Plants, Fungi, and Palaeoclimate of High Arctic Fossil Forests (Nunavut Palaeontology Permit no. 04-03P) James Basinger

The modern Arctic is defined by a cold climate, with brief cool summers, and long cold winters. There is also seasonal change in sunlight as well, so that summers experience continuous daylight, and the winters are continuously dark. The fossil record of plants in the High Arctic, however, has shown us that the climate was much warmer in the geological past. Our earlier work on fossil forests of Axel Heiberg and Ellesmere Island has revealed that towering forests of redwoods, cedars, oaks, walnuts, birch, pine and many other types of trees grew throughout the Far North about 50 million years ago. Warm temperatures and continuous daylight in the summers promoted rapid, lush growth, while the dark winters caused most trees to become dormant at the end of the summer, shedding their leaves and waiting for the return of the sun in the spring.

Global temperatures declined after 40 million years ago, so that many of the warm-climate trees such as redwoods disappeared from the North. However, forests of spruce and larch, similar to forests now found around Great Slave Lake, existed throughout the High Arctic as recently as 3 million years ago. Fossils of trees and mosses, and fossil bones of many animals, have been discovered in the 3.5 million-year-old sediments near Strathcona Fiord on Ellesmere Island, these fossils indicate what life was like in the Arctic just before the beginning of the Ice Age.

By knowing the kinds of plants that grew in the ancient arctic, we can say something about the kind of climate that existed there. By studying the chemistry of the wood we can get even more information about climate. As trees grow, they deposit a continuous record of local climate in their wood. By studying the chemistry of the woods (stable isotopes of carbon, oxygen, and hydrogen), it is possible to interpret temperature, humidity, and rainfall experienced by the tree. This helps us to understand local and regional weather, climate, and seasonality.

We know that the Far North is very sensitive to global climatic change, making Canadians very concerned about the human-caused greenhouse effect and climate change. This sensitivity also means that the fossil record of climate in the North is the key to our understanding of global climates in the distant past. The High Latitudes act as a "thermometer of the world".

Our field work in 2004 was targeted at collecting good wood specimens for chemical analysis. We were mainly interested in woods from the last time when the Earth was very warm (45-million-year-old woods of Axel Heiberg Island), and from the last time that trees could survive in the Arctic (3.5-million-year-old woods of Ellesmere Island). To better understand the ecology and evolution of these forests, we also collected ancient and modern soil samples for remains of fungi that live in the roots of plants and are essential to healthy growth of most types of plants.

This work will help us to understand how vegetation and climate has changed in the North, and will tell something of the origins of the plants that we now find in the boreal and northern deciduous forests. This work will also contribute to an understanding of the relationship of global climate to northern climate and vegetation patterns, and may help us to predict the kinds of changes that may happen as a result of human-cause global climatic change.
Captions

Photo 1: One of the 45-million-year-old fossil forests of Axel Heiberg Island. The stumps are about 1 metre in diameter, and are preserved in the position in which they grew. The fossil woods are not petrified, but are still woody, and many are extremely well preserved. This unusually well preserved woods allows us to study the chemistry of the woods.

Photo 2: A 3.5-million-year-old log preserved in ancient river sands near Strathcona Fiord, Ellesmere Island. This fossil wood has been preserved in permafrost since it died. It is extremely well preserved, so that it can be analyzed with the same techniques used for modern wood samples. Jim Basinger (background); Adam Csank (M.Sc. student) is taping the log to hold it together before cutting his sample.