the environment.

Photographic Potential

Our project is heavily dependant on high quality photography. We will be photographing all the localities that we will be exploring using several high quality cameras, as any material we publish on must be well documented. This means not only close in photographs of each specimen, but also wide-angle photos of the general outlay of the region the fossils were found in. This alone would be able to provide our sponsors with high quality photographs of a very remote region. As well, we will be photographing while we are moving from site to site, showing our group members wearing any sponsored gear in an extreme region with extreme climates.

Education and Outreach

In previous years, expedition members have given talks to widely different groups of individuals. Drs. Rybczynski and Larsson have both presented talks in the northern communities in which they were based, as well as public lectures in their home cities of Montreal and Ottawa. In addition to lectures intended for the general public, they have given several oriented towards a more scientific audience. As well, Matthew Vavrek has presented research on some of the fossils recovered from Axel Heiberg Island at a scientific conference. We are further investigating opportunities to present our research and findings to as broad an audience as possible, and would welcome any invitations from your organization to discuss our expeditions, both past and future, in any context. Please note that as our members do originate from several regions (Montreal, Ottawa, Drumheller/Calgary) making us readily available in a number of major centers, and that several of our team members are bilingual (English/French).

Press Coverage And Publicity From Previous Expeditions

In previous years, similar Arctic expeditions have garnered reasonable interest from major media outlets, such as CBC, BBC The Washington Post and The Globe and Mail (see list at end of section). This attention largely occurred as a result of a shorter and smaller expedition two years ago. The hope is that with this expedition that with a longer period and more people exploring that there is a much greater potential for finding even

more and better preserved remains. This trip is also concerned with changes in biodiversity and what ecosystems were like in the high Arctic when there were high temperatures in the region, leading to a better understanding of long term climate change.

National Geographic is providing some monetary support for this expedition, with the understanding that any interesting finds would be reported in the magazine, including photographs of the trip.

Manuscripts are also now being submitted to scholarly journals for publication on finds from previous years, as well as presentations (oral and poster) at many major scientific conferences. Any support for this project would be recognized in these articles and presentations.

Previous Press Coverage
CBC (http://www.cbc.ca/story/science/national/2004/10/19/dino_baffin041019.html)
BBC (http://www.bbc.co.uk/radio4/science/leadingedge_20040701.shtml)
Washington Post (http://www.washingtonpost.com/ac2/wp-dyn/A40810-2004Oct17?language=printer)
Science Daily (http://www.sciencedaily.com/releases/2004/10/041018084253.htm),
Alaska Science Outreach (http://www.alaskascienceoutreach.com/index.php/science_seen/item/tyrannosaur_fossils_found_in_canadian_arctic/)

Requested Items

As each region we will be visiting is hundreds of kilometers away from any permanent structures, we will be camping in tents for the entire trip. While PCSP has provided us with very durable tents, they are unable to provide sleeping bags. Each of us will require a sleeping bag rated to at least -15^{o}C, as well as some type of resting pad, as the temperatures can drop very low, even during the middle of summer. As well, each person will need a full wind and rain proof breathable jacket and pants, as if poor weather strikes during the middle of the day we will have no way to immediately find shelter. The ground in the area is permafrost, and during the summer the upper layers melt while the lower, frozen layers prevent the water from draining away, making the ground soft and wet. This means that each person must have sturdy waterproof hiking and a pair of gaiters. During the prospecting phase, we will be backpack camping, and so a solid, large volume (80L+) backpack will be essential. A smaller size is not an option as we will not only be packing our gear and food, but also any fossils that we find along the way. Because we will be hiking for such prolonged periods over difficult terrain, everyone should have a set of hiking poles to aid them. GPS units are also very important, as we will be in regions without any trails and a very poorly known topology, so it is essential that we can accurately map our location at all times. Other minor but important items are also needed, such as warm, waterproof gloves and hats/toques, thermal underwear socks, sunglasses/ski goggles, watches, multi-tools/knives, binoculars and socks.

Summarized List of Items

Primary Items Required:

Sleeping Bag (rated -15^{o}C or better)
Sleeping Pad
Waterproof, Breathable Jacket/Pants
Hiking Boots (waterproof) and Gaiters
Frame Backpack (80L+)
Hiking Poles
GPS

Secondary Items Required:
Waterproof Gloves and Hats
Neck Warmers/Balaclavas
Thermal Underwear
Socks
Sunglasses/Ski Goggles
Watches
Multi-tools (ie knives, etc)
Binoculars

Further Information Online

International Polar Year Proposal - Pliocene Forest Communities of the Canadian High Arctic - A Time Capsule for Climate-change Research
(http://www.ipy.org/development/eoi/proposal-details-print.php?id=320)
International Polar Year Proposal - Cretaceous – Tertiary Vertebrate Faunal Transition
(http://www.ipy.org/development/eoi/details.php?id=955)
Larsson Lab website
(http://www.redpath-staff.mcgill.ca/larsson/index.htm)
First known fossil chewing reptile
(http://news.nationalgeographic.com/news/2001/06/0607_chewer.html)

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Budget

Funding Sources

Grant Name	Amount	Confirmed	Pending
NSERC (Larsson and Rybczynski)	$5,000	X	
National Geographic (Rybczynski)	$17,000	X	
Canada Research Chairs (Larsson)	$6,000		X
Northern Science Training Program (de Boef, Dececchi, Maxwell, Tissandier and Vavrek)	$4,000 X 5		X
Canadian Museum of Nature, internal funding (Rybczynski)	$4,000	X	
Redpath Museum, internal funding (Larsson)	$1,000	X	
Royal Tyrrell Museum of Palaeontology, internal funding (Therrien)	$5,000		X
Polar Continental Shelf Project (Larsson and Rybczynski)	$72,000	X	

Total Estimated Grant Funding: $130,000

Most of the funding for the trip has already been confirmed, including the most important and largest grant, that from the PCSP. PCSP is the governmental agency which co-ordinates the transportation, communications, accommodations, field equipment and related services for researchers within the Canadian Arctic. By having this confirmation, our travel plans are relatively set with no major further organizational problems while we will be in the Arctic. Most of the other grants are to help cover food and transportation costs to the Arctic.

Expenditures

Trip Expense	Cost/person	Total
Commercial plane tickets to Resolute, Nunavut	$4,000 X 11	$44,000
Air support in Nunavut		$69,000
Equipment Rentals		$8,000
Lodging/meals in Resolute	$500 X 11	$5,500
Meals while camping	$500 X 11	$5,500

Total Estimated Expenses: $132,000

The largest expenditure by fair will be air travel to and support in the Arctic. The cost to fly on commercial airlines to Resolute is approximately $4000 per person, and while we are in the area helicopter and twin otter time is quite expensive. The other major costs are equipment rentals, which include tents and communication equipment, and food costs both while in Resolute and in the field.

Personal Gear Budget

Item	Cost
Sleeping Bag (rated -15^{o}C or better)	$300
Sleeping Pad	$75
Waterproof, Breathable Jacket/Pants	$500
Hiking Boots (waterproof) and Gaiters	$250
Frame Backpack (80L+)	$300

Hiking Poles	$150
GPS	$150
Waterproof Gloves and Hats	$75
Neck Warmers/Balaclavas	$40
Thermal Underwear/Socks	$100
Sunglasses/Ski Goggles	$100
Watches	$100
Multi-tools (ie knives, etc)	$80
Binoculars	$100

Personal Gear Total: $2320

While we obviously have a large budget for this expedition, what is not readily apparent is how the grant monies are awarded. All of the grants listed above are explicitly for logistical purposes, and are not allowed to be used for the purchase of personal equipment. Because many of our members are students our group is on a restricted budget, and so any possible donations of gear or any other support would be greatly appreciated.

Sample Images From Previous Expeditions